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PRACTICA DE DISEÑO Y CONSTRUCCION EN EL JAPON

COMENTARIOS SOBRE LAS NORMAS INDUSTRIALES JAPONESAS DE LA CALIDAD DEL CONCRETO

CENTRO NACIONAL DE PREVENCION DE DESASTRES
MEXICO

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COMENTARIOS SOBRE LAS NORMAS INDUSTRIALES JAPONESAS DE LA CALIDAD DEL CONCRETO

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COORDINACION DE INVESTIGACION

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PRESENTACION

Uno de los objetivos del Convenio de Cooperación Técnica entre la Agencia de Cooperación Internacional del Japón (JICA) y el Centro Nacional de Prevención de Desastres es la difusión en México de tecnologías y metodologías de diseño y construcción de estructuras en el Japón.

Estas prácticas y experiencias son descritas en conferencias o seminarios dictados, o bien mediante la traducción al castellano de los textos originales del japonés, por los expertos japoneses de corto y largo plazo que colaboran en las actividades de investigación del CENAPRED.

Para lograr una difusión más amplia de las tecnologías y metodologías del Japón, el CENAPRED ha emprendido la publicación de esta serie como parte de los Cuadernos de Investigación.

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COMENTARIOS SOBRE LAS NORMAS INDUSTRIALES JAPONESAS EN LA CALIDAD DEL CONCRETO

Editados por:
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Asesores japoneses del Proyecto de Prevención de Desastres Sísmicos
Traducidos del japonés al español por Keiko Suzuki.

PROLOGO

Al ejecutar una obra de construcción de concreto reforzado, el director responsable de la obra tiene que controlar las propiedades del concreto de manera que éstas cumplan con las especificaciones del diseño. Para controlar las caracteristicas del concreto es necesario determinarlas por medio de ensayes y pruebas; en Japón, los métodos de estos ensayes y pruebas están establecidos en las normas JIS. Las normas JIS relacionadas con las caracteristicas del concreto son 18, mismas que se incluyen en el anexo de esta publicasión. Las pruebas más frecuentemente utilizadas son: la prueba de resistencia, la de revenimiento y la de sangrado.

En esta publicación se explican, en forma resumida, los procedimientos de ejecución de estas tres pruebas, de acuerdo con las normas JIS. Los autores de los textos incluidos en esta publicación, el Ing. Kenzo Kishi y el Ing. Toshio Suzuki, trabajan en la Sección de Pruebas de Materiales no Orgánicos del Laboratorio Central del Centro de Pruebas de Materiales de Construcción, y son verdaderos expertos en estas técnicas.

Los tres textos fueron elaborados para la revista de difusión que tiene el Centro: **información sobre pruebas de materiales de construcción.** Los capítulos 1 y 2, 1989 y el 3, en 1990. Redactos originalmente en japonés, los textos fueron traducidos al español por Keiko Suzuki y revisados posteriormente por el Dr. Sergio Alcocer, del Area de Ensayes Sísmicos de la Coordinación de Investigación del CENAPRED. Agradecemos especialmente la valiosa colaboración que recibimos del Dr. Alcocer.

CAPITULO 1

Método de fabricación de muestras de concreto y de especímenes para los ensayos de resistencia

por
Kenzou Kishi

1. Introducción

Las propiedades físicas del concreto muestran valores diferentes dependiendo de los métodos de fabricación de muestras y de los especímenes utilizados. Por lo tanto, si los métodos aquí presentados no se llevan a cabo correctamente, es imposible conseguir datos confiables. Es este sentido, los métodos mencionados en este texto son fundamentales para los ingenieros y técnicos que se dedican a la investigación y pruebas del concreto.

En la fabricación de mezclas, el aspecto más importante es la proporción de los materiales utilizados, mientras que en la fabricación de especímenes para los ensayos de resistencia, los factores que más influyen son el control de superficie de los moldes, el método de muestreo y el método de compactación.

A continuación, se enumerarán los puntos más importantes de cada aspecto.

2. Método de fabricación de muestras en laboratorios (Cuadro 1)

2.1. Preparación de materiales

Las propiedades físicas del concreto fresco, como revenimiento, volumen de aire, fraguado y sangrado, y las diferentes propiedades físicas del concreto endurecido varían dependiendo de la temperatura en el momento de la terminación del mezclado, por lo que es importante mantener los materiales utilizados a una temperatura constante. En la norma JIS A 1138, se determina que la mezcla de las muestras de concreto se debe realizar en un laboratorio a una temperatura de 20±3°C. Al ajustar la temperatura de los materiales a este intervalo se puede lograr una mejor calidad del concreto.

Cuando la finura del agregado es variable, se presentan fluctuaciones en el volumen unitario de agua, en el porcentaje de agregado fino y en la cantidad necesaria de aireante para lograr el revenimiento o el volumen de aire determinados; es importante almacenar los agregados clasificados por su finura. En nuestro laboratorio, se tienen almacenados agregados finos clasificados en dos categorías y agregados gruesos en tres, según su finura, y se miden separadamente en el momento de utilizarlos, para mantener la distribución granulométrica necesaria.

La humedad de los agregados también produce grandes efectos en el revenimiento, en el volumen unitario de agua y en la resistencia. Es necesario mantenerlos en condiciones cercanas al estado seco superficial y además, lo más homogéneos posible. En este laboratorio, se mantiene la humedad del agregado fino agregándole agua en la cantidad correspondiente a la diferencia"entre el factor de absorción y el porcentaje de contenido de agua", o este valor más el 1% de agua, manteniéndolo en un estado con un poco de agua en su superficie; los agregados gruesos se ajustan con el lavado de agua primero y secándolos con tela después, y se conservan en un contenedor de plástico para que no se sequen hasta su utilización. Antes de utilizar estos agregados, se determina su contenido de agua, y se compensa la diferencia con el factor de absorción en el momento de la dosificación.

Cuadro 1

1.	Nombre de la prueba	Método de fabricación de concreto.
2.	Objetivo de la prueba	Conocer el método para fabricar muestras de concreto.
3.	Preparación de materiales	Los materiales que se utilizan en la fabricación del concreto deben estar a una temperatura de 20±3°C previos a su utilización. 1) Cemento: almacenar en un recipiente libre de humedad, para evitar su contaminación. 2) Agregados: reducir la disparidad de la finura y conservarlos a una humedad homogénea. 3) Agua: agua potable. 4) Aditivos: diluirlos según se requiera para aumentar la precisión en la medición.
4. Método de prueba	Resumen	Fabricar muestras de concreto homogéneo.
	Norma aplicable	JIS A 1138 (Método de fabricación de muestras de concreto en laboratorios).
	Dispositivos de la prueba	Revolvedora de concreto.
	Condiciones de la prueba	Temperatura 20±3°C, humedad igual o mayor al 60%.
	Detalles del método	1) Preparación de materiales: Los materiales utilizados deben estar a una temperatura de 20±3°C, y los agregados en estado saturado de agua con superficie seca (estado superficialmente seco), o un estado cercano. Los materiales que se usan en cantidades muy pequeñas, como aditivos, deben estar diluidos. 2) Medición de materiales: En principio se mide en masa. La precisión debe estar calculada correctamente para que sea igual o mayor a 0.5% de la masa medida. El agua y los aditivos pueden ser medidos en volumen. 3) Mezclado: La mezcla se realiza, en principio, en un laboratorio con una temperatura ambiente de 20±3°C e igual o mayor al 60% de humedad, utilizando revolvedora. La cantidad de cada mezcla debe ser igual o mayor a la cantidad necesaria más 5 litros y además igual o mayor al 50% e

4. Método de prueba	Detalles de la prueba	igual o menor al 100% de la capacidad nominal de la revolvedora utilizada. Antes de comenzar la mezcla, se hace un mezclado previo con una cantidad de concreto de la misma formulación, para que las paredes de la mezcladora ya estén cubiertas de mortero. El orden de colocación de los materiales se define para que se mezclen rápida y homogéneamente, evitando que el cemento o el mortero se adhieran al aspa de la revolvedora. Se considera apropiado como tiempo de mezclado más de 3 minutos en el caso de una revolvedora de circulación forzada, y más de 2 minutos en el caso de una revolvedora basculante, después de haber integrado todos los materiales necesarios. Cuando se quiere tener un concreto no aireado con un revenimiento igual o mayor a 10 cm en una cantidad igual o menor a 20 litros, se puede mezclar el concreto con pala sobre la tabla con cuchara de concreto. En el caso del mezclado a mano, primero se mezcla homogéneamente el cemento y los agregados finos y se les agrega una porción de agua mezclándolos bien, luego se colocan los agregados gruesos y el resto del agua y se mezclan muy bien hasta lograr la homogeneidad. En este caso, se debe dejar con mortero pegado en la superficie de la tabla.

El cemento debe ser conservado en una bolsa de plástico para evitar su contaminación. Si se conserva envasado y en un lugar ventilado, se puede utilizar sin grandes alteraciones de calidad después de aproximadamente seis meses.

Se debe cuidar que el agua y los aditivos no se contaminen con impurezas (sal, lodo o azúcar). Los aditivos conservados durante mucho tiempo después de su fabricación tienden a presentar separaciones, por lo que es necesario mezclarlos muy bien antes de utilizarlos y tener cuidado de eliminar los aditivos demasiado viejos. Cuando se trata de aditivos que se utilizan en cantidades muy pequeñas, como aireantes, es necesario diluirlos diez o cien veces antes de utilizarlos, ya que sin dilución se presentan grandes diferencias por cualquier error de medición de estos productos.

2.2. Medición de materiales

Los materiales se miden por masa, en principio, pero el agua y los aditivos pueden ser medidos por volumen.

Un error en la medición de los materiales puede provocar grandes diferencias en los resultados de las pruebas. Aunque se trata de maniobras muy sencillas, hay que tener suficiente cuidado al medir los materiales, sobre todo en el cemento y el agua.

Cuando se miden aditivos por volumen, hay que tomar en cuenta que éstos tienen pesos específicos diferentes al agua.

Las pesas utilizadas deben satisfacer el grado de precisión requerido (0.5% del valor de la medición).

2.3. Mezcla del concreto

La mezcla del concreto tiene como objetivo combinar homogéneamente los materiales; y para esto es necesario dar atención a la cantidad y tiempo del mezclado y al orden en que se agregan los materiales.

El volumen de la mezcla debe ser mayor a la mitad y menor a la capacidad nominal de la revolvedora, y además, más de 5 litros más que la cantidad necesaria para la prueba.

El tiempo de mezclado cambia según la capacidad y modelo de la revolvedora y de las condiciones de proporcionamiento. Es necesario tener un tiempo de mezclado de más de tres minutos después de haber agregado todos los materiales, cuando se trata de una revolvedora basculante, y de más de dos minutos cuando se utiliza una revolvedora de circulación forzada.

El orden de la integración de los materiales se define por el tipo de la revolvedora utilizada, cuidando de que los materiales no se adhieran en el interior de la mezcladora y que se logre una homogeneidad rápidamente.

En nuestro laboratorio, cuando se utiliza una revolvedora de circulación forzada,se mezcla durante 1.5 minutos el mortero, colocando luego los agregados gruesos; cuando se trata de una revolvedora basculante, se integran todos los materiales, en el orden siguiente:a) agregados gruesos, b) mitad del agua, c) mitad de la arena, d) cemento,e)mitad de la arena, f) mitad del agua, y se mezcla todo durante tres minutos.

Por otra parte, las propiedades del concreto son vulnerables a la influencia de la temperatura, por lo que es deseable mantener el laboratorio donde se realiza la mezcla a una temperatura y a una humedad constantes. En principio, el mezclado debe realizarse a 20±3°C de temperatura y al 60% o más de humedad. En este laboratorio, las condiciones se ajustan de acuerdo con los requisitos mencionados, para que lo podamos utilizar en cualquier momento del año, ya que a menudo realizamos pruebas para evaluar la calidad de diferentes aditivos.

3. Método de fabricación de especímenes para los ensayos de resistencia

3.1. Especímenes para los ensayos de resistencia a la compresión

Los especímenes tienen forma cilíndrica, con una altura que corresponde al doble del diámetro, porque con esto se elimina la corrección a la resistencia a la compresión. Los especímenes cilíndricos son los más comúnmente utilizados. Para el concreto de uso constructivo, como la medida máxima de los agregados gruesos es igual o menor a 25 mm, generalmente se utilizan especímenes con 10 cm de diámetro y 20 cm de altura. Cuando se utilizan agregados gruesos cuyo tamaño máximo de agregado es igual o superior a 50 mm, generalmente se aplica el cernido en húmedo con una malla de 50 mm antes de utilizar el concreto para la fabricación de especímenes. Ya en la fabricación misma de los especímenes, es muy importante lograr una compactación adecuada. Cuando se trata de un concreto que tiende a mostrar segregación, hay que reducir el número de varillazos y aplicar otras maniobras alternativas, que permitan la compactación sin riesgos de segregación.

Cuando se compactan los especímenes varillándolos -un espécimen con 15 cm de diámetro y 30 cm de altura, por ejemplo- se divide en tres capas y se pica 25 veces por capa. Se comienza varillando en un lugar cercano a la circunferencia, y se va picando en forma espiral hasta llegar al centro del espécimen en la picada número 25. En la primera capa, hay que tener cuidado para que la varilla no llegue a la placa del fondo del molde. En la segunda y tercera capa, es conveniente meter la varilla hasta que llegue a la capa inferior. Cuando falta profundidad en la picada, se presenta un acabado cacarizo, impidiendo que se obtenga una medida correcta de la resistencia.

En el caso de especímenes que no tengan la dimensión de Ø15 X 30 cm, un grosor de 10 a 15 cm se considera como una capa, y se pica una vez más por cada 7 cm^2 de sección transversal adicional. Por ejemplo cuando se trata de un espécimen de Ø10 x 20 cm, como la sección transversal del espécimen tiene una dimensión de 78.5 cm^2, se picará 11 veces.

Cuando los especímenes se fabrican de concreto seco, se utiliza vibrador interno para su formación. En un espécimen con un diámetro de 10 a 20 cm, el concreto se deposita en dos capas, y se pica una vez por cada 60 cm^2 de sección transversal. El vibrador puede insertarse rápidamente, pero se debe sacar lentamente y con sumo cuidado. En la primera capa, el vibrador no debe tocar el fondo del molde, y en la segunda se debe llegar a unos 3 cm adentro de la primera capa. El tiempo de vibrado varía según el tipo de concreto, pero siempre hasta que una delgada capa de pasta cubra la superficie (sangrado). Después del vibrado, se le aplican ligeros golpes con un mazo de madera.

Después de terminar la compactación, se retira el material de sangrado sobre la superficie, con una escobilla de acero; después de 2 a 6 horas en el caso del concreto seco y de 6 a 24 horas en el caso del concreto con alto revenimiento, se humedece y se le coloca pasta de cemento y se le comprime con una placa de vidrio para cabecearlo. La pasta de cemento utilizada para el cabeceo debe tener una relación agua-cemento de alrededor de 28%; se mezcla y se conserva durante dos horas aproximadamente antes de usarla. En el momento del cabeceado, es necesario escoger un material adecuado para utilizarlo entre el vidrio y el cemento. Generalmente se utiliza una placa fina de cloruro de vinilo, pero muchas veces con este tipo de placa no es posible lograr una superficie plana como la estipulada en JIS. Es como utilizar una hoja de papel para mecanografía previamente mojada.

Como otros métodos de cabeceo, se pueden citar, el yeso o una mezcla de yeso con cemento, o el azufre fundido con otros minerales. En estos casos, el cabeceo se realiza después del desmolde, y aparte de verificar horizontalidad de la superficie del cabeceo que siempre debe estar dentro de 0.05 mm, si la resistencia a la compresión rebasa 300 kgf/cm^2, hay que revisar la resistencia del material del yeso o de la mezcla de yeso con cemento.

Si se quiere eliminar el cabeceo, se debe maquinar la superficie superior del espécimen para que tenga una horizontalidad igual o menor a 0.05 mm. Recientemente, gracias a los grandes adelantos tecnológicos, se han desarrollado buenas máquinas pulidoras, que permiten la precisión necesaria, por lo que se debe tomar en cuenta la posibilidad de pulir mecánicamente, sobre todo cuando no se tienen técnicos capacitados.

3.2. Especímenes para los ensayos de resistencia a la tensión

Los especímenes deben tener un diámetro igual o mayor a cuatro veces el tamaño máximo del agregado grueso e igual o menor a 15 cm, y una longitud igual o mayor al diámetro e igual o menor a dos veces el diámetro; el tamaño más general de especímenes de este tipo es de Ø15 x 20 cm. Cuando se utiliza la varilla para la compactación, el procedimiento es muy similar a lo que se hace en especímenes para los ensayos de resistencia a la compresión, únicamente que el grosor de una capa debe ser de 7.5 a 10 cm. Cuando se utiliza vibrador interno, el procedimiento puede ser igual al caso de los especímenes para las pruebas de compresión.

3.3. Especímenes para los ensayos de resistencia a la flexión

La sección transversal del espécimen debe ser de 15 x 15 cm cuando el tamaño máximo del agregado grueso es igual o menor a 50 mm, en principio. Cuando se quiere utilizar un espécimen con una menor sección, se permiten especímenes cuyo lado sea igual o mayor a tres veces el tamaño máximo del agregado grueso e igual o mayor a 10 cm. La longitud del espécimen debe ser igual o mayor a tres veces el lado de la sección transversal más 8 cm.

Cuando se utiliza varilla para la compactación, el material se deposita en dos capas, y se pica una vez por cada 10 cm^2 de sección transversal. Cuando se teme la segregación, se puede reducir el número de golpes, igual que en el caso de la fabricación de especímenes para los ensayos de compresión. Después de terminar la compactación en las dos capas, se introduce una placa para separar el concreto del molde, se aplican golpes ligeros a los lados del molde para que desaparezcan los orificios producidos por la compactación.

Cuando se utiliza un vibrador interno, se deposita el concreto en una capa, hasta que quede un poco copeado al nivel superior del molde. El vibrador se inserta equidistantemente por cada 100 cm^2 de la sección transversal. Cuando se saca el vibrador, hay que hacerlo con mucho cuidado y lentamente, para que no quede un orificio en la superficie. Después de la compactación, se introduce una placa para separar el concreto del molde, igual que cuando se utiliza la varilla compactadora. Luego se quita el concreto sobrante de la superficie aplanándola con una cuchara o llana.

3.4. Método de desmolde y de curado

Después del moldeo, se espera el endurecimiento del concreto para realizar el desmolde. Se desmolda después de 24 horas y antes de 48 horas. Mientras tanto, el espécimen se conserva a una temperatura ambiente de 20±3°C, evitando la evaporación de agua desde la superficie superior.

El espécimen se cura generalmente con agua, excepto cuando se tienen objetivos especiales. El método más común es sumergirlo en agua, pero a veces se conserva en arena saturada o en vapor saturado. Cuando se conserva en agua, se debe usar una tina de agua sin circulación, para evitar que el espécimen se lave constantemente con agua fresca. Cuando se quiere simular un estado de aplicación en obras, generalmente se cura en estado "sellado" (en una bolsa de plástico, por ejemplo).

Cuadro 2

1.	Nombre de la prueba	Método de fabricación de especímenes para los ensayos de resistencia del concreto.
2.	Objetivo de la prueba	Fabricar especímenes para ensayos de resistencia a la compresión, la tensión y la flexión.
3.	Muestra del concreto	El método de fabricación de muestras de concreto en laboratorios debe estar de acuerdo con JIS A 1138 (Método de fabricación de concreto en laboratorios). Número de código: 120101. Ver cuadro 1.
4. Método de prueba	Resumen	Moldear los especímenes con un método que permita una compactación suficiente del concreto dentro del molde y que no provoque separación de materiales.
	Norma aplicable	JIS A 1132 (Método de fabricación de especímenes para los ensayos de resistencia del concreto).
	Instrumentos	Molde, varilla compactadora, mazo de madera y placa de vidrio para el cabeceo.
	Condiciones de la prueba	En principio, en un laboratorio con una temperatura ambiental de 20±3°C.
	Detalles de la prueba	**1. Especímenes para el ensayo de resistencia a la compresión.** 1) Medidas del espécimen: un cilindro que tenga una altura que corresponda a dos veces el diámetro. Este debe ser, en principio, de 15 cm, pero puede ser cualquier diámetro que sea igual o mayor qué tres veces el tamaño máximo del agregado grueso y al mismo tiempo, 10 cm o mayor. 2)Colocación del concreto: En caso de un espécimen que tenga 15 cm de diámetro y 30 cm de altura, el concreto se deposita en tres capas, se dan 25 varillazos por capa, luego se dan golpes suaves para que desaparezcan los orificios producidos por la varilla compactadora. En el caso de los especímenes que no tengan esta dimensión, el grosor de la capa puede ser de 10 a 15 cm,y se pica una vez por cada 7 cm^2 de superficie superior. Cuando se utiliza el vibrador interno, el concreto se deposita en dos capas, y se inserta el vibrador una vez por cada $60cm^2$ de superficie superior. También se aplican pequeños golpes con el mazo de madera para que desaparezcan los orificios producidos por la compactación. Después de la compactación, la superficie superior del espécimen debe quedar un poco debajo del nivel superior del molde.

4. Método de prueba	Detalles de la prueba	3) La superficie del espécimen debe tener un acabado con una horizontalidad igual o menor a 0.05 mm, por cabeceo o por pulido. Cuando se cabecea antes del desmolde, se retira el sangrado de la superficie, se le lava con agua, se le coloca pasta de cemento y se le comprime con una placa de vidrio. Hay otros métodos para cabecear después del endurecimiento del concreto: con un mezcla de azufre o de yeso, puliendo la superficie después del endurecimiento, etcétera. **2. Especímenes para el ensayo de resistencia a la tensión.** 1) Medidas del espécimen: cilindro con un diámetro igual o mayor a cuatro veces el tamaño máximo del agregado grueso e igual o mayor que 15 cm, con una longitud igual o mayor al diámetro, e igual o menor a dos veces el diámetro. 2) Colocación del concreto. El método de colocación del concreto es parecido al que se utiliza en el espécimen para el ensayo de resistencia a la compresión, sólo que aquí la capa tiene un espesor de 7.5 a 10 cm cuando se usa varilla para la compactación. El concreto debe colocarse y conservarse en un lugar nivelado. 3) La superficie superior del espécimen debe quedar al nivel de la superficie superior del molde; se termina con una cuchara o llana. **3. Especímenes para el ensayo de resistencia a la flexión.** 1) Medida del espécimen: El espécimen tiene una sección cuadrada, cuyo lado es de 15 cm en principio. Su longitud debe ser igual o mayor a tres veces el lado de la sección transversal más 8 cm. También, un lado de la sección transversal puede ser igual o mayor que tres veces el tamaño máximo del agregado grueso e igual o mayor de 10 cm. 2) Colocación del concreto: El molde se coloca horizontalmente sobre su eje largo, se le coloca el concreto en dos capas, picándole una vez por cada 10 cm^2, aproximadamente con la varilla compactadora. Se hace el espaciamiento a lo largo de los lados y puntas, se golpea ligeramente en los lados para que desaparezcan los orificios de compactación. Cuando se utiliza el vibrador interno, se inserta una vez por cada 100 cm^2. 3) La superficie superior del espécimen se termina con una cuchara o con llana. **4. Método de desmolde y de curado.** 1) El desmolde se realiza en principio entre 24 y 48 horas

4. Método de prueba	Detalles de la prueba	después de la colocación del concreto. Mientras tanto, se toman medidas para evitar la evaporación de agua desde la superficie. 2) Método de curado del espécimen: Debe ser curado con agua a una temperatura de 20±3°C como estándar. El espécimen se deja en agua hasta inmediatamente antes de la prueba de resistencia.

CAPITULO 2

Método para la prueba de revenimiento de concreto

por
Toshio Suzuki

1. Introducción

Una de las características del concreto fresco antes de fraguarse es la trabajabilidad, que se considera como el índice que expresa su aptitud para la aplicación, y su calidad y homogeneidad después del fraguado. La facilidad de aplicación se define principalmente por la consistencia, que varía por la cantidad de agua que contiene el concreto. Esta consistencia se mide por la prueba de revenimiento. Por otra parte, para lograr una calidad homogénea después del fraguado, es necesario que el concreto tenga plasticidad, que evita que ocurra la separación de materiales. Esta propiedad se mide por la proporción (dispersión/revenimiento) o por la observación visual del concreto en el momento de la prueba de revenimiento. Mientras más pequeño es el revenimiento, el concreto es más homogéneo , por lo que se considera mejor el concreto con menor revenimiento. Sin embargo, la aplicación se hace difícil cuando se trata de una pieza de tamaño reducido. Por consiguiente, el valor de revenimiento se establece de acuerdo con el tamaño de la pieza. Como el revenimiento se define por la cantidad de agua contenida, al medir este valor se puede saber la variación de la calidad. La prueba es sencilla, y por esta razón se utiliza como una de las pruebas más comunes del control de calidad del concreto; es uno de los conceptos que se incluyen en la inspección de la calidad del concreto premezclado. En términos generales, cuando el revenimiento es grande, el concreto contiene mayor cantidad de agua por unidad de peso, por lo que se reduce su resistencia a la compresión, mientras que el revenimiento reducido significa una menor cantidad de agua por unidad y, por tanto aumenta la resistencia a la compresión. Es común que se utilice el concreto con revenimientos de 18 cm para edificios y de 8 cm para otras obras civiles.

2. Objetivo de la prueba.

La prueba de revenimiento, se realiza con la mezcla tentativa para definir la adecuada formulación del concreto que satisfaga los requisitos establecidos o para ver si un concreto mezclado satisface los requisitos establecidos.

La prueba se realiza para control de calidad en las plantas de concreto fresco y como inspección de entrada del concreto premezclado en las obras de construcción. El concreto que tiene un revenimiento extraordinariamente alto no sólo es poco resistente a la compresión sino también muestra una segregación muy grande de materiales, además de una serie de desventajas, como el aumento de sangrado, la reducción de impermeabilidad por la formación de una membrana acuosa en la superficie inferior de los agregados y el incremento de la contracción por secado.

3. Método de prueba

1) Muestra: Cuando se utilizan muestras elaboradas en el laboratorio, cada una de las mezclas deben homogeneizarse. Cuando se realiza como una prueba para la inspección del concreto premezclado en una obra, se sacan tres muestras, a una distancia de tiempo

igual, del material que sale del carro-agitador, exceptuando la parte inicial y la final. El volumen recolectado será de 20 litros, 5 litros más del volumen necesario para la prueba.

2) Aparatos necesarios para la prueba:

a. Cono de revenimiento: un cono de acero de 30 cm de altura, 10 cm de diámetro interior en la punta superior y de 20 cm de diámetro interior en la punta inferior con sujetadores y asas en los lugares apropiados, como se muestra en la figura 1.

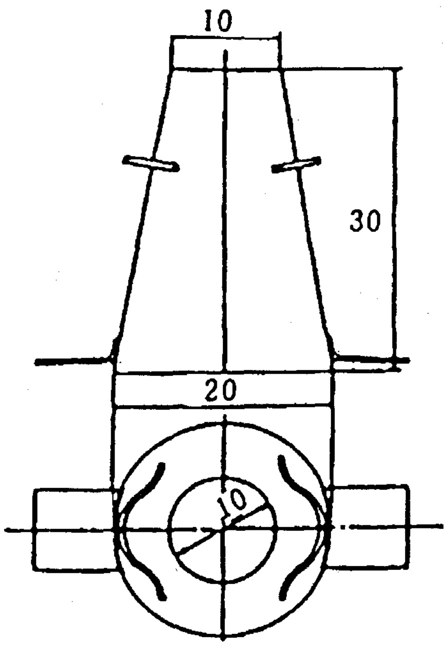

Figura 1. Cono de revenimiento (dimensiones en mm)

b. Varilla compactadora: varilla redonda de acero de 16 mm de diámetro y 50 cm de largo, con punta semiesférica (punta de bala).

c. Placa impermeable: una placa cuadrada de acero de 60 cm de lado con un espesor de 10 mm o similar.

d. Regla o escala para medir el revenimiento con divisiones mínimas de 0.5 cm.

3) Colocación del material: se coloca el concreto en tres capas, en volúmenes iguales, que equivale a la altura de 6 cm, 15 cm y 30 cm desde la punta inferior del cono. La muestra de concreto se coloca en la forma más homogénea posible, evitando que se aloje en un lado, girando la punta de la pala a lo largo de la parte superior del cono, para evitar la separación. Cuando se usan dos palas, deberán utilizarse simultáneamente desde las direcciones opuestas.

4) Compactación: se deberá compactar desde la parte periférica hacia el centro, en forma espiral. Se varilla siguiendo la inclinación del cono cerca de la pared lateral y verticalmente en la parte central. Cada capa se compacta 25 veces.

5) Levantar el cono: cuando se levanta el cono, no se debe levantar con la fuerza del brazo sino poniéndose de pie con los brazos extendidos, para que el cono se levante a un ritmo constante sin una variación grande de velocidad.

6) Medición: El asentamiento varía según el lugar de medición, por lo que primero hay que observar cuidadosamente el estado del concreto después de la prueba. Se mide la cresta asentada del cono, quitando el agregado grueso cuando se encuentre alguno. En las figuras 2 a 5 se señalan algunos casos típicos del lugar de medición. El revenimiento se mide con una aproximación de 0.5 cm. De acuerdo con el JIS A 5308 (concreto premezclado), la tolerancia en la medición del revenimiento es la siguiente:

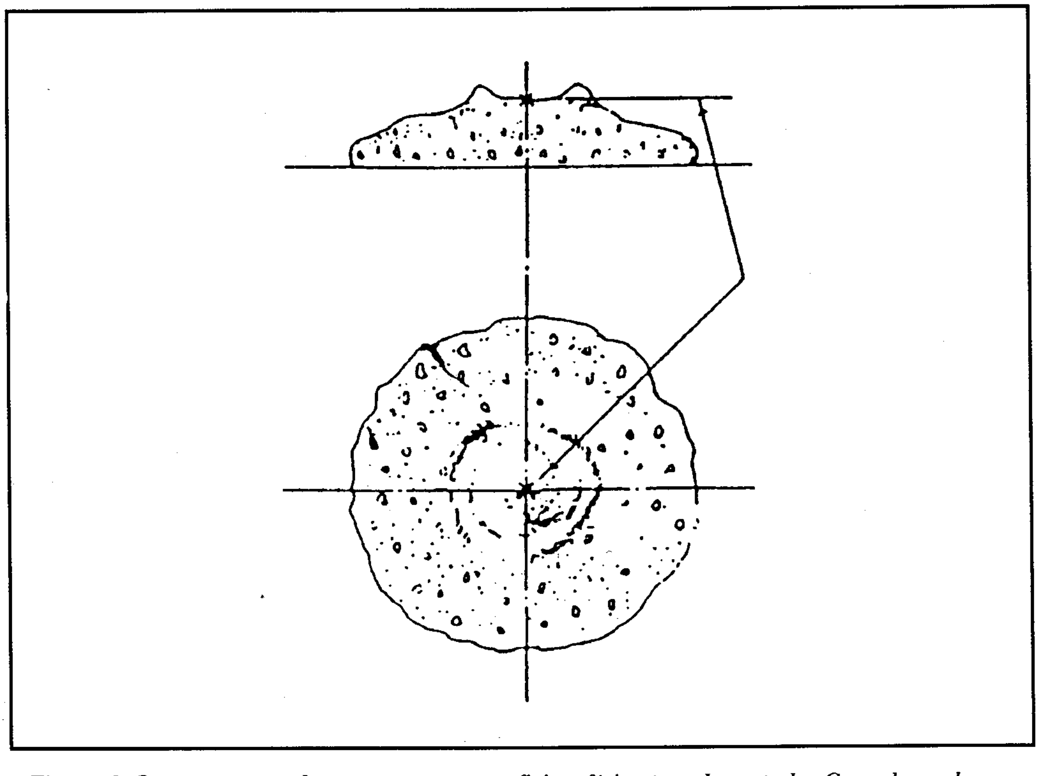

Figura 2. La parte central presenta una superficie esférica poco levantada. Cuando se observan salidas independientes de los agregados gruesos, se eliminan estos materiales gruesos antes de proceder a hacer la medición.

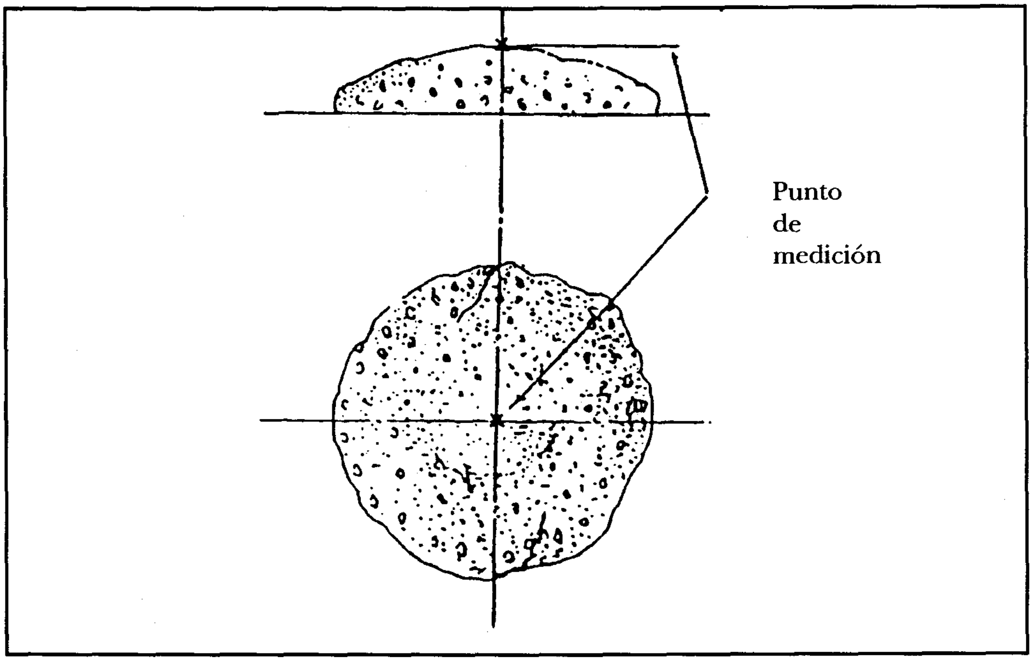

Figura 3. Cuando se observa una salida como de caldera volcánica alrededor del centro y que este anillo tiene una mayor altura que la parte central, hay que medir la altura de la parte central teniendo cuidado de no modificar al tocar el anillo exterior. Se presenta este tipo de formas con frecuencia cuando se trata de concreto ligero.

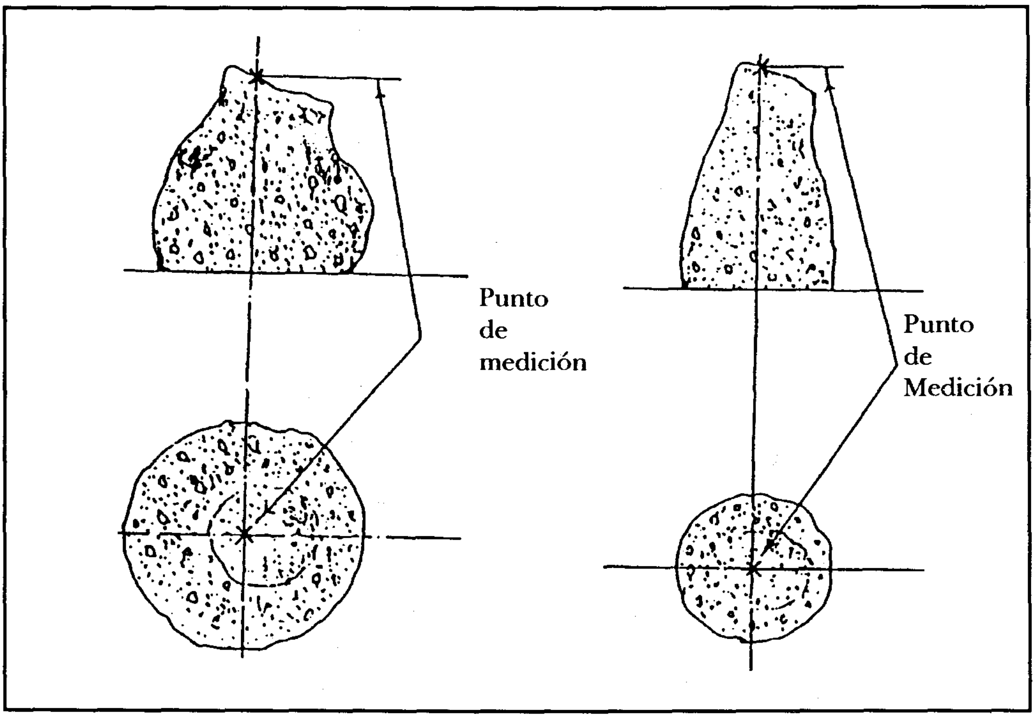

Figura 4. Cuando la superficie superior tiene una inclinación suave.

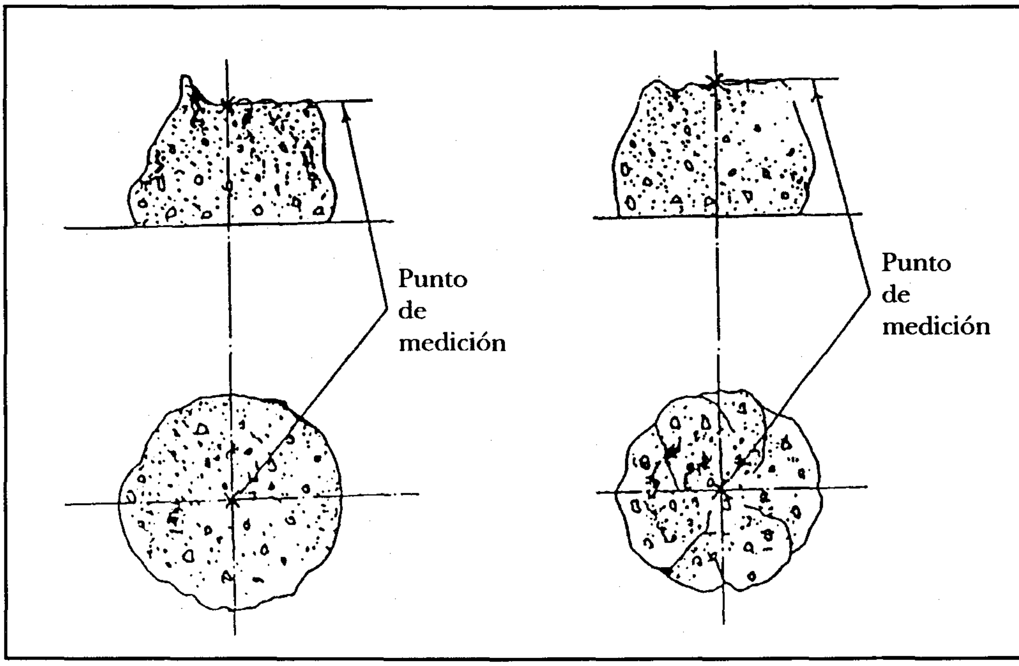

Figura 5. Cuando la parte superior es relativamente plana, pero con irregularidades superficiales.

Cuadro 1

1.	Nombre de la prueba	Prueba de revenimiento de concreto.
2.	Objetivo de la prueba	Juzgar la trabajabilidad del concreto no fraguado.
3.	Muestra	Muestra tomada de acuerdo con JIS A 1115 (método de muestreo del concreto no fraguado) del concreto elaborado siguiendo la norma de JIS A 1138 (método para elaborar concreto en laboratorios) o JIS A 5308 (concreto premezclado).
4. Método de prueba	Resumen	Se coloca el concreto fresco en el cono de revenimiento, y se mide el asentamiento cuando se levanta el cono.
	Norma aplicable	JIS A 1101 (método de prueba para revenimiento del concreto).
	Aparatos necesarios para la prueba y equipos de medición	1) Un cono de revenimiento de acero, de 10 cm de diámetro interior en la punta superior y de 20 cm de diámetro interior en la punta inferior, de 30 cm de altura, con sujetadores y mangos en los lugares apropiados.

<table>
<tr><td rowspan="3">4. Método de prueba</td><td>Aparatos necesarios para la prueba y equipos de medición</td><td>2) Una varilla compactadora de acero redondo, de 16 mm de diámetro y 50 cm de largo, con punta semiesférica (punta de bala).

3) Una regla o escala para medir el revenimiento.

4) Una placa impermeable de acero de 60 cm de lado con un espesor de 10 mm. Condiciones de la prueba: se hace sobre un piso plano y resistente.</td></tr>
<tr><td>Condiciones de la prueba</td><td>Se hace sobre un piso plano y resistente.</td></tr>
<tr><td>Detalles de la prueba</td><td>1) Se coloca la placa impermeable sobre un piso regular y resistente. Se limpia con un trapo húmedo el interior del cono de revenimiento y la superficie de la placa. Los sujetadores se fijan firmemente con los pies, para evitar la fuga de agua por el fondo y para que no se levante el cono.

2) Se coloca la muestra en tres capas, en cantidades iguales (la primera capa llega a la altura de 6 cm del fondo, la segunda hasta 15 cm).

3) Cada capa se compacta con la varilla semiesférica, después se varilla 25 veces en forma espiral, desde la periferia hacia la parte central. Después de picar la última capa, la superficie superior de la muestra se aplana al nivel de la punta superior del cono.

4) Se sigue sujetando el cono con las manos, y se sacan los pies de la placa impermeable. Después el cono se levanta verticalmente con cuidado, y se mide la altura de la parte central asentada del cono, la cual se toma como el revenimiento.</td></tr>
<tr><td rowspan="2">5. Método de evaluación</td><td>Norma aplicable</td><td>JIS A 5308 (concreto premezclado)</td></tr>
<tr><td>Criterios de juicio</td><td><table><tr><th>Revenimiento (cm)</th><th>Tolerancia del revenimiento (cm)</th></tr><tr><td>2.5</td><td>±1</td></tr><tr><td>5 y 6.5</td><td>±1.5</td></tr><tr><td>Más de 8 menos de 18</td><td>±2.5</td></tr><tr><td>Más de 19</td><td>±1.5</td></tr></table></td></tr>
<tr><td>6.</td><td>Expresión del resultado</td><td>En unidades de 0.5 cm.</td></tr>
<tr><td>7.</td><td>Sugerencia</td><td>Cuando se trata de un concreto con un revenimiento grande, se puede medir la expansión horizontal del concreto (valor de fluidez) para juzgar la trabajabilidad.</td></tr>
</table>

Cuadro 2. Tolerancia en la medición del revenimiento

(Unidad:cm)

Revenimiento	Tolerancia
2.5	±1
5 y 6.5	±1.5
Más de y 8 menos de 18	±2.5
Más de 19	±1.5

4. Puntos que hay que cuidar

1) Cuando existe el riesgo de separación en el material compactado con la varilla compactadora, se puede reducir el número de varillazos al grado que no ocasionen la separación.

2) Cuando se varilla la primera capa, se debe tener cuidado para no golpear la placa impermeable, y cuando se varilla la segunda capa y la tercera, se debe introducir la varilla hasta la capa inmediatamente inferior.

3) Cuando se levanta el cono, la persona que mide no debe subirse a la placa. Cuando la forma del concreto asentado es excéntrica sobre el eje central del cono o es irregular por el desmoronamiento, se debe repetir la prueba utilizando una muestra diferente.

4) El levantamiento del cono de asentamiento debe durar entre 2 y 3 segundos hasta llegar a una altura de 30 cm.

5) Cuando se trata de concreto cuyo tamaño máximo de agregado grueso es de 40 mm o mayor, la prueba debe realizarse después de haber eliminado los agregados de 40 mm y de mayor tamaño.

6) El revenimiento del concreto varía con el tiempo después del mezclado, por lo que es deseable medirlo lo más rápidamente posible. Sobre todo, en el caso del concreto premezclado, el valor cambia por el tiempo de transporte de la planta al lugar de la obra, y el revenimiento disminuye en el verano, cuando se registran temperaturas altas durante el transporte.

5. Sugerencia

1) En el caso del concreto con alto revenimiento, el medir la expansión horizontal del concreto (valor de fluidez) puede servir como un criterio para juzgar su trabajabilidad. Cuando se presenta una gran expansión horizontal, el concreto tiende a separarse; cuando la expansión es reducida, significa que tiene una alta viscosidad. Cuando se trata de un concreto cuyo revenimiento es de unos 18 cm, esta expansión horizontal

debe ser aproximadamente de 1.5 - 1.8 veces del valor del revenimiento, con lo que se considera como un concreto de buen desempeño.

2) Después de la medición del revenimiento, se pueden determinar otras características del concreto, como la plasticidad, por medio de golpes dados a la parte exterior del concreto y por la observación de la expansión del material. Cuando el concreto tiene un proporcionamiento apropiado y con buena trabajabilidad, con los golpes de la varilla se extiende sin mostrar separación, mientras que en caso de un concreto con una dosificación no apropiada se tiende a desmoronar en pedacitos o a separarse con la pasta que se extiende más rápidamente.

CAPITULO 3

Prueba de sangrado y de fraguado del concreto

por

Kenzou Kishi

1. Introducción

Entre las pruebas que se realizan para conocer las características del concreto, existen las pruebas de sangrado y de fraguado. El concreto es una mezcla de materiales con diferentes pesos específicos, y el material con el peso específico más pequeño, que es el agua, rezuma del concreto, fenómeno que se denomina "sangrado". Por medio de la prueba de sangrado se mide el volumen del agua que brota del concreto. Mientras más blando sea el concreto (o sea, mientras más alto, sea el revenimiento), se espera tener un mayor sangrado. Un concreto con exceso de sangrado tiende a formar huecos debajo de las varillas de refuerzo y de las parrillas de acero distribuidas horizontalmente, reduciendo en gran medida la adherencia, y provocando la oxidación de las varillas, causando fisuras a lo largo de ellas. Por otra parte, la prueba del tiempo de fraguado se hace para determinar en cuánto tiempo empieza a fraguar el concreto. Si este tiempo es demasiado corto, se crean problemas en la colocación, pero si el tiempo de fraguado es largo, tiende a aumentar el sangrado. Se utilizan aditivos para retardar el tiempo de fraguado en verano, cuando la temperatura ambiental es alta, y para acortarlo en invierno, cuando la temperatura es baja. A menudo, la prueba de fraguado se realiza para conocer los efectos de estos aditivos, y también cuando se trata de concretos especiales.

2. Prueba de sangrado

2.1. Objetivo de la prueba

El concreto debe tener una consistencia adecuada para su manejo. Cuando el concreto es demasiado blando, tiende a producir la separación de materiales, perdiéndose la homogeneidad del concreto. La prueba de sangrado tiene como objetivo conocer la cantidad de agua que se separa, ya que es uno de los factores causantes de la segregación.

2.2. Muestras

Las muestras que se utilizan en la prueba se obtienen según JIS A 1115 (Método de obtención de material del concreto no fraguado) del concreto elaborado de acuerdo con JIS A 1138 (Método de elaboración del concreto en laboratorios) o JIS A 5308 (Concreto premezclado), se mezcla hasta lograr una homogeneidad y se usa de inmediato para la prueba. Cuando el tamaño máximo de agregado rebasa los 50 mm, se aplica el filtrado en húmedo (wet screening) para eliminar los agregados gruesos iguales o mayores a 50 mm.

2.3. Instrumentos para la prueba

1) Recipiente: Cilindro metálico maquinado en su cara interior, impermeable y suficientemente sólido de 25 cm de diámetro interior y 28.5 cm de altura. Generalmente, se le coloca una asa para facilitar su manejo.

Cuadro 1

1.	Nombre de la prueba	Método de prueba de sangrado del concreto.
2.	Objetivo de la prueba	Medir el volumen y la relación porcentaje del concreto, para conocer la segregación de los materiales que componen el concreto.
3.	Muestra	Muestras obtenidas según JIS A1 115 (Método de obtención de muestras del concreto no fraguado) de concreto elaborado de acuerdo con JIS A 1138 (Método de elaboración de concreto en laboratorios) o JIS A 5308 (Concreto premezclado). El tamaño máximo de los agregados gruesos debe ser igual o menor a 50 mm.
4. Método de prueba	Resumen	Se deposita concreto fresco en el recipiente, y se mide el volumen de agua que sale a la superficie superior, para determinar volumen y la tasa del sangrado.
	Norma aplicable	JIS A 1123 (Método de prueba de sangrado del concreto).
	Instrumentos de la prueba y dispisitivos de medición	1) Recipiente metálico de forma cilíndrica con la cara interior maquinada, impermeable y suficientemente sólido, de 25 cm de diámetro interior y de 28.5 cm de altura. 2) Báscula con una sensibilidad de 10 g. 3) Probetas graduadas de 10, 50 y 100 ml. Goteros para sacar el agua. 4) Varilla compactadora de acero, de 16 mm de diámetro y de 50 cm de longitud, con punta redondeada o de bala.
	Condiciones en el momento de la prueba	Debe realizarse en un lugar cerrado, con una temperatura ambiental de 20±3 °C.
	Detalles de la prueba	1) Se coloca el concreto en el recipiente de acuerdo con 4.1 de JIS A 1116 (Método de la prueba de peso volumétrico unitario del concreto no fraguado), se aplana para que la superficie superior del concreto quede 3±0.3 cm por debajo del nivel superior del recipiente. 2) Se registra la hora al terminar el aplanado de la superficie de la muestra con la llana. Se coloca el recipiente sobre una tarima o un piso horizontal, para que no se mueva ni vibre. Se tapa. Mientras dure la prueba, el recipiente debe estar tapado, excepto cuando se quite la tapa para extraer el agua. 3) Durante 60 minutos después de la hora registrada, se saca el agua de la superficie del concreto cada 10 minutos.

4. Método de prueba	Detalles de la prueba	Transcurridos los 60 minutos, se saca el agua cada 30 minutos, hasta que ya no se observe el sangrado. Dos minutos antes de que se saque el agua, se coloca un bloque de concreto de 5 cm de altura debajo del recipiente en un lado, haciendo inclinar el recipiente con cuidado. Después de haber sacado el agua con un gotero, el bloque se quita y el recipiente se vuelve a colocar horizontalmente, siempre con cuidado. El agua extraída de la muestra se coloca en el cilindro graduado, registrando el agua acumulada con una precisión de 1 ml. 4) Cuando ya no se observe el sangrado, se mide inmediatamente la masa del recipiente y del concreto. 5) Se calculan el volumen y la tasa de sangrado de acuerdo con las siguientes fórmulas. Volumen del sangrado (cm^3/cm^2) $= \frac{V}{A}$ V: Volumen de agua por sangrado acumulado hasta la última medición (cm^3) A: Superficie de recipiente (cm^2) Tasa del sangrado (%)= $\frac{B}{C} \times 100$, donde: $C = \frac{w}{W} \times S$ B: Superficie de la cara superior del concreto (cm^2) C: Peso del agua por sangrado acumulado hasta la última medición (kg) W: Peso del concreto por m^3 (kg) w: Peso del agua que contiene el concreto por m^3 (kg) S: Peso de la muestra (kg)
5.	Expresión de los resultados	El volumen y la tasa de sangrado se calculan hasta el segundo decimal.
6.	Consideración	El sangrado aumenta a medida que crece la relación agua-cemento, y cuando disminuye la cantidad de agregados muy finos (tanto del cemento como de los agregados).

2) Báscula: Báscula con un sensibilidad igual o mayor a 10 g y con una capacidad mayor a 50 kg.

3) Probeta graduada: Se utiliza para medir el volumen del agua que sale a la superficie por el sangrado, por lo que se recomienda utilizarlo de acuerdo con la cantidad del sangrado. Por lo general, se recomienda tener a la mano probetas graduadas de 10, 50 y 100 ml.

4) Varilla compactadora: Varilla de acero de 16 mm de diámetro y de 50 cm de longitud,con la punta redondeada (punta de bala).

2.4. Método de la prueba

1) Método para depositar la muestra en el recipiente: El concreto se deposita de acuerdo con 4.1 de JIS A 1116 (Método de prueba del peso volumétrico del concreto fresco), y se aplana con una llana de tal forma que la superficie superior del concreto quede 3±0.3 cm por debajo del nivel superior del recipiente.

2) Conservación de la muestra: Se registra la hora al terminar de aplanar la superficie, se coloca el recipiente con la muestra sobre una tarima o un piso horizontal sin vibraciones, y se conserva tapado para evitar la evaporación del agua por la superficie superior. El recipiente debe mantenerse tapado, excepto en el momento de medición.

3) Medición: Durante 60 minutos después del aplanado de la superficie de la muestra, se mide el volumen del agua de sangrado cada 10 minutos, y después, cada 30 minutos hasta que ya no se observe el fenómeno. El agua que sale a la superficie se recolecta utilizando un gotero, se traslada a un cilindro graduado para medir su volumen acumulado con la precisión de 1 ml. Dos minutos antes de la medición se levanta unos 5 cm un lado del recipiente, para que el agua se acumule en un lugar; después de la medición se vuelve a colocar en posición horizontal con cuidado.

4) Medición de la masa de la muestra: Para calcular la tasa de sangrado mencionado en el punto (5), es necesario medir la masa de la muestra cuando ya no se observe el fenómeno de sangrado.

5) Cálculo del resultado: El resultado de la prueba de sangrado se expresa por el volumen de sangrado (volumen de agua de sangrado por centímetro cuadrado) o por la relación porcentaje (proporción del agua de sangrado y el contenido de agua del concreto), calculados de acuerdo con las siguientes fórmulas:

$$\text{Volumen del sangrado} = \frac{V}{A}$$

donde V: volumen del agua de sangrado acumulada hasta el último momento (cm^3).

A: superficie del recipiente (490.6 cm^2).

$$\text{Tasa de sangrado} = \frac{B}{C} \times 100, \quad C = \frac{w}{W} \times S$$

donde B: agua de sangrado acumulada hasta el último momento (kg)

C: contenido de agua de la muestra (kg)

W: peso volumétrico del concreto (kg/m^3)

w: agua contenida en un metro cúbico del concreto (kg/m^3)

S: masa de la muestra (kg/m^3) - suma de la masa de la muestra calculada en (4) más el agua de sangrado

2.5. Puntos de observación y puntos de cuidado

1). Al aplanar la superficie del concreto, hay que tener cuidado para que se aplane con el mínimo de trabajo. Si se trabaja demasiado con la cuchara o llana, se provoca que el agua salga, aumentando el volumen del agua de sangrado, y modificando los resultados de la prueba. Un mal aplanado ocasiona que el agua de sangrado se acumule en las partes bajas, dificultando sacar todo el agua para una medición precisa.

2). El agua de sangrado aumenta si se le aplican vibraciones al recipiente, por lo que es importante conservar la muestra sin vibraciones hasta donde sea posible. Cuando se le aplican golpes ligeros de mazo de madera al recipiente después de depositar el concreto en él, se debe tener cuidado para no golpear más de lo estrictamente necesario.

3) El volumen de agua de sangrado varía según la temperatura, por lo que es necesario mantener un cierto nivel de temperatura del concreto al momento de terminar el mezclado y la temperatura ambiental del laboratorio (normalmente a los 20±3°C).

4). El volumen de sangrado difiere mucho según los materiales utilizados o el proporcionamiento del concreto. Sobre todo, es posible reducir el contenido de agua mediante aditivos químicos que agregan aire al concreto.

3. Prueba de fraguado

3.1. Objetivo de la prueba

El tiempo de fraguado del concreto depende principalmente del tipo de cemento y del contenido de finos del agregado. Cuando es demasiado corto el tiempo de fraguado, no se tiene el tiempo necesario para el acabado superficial, por lo que es necesario ajustar este tiempo dentro de intervalo aceptable. Cuando se estima de antemano que el tiempo de fraguado va a ser demasiado corto, se deben utilizar aditivos para ajustarlo. Consecuentemente, esta prueba se realiza para conocer los efectos de aceleradores o retardantes del fraguado.

3.2. Muestras

La prueba de fraguado se realiza con muestras de mortero, es decir eliminando del concreto recolectado (según JIS A 1115) los agregados gruesos por un cernido húmedo con una malla de 5 mm. El tiempo de fraguado se mide desde el momento en que el cemento se pone en contacto con el agua, por lo que es necesario registrar la hora en que se inicia el mezclado.

3.3. Instrumentos para la prueba

1) Dispositivo de medición de la resistencia a la penetración: Es un dispositivo que ejerce fuerza de penetración sobre la aguja penetrante por medio de un sistema hidráulico o de resortes. El dispositivo debe tener una capacidad máxima de 100 kgf (981 N), con una precisión de 1 kgf (9.8N) de medición.

2) Aguja penetrante: Varillas de acero con las secciones transversales de 1, 0.5, 0.25 y 0.125 cm^2, con la punta plana, cuyas cabezas pueden ser montadas y desmontadas del dispositivo de penetración. Deben de estar marcadas a lo largo de la circunferencia a los 25 mm de la punta.

3) Recipiente: Recipiente metálico impermeable y suficientemente sólido, de más de 150 mm de diámetro e igual o mayor que 150 mm de altura interior.

4) Varilla compactadora: La misma que se utiliza en la prueba de sangrado.

3.4. Método de la prueba

1) Método de depósito de la muestra en el recipiente: Después de haber mezclado homogéneamente la muestra de mortero cernido mencionado en 3.2, se deposita en el recipiente de manera que el nivel de la muestra quede a 1 cm por debajo del nivel superior del recipiente. Se aplana la superficie de la muestra con la varilla compactadora. Se da un varillazo por cada 6 cm^2, después se dan pequeños golpes a los lados del recipiente para que desaparezcan los orificios de la compactación y se vuelve a aplanar.

2) Conservación del recipiente con la muestra: El recipiente con la muestra se traslada a una cámara de temperatura constante, de 20±3°C de temperatura y de igual o más del 80% de humedad, y se conserva sobre una tarima o un piso horizontales evitando las vibraciones. El recipiente debe estar tapado, excepto cuando se efectúa la medición.

3) Eliminación del agua de sangrado: El agua de sangrado que sale a la superficie de la muestra se elimina inmediatamente antes de efectuarse la prueba de penetración.

4) Prueba de penetración: Se selecciona una aguja con una superficie apropiada de acuerdo con el estado del fraguado de la muestra, y se monta al dispositivo de medición de la resistencia a la penetración. Después se introduce la aguja hasta 25 mm en 10 segundos, registrándose el tiempo y la fuerza (kgf) (N) necesaria para la penetración.

Cuadro 2

1.	Nombre de la prueba	Método de la prueba del tiempo de fraguado del concreto.
2.	Objetivo de la prueba	Determinar el tiempo de fraguado.
3.	Muestra	Mortero que se consigue eliminando agregados gruesos igual o mayor que 5mm, de la muestra recolectada según JIS A 1115 (Método de muestreo del concreto no fraguado) del concreto elaborado de acuerdo con las especificaciones del JIS A 1138 (Método de elaboración del concreto en laboratorios),o del JIS A 5308 (Concreto premezclado).
4. Método de prueba	Resumen	Se coloca el mortero en el recipiente, se mide la resistencia a la penetración utilizando agujas, y se determina el principio y el fin del fraguado.
	Norma aplicable	Anexo 1 (Método de prueba del tiempo de fraguado del concreto) de JIS A 6204 (Aditivos químicos para concreto).
	Instrumentos para la prueba, dispositivos de medición	1) El dispositivo para la determinación de la resistencia a la penetración tiene la función de ejercer la fuerza de penetración por medio de un sistema hidráulico o de resorte, y debe tener la capacidad para medir hasta 100 kgf (981 N) con una precisión de 1 kgf (9.8N) por manómetro o por resorte. 2) Las agujas penetrantes son varillas de acero con secciones transversales de 1, 0.5, 0.25 y 0.125 cm^2 con puntas planas. Sus cabezas son desmontables en el dispositivo para la determinación de la resistencia a la penetración, y están marcadas a lo largo de la circunferencia a la altura de 25 mm desde la punta. 3) El recipiente es un cilindro o un rectángulo de metal impermeable y suficientemente sólido, de 150 mm o más de diámetro o de ancho y con 150 mm o más de altura interior. 4) La varilla de vibrado es una varilla de acero de 16 mm de diámetro y de 50 cm de largo, con la punta de media esfera (punta de bala).
	Condiciones de la prueba	Se debe realizar en un lugar cerrado, con la temperatura ambiental de 20±3°C y con la humedad igual o mayor que 60%.
	Detalles de la prueba	1) Se registra la hora en que el cemento se pone en contacto con el agua.

<table>
<tr><td rowspan="1">4. Método de prueba</td><td>Detalles de la prueba</td><td>2) Se coloca el mortero suficientemente batido en el recipiente. Se da un varillazo por cada 6 cm^2, luego se le aplican ligeros golpes a los lados del recipiente para que desaparezcan los orificios de vibrado. Se aplana la superficie superior del mortero para que quede aproximadamente 1 cm por debajo del nivel superior del recipiente.

3) Se coloca el recipiente sobre una tarima o un piso horizontal y se tapa. El recipiente debe estar siempre tapado, excepto cuando se le aplican las pruebas de penetración.

4) Inmediatamente antes de efectuar las pruebas de penetración, se elimina el agua de sangrado de la superficie de la muestra. Después de retirar el agua, el recipiente se vuelve a colocar en forma horizontal.

5) Se elige una aguja con área apropiada según el estado de fraguado y se monta en el dispositivo de prueba de resistencia a la penetración. Se inserta con cuidado la aguja verticalmente 25 mm en la muestra. La inserción debe tomar unos 10 segundos.

6) Se lee en el dispositivo la fuerza requerida para la prueba (en kgf o en N) y se registra con la hora en que se realizó la prueba.

7) Las pruebas se efectúan más de seis veces, hasta que el valor de resistencia a la penetración se haga mayor a 280 kgf/cm^2 (27.46 N/mm^2). La resistencia a la penetración kgf/cm^2 (N/mm^2) se calcula dividiendo la fuerza requerida para la penetración (kgf o N) entre el área de la acción transversal de la aguja (cm^2 o mm^2). Los valores se redondean a números enteros.

8) Se expresa gráficamente el tiempo transcurrido y la resistencia a la penetración, y se lee, en unidades de 5 min, el tiempo transcurrido desde el inicio de la prueba hasta que el valor de resistencia llegue a 35 kgf/cm^2 (3.43 N/mm^2) y a 280 kgf/cm^2 (27.46 N/mm^2).</td></tr>
<tr><td rowspan="2">5.Método de evaluación</td><td>Norma aplicable</td><td>—</td></tr>
<tr><td>Criterios de juicio</td><td>—</td></tr>
</table>

6. Expresión de los resultados	Se toma como el principio del fraguado el tiempo transcurrido hasta que el valor de resistencia llegue a 35 kgf/cm^2 (3.43 N/mm^2). Se toma como el fin del fraguado el tiempo transcurrido hasta que el valor de resistencia llegue a 280 kgf/cm^2 (3.43 N/mm^2).
7. Consideración	Esta prueba se realiza con el fin de confirmar el funcionamiento de diferentes aditivos, o para conocer la calidad de los concreto utilizados en condiciones de alta o baja temperatura, o de los concretos especiales.

5) Cálculo de la resistencia a la penetración: Se divide la fuerza necesaria para la penetración entre el área de la sección transversal de la aguja, calculando, de esta forma, la resistencia a la penetración por centímetro cuadrado. Se redondea a números enteros. La prueba de penetración debe efectuarse más de seis veces antes de que la resistencia a la penetración llegue a ser igual o mayor a 280 kgf/cm^2 (27.46 N/mm^2).

6) Cálculo del resultado: Se muestra gráficamente la relación entre el tiempo transcurrido desde la agregación de agua a la muestra y la resistencia a la penetración; para leer el tiempo transcurrido hasta que la resistencia a la penetración llegue a 35 kgf/cm^2 (3.43 N/mm^2) (principio de fraguado) y a 280 kgf/cm^2 (27.46 N/mm^2) (fin de fraguado) en unidades de 5 minutos. Estos tiempos transcurridos se pueden calcular deduciéndolos de dos valores de resistencia en cuyo intermedio se sitúan los dos valores arriba mencionados.

7) Expresión del resultado: Se hacen dos pruebas en las mismas condiciones, y se toma como el principio del fraguado el promedio del tiempo transcurrido hasta que la resistencia a la penetración llegue a 35 kgf/cm^2 (3.43N/mm^2), y como el fin de fraguado el promedio del tiempo transcurrido hasta que la resistencia llegue a 280 kgf/cm^2 (27.46 N/mm^2).

3.5. Puntos de observación, puntos de cuidado

1) La muestra de mortero se elabora eliminando del concreto los agregados gruesos de tamaño igual o mayor de 5 mm por el filtrado en húmedo. Por lo tanto, al principio contiene mayores cantidades de pasta de cemento y gradualmente aumenta el contenido de agregados finos. Consecuentemente, si el cernido no se hace en forma homogénea, no se pueden conseguir muestras estandarizadas; es necesario tener cuidado en este aspecto.

2) Si se aplican vibraciones al recipiente, aumenta el agua de sangrado y, por ende, se hace difícil obtener valores correctos. Es necesario manejar el recipiente con cuidado.

3) El lugar donde se inserta la aguja debe ser un lugar donde no se observe la influencia de una inserción anterior. Debe tener una distancia igual o mayor a 15 mm y al doble del diámetro de la aguja que se utiliza desde una inserción anterior, además de

mantener una distancia igual o mayor a 20 mm entre la cara interior del recipiente y la parte exterior de la aguja.

4) Como un criterio, la prueba de penetración puede ser iniciada cuando ya deja de salir el agua del sangrado. En el caso del concreto normal, la prueba se inicia 3 ó 4 h después del mezclado. Cuando se trata de un concreto con algún acelerante, sería conveniente iniciar la prueba una hora antes, y en caso de un concreto con algún retardante, una hora después. La medición se efectúa cada 30 min en principio, pero cuando el valor se acerca al valor final de resistencia a la penetración, la última medición podría realizarse después de 15 min. de la penúltima. Si se comienza la medición en una etapa demasiado temprana, al final ya no habrá lugar para insertar la aguja, por lo que hay que ir observando el avance del fraguado para ajustar el tiempo de medición.

5) El tiempo de fraguado puede variar con la temperatura. Es necesario registrar la temperatura ambiental del laboratorio donde se realiza la medición, y mantener constantes las condiciones del laboratorio. También es necesario cuidar la temperatura de los materiales, mantener constante la temperatura del concreto mezclado, y evitar que se seque la muestra.

6) Cuando se comparan los resultados de dos pruebas: la prueba de aditivos químicos para concreto y la prueba con concreto estándar sin aditivos, es muy importante hacer las mediciones simultáneamente a las dos muestras.

Frecuentemente, se realiza la prueba de revenimiento y la prueba del volumen de aire como pruebas de calidad del concreto fresco. Si el nivel de revenimiento y de contenido de aire es adecuado, generalmente el concreto es de buena calidad y presenta poco sangrado. Sin embargo, dependiendo del momento de aplicación, a menudo se altera el tiempo de fraguado, lo cual ocasiona dificultades en la colocación. El tiempo de fraguado tiene relación con el volumen de sangrado; cuando un concreto tiene poco tiempo de fraguado, en el verano presenta poco sangrado y un alto riesgo de producir fisuras por secado temprano, y en el invierno presenta mucho sangrado y puede ocasionar fisuras por congelación inicial. A los concretos que se utilizan bajo ciertas condiciones se les exige tener la calidad apropiada a estas condiciones, por lo que se hacen necesarias las pruebas que puedan dar criterios para juzgar su calidad. Las pruebas de sangrado y de fraguado que se mencionaron en este texto son algunas de estas pruebas. Este texto, hace referencia a los puntos que hay que cuidar al realizar estas pruebas, para que se tomen en cuenta al practicarlas. En el cuadro 3, se muestran los valores de medición referentes al sangrado y al tiempo de fraguado, establecidos en JIS, en relación con "los aditivos químicos para concreto".

Cuadro 3. Calidad de los aditivos químicos.

Concepto de la calidad \ Tipo		Aditivo AA	Reductor de agua			Reductor de agua AA		
			Estándar	Retardante	Acelerador	Estándar	Retardante	Acelerador
% del volumen de sangrado		Menor a 75	Menor a 100	Menor a 100	Menor a 100	Menor a 70	Menor a 70	Menor a 70
Diferencia en tiempo de fraguado (min)	Principio	-60 - +60	-60 - +90	+60 - +210	Menor a +30	-60 - +90	-60 - +210	Menor a +30
	Fin	-60 - +60	-60 - +90	Menor a +210	Menor a 0	-60 - +90	Menor a +210	Menor a 0

Apéndices:
Normas Industriales Japonesas en la Calidad del Concreto

(A1)

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JAPANESE INDUSTRIAL STANDARD

J I S

Concrete Terminology

A 0203-1980
(Reaffirmed: 1987)

1. Scope

This Japanese Industrial Standard specifies the principal terms, hereinafter referred to as the "terms", their reading, and difinitions to be used concerning concrete.

Further, the equivalent English is shown for reference.

2. Classification

The terms shall be classified as follows:

(1) Concrete

(2) Materials

(a) Cement

(b) Admixture

(c) Aggregate

(d) Reinforcement

(3) Properties of concrete and materials

(4) Equipment and execution of works

3. Numbers, Terms, Readings and Definitions

The numbers, terms, readings and definitions shall be as follows:

Remarks 1. Where two or more terms are described in one term column, any one of the terms may be used.

2. The term a part of which is shown in parentheses indicates that the term including the letters in the parentheses and also the term omitted with the letters in the parentheses may be used.

Applicable Standards: See pages 27 and 28.

(1) Concrete

No.	Term	Reading	Definition	Reference Equivalent English
1001	Concrete	KONKURĪTO	A mixture of cement, water, fine aggregate, and coarse aggregate, as required with adding admixture.	concrete
1002	Plain concrete	PURĒN KONKURĪTO	Concrete without using chemical admixture, particularly air entraining agent.	plain concrete
1003	AE concrete	ĒĪ KONKURĪTO	Concrete in which micro air bubbles are contained schematically by using air entraining agent.	air entrained concrete
1004	Mortar	MORUTARU	A mixture of cement, water and fine aggregate, as required with adding admixture.	mortar
1005	Cement paste	SEMENTO PĒSUTO	A mixture of cement and water, as required with adding admixtdure.	cement paste
1006	Lightweight concrete	KEIRYŌ KONKURĪTO	Concrete of low mass made by using lightweight aggretate and by containing a large amount of air bubbles.	lightweight concrete
1007	Lightweight aggregate concrete	KEIRYŌ KOTSUZAI KONKURĪTO	Concrete of low mass made by using light-weight aggregate.	lightweight aggregate concrete
1008	Heavy (-weight) concrete, high density. concrete	JŪRYŌ KONKURĪTO	Concrete of high mass made by using heavy-weight aggregate.	heavy (-weight) concrete, high density concrete

No.	Term	Reading	Definition	Reference Equivalent English
1009	Plain concrete, unreinfor-ced concrete	MUKIN KONKURĪTO	Concrete without rein-forcement.	plain concrete, unreinforced concrete
1010	Reinforced concrete	TEKKIN KONKURĪTO	Concrete containing adequate reinforcement.	reinforced concrete
1011	Steel framed reinforced concrete	TEKKOTSU TEKKIN-KONKURĪTO	Concrete reinforced by steel frame and reinforcement.	steel framed reinforced concrete
1012	Prestressed concrete	PURESUTO-RESUTO KONKURĪTO	Concrete given with prestress.	prestressed concrete

(2) Materials

(a) Cement

No.	Term	Reading	Definition	Reference Equivalent English
2101	Cement	SEMENTO	Mineral powders which harden by reaction with water.	cement
2102	Portland cement	PORUTORAND SEMENTO	A cement produced by pulverizing clinker consisting essentially of hydraulic calcium silicates and added with a proper amount of gypsum.	portland cement
2103	Ordinary portland cement	FUTSŪ PORUTORANDO SEMENTO	A portland cement used most generally and specified in JIS R 5210.	ordinary portland cement

No.	Term	Reading	Definition	Reference
				Equivalent English
2104	High-early-strength portland cement	SŌKYŌ PORUTORANDO SEMENTO	A portland cement adjusted so as to produce earlier strength particularly and specified in JIS R 5210.	high-early-strength portland cement
2105	Ultra high-early-strength portland cement	CHŌSŌKYŌ-PORUTORANDO SEMENTO	A portland cement adjusted so as to produce earlier strength further than the high-early-strength portland cement and specified in JIS R 5210.	ultra high-early-strength portland cement
2106	Sulfate resisting portland cement	TAIRYŪSANEN-PORUTORANDO SEMENTO	A portland cement adjusted for tricalcium aluminate to be reduced so as the resistance against corrosion by sulfate particularly to become large, and specified in JIS R 5210.	sulfate resisting portland cement
2107	Moderate heat portland cement	CHŪYŌNETSU PORUTORANDO SEMENTO	A portland cement so adjusted that the heat of hydration particularly becomes small and specified in JIS R 5210.	moderate heat portland cement
2108	White portland cement	HAKUSHOKU PORUTORANDO SEMENTO	A white portland cement having low iron content so as the colour of cement paste to become white even after hardening.	white portland cement
2109	Blended cement	KONGŌ SEMENTO	A cement consisting essentially of portland cement, blended with the materials consisting essentially of silica and lime substances such as pozzolan, rapidly cooled blast-furnace slag, etc.	blended cement
2110	Portlment blast-furnace slag cement	KŌRO SEMENTO	A blended cement using rapidly cooled blast-furnace slag and specified in JIS R 5211.	portlment blast-furnace slag cement

No.	Term	Reading	Definition	Reference Equivalent English
2111	Portland pozzolan cement	SHIRIKA SEMENTO	A blended cement using pozzolan other than fly-ash and specified in JIS R 5212.	portland pozzolan cement
2112	Portland fly-ash cement	FRAIASSHU SEMENTO	A blended cement using fly-ash and specified in JIS R 5213.	portland fly-ash cement
2113	High alumina cement	ARUMINA SEMENTO	A cement produced by pulverlizing clinker consisting essentially of hydraulic calcium aluminate.	high alumina cement

(b) Admixture

No.	Term	Reading	Definition	Reference Equivalent English
2201	Admixture	KONWAZAI-RYŌ	A material other than cement, water, aggregate and added immediately before or during mixing to give concrete or the like the particular properties.	admixture
2202	Admixture	KONWAZAI	Admixture of which volume is to be added to the mixed volume of concrete or the like.	admixture
2203	Pozzolan	POZORAN	Pulvererized silica material which has almost no hydraulic property but hardness by making insoluble compound based on the gradual reaction with calcium hydroxide under existence of water at ordinary temperature.	pozzolan

No.	Term	Reading	Definition	Reference Equivalent English
2204	Fly ash	FRAIASSHU	A kind of pozzolan collected from the waste gas of pulverized-coal burning boiler, and specified in JIS A 6201.	fly ash
2205	Blast-furnace slag	KŌRO SURAGU	Mineral material consisting of compounds such as silica, alumina, line, etc. generated from iron ores and lime stones melt in a blast furnace.	blast furnace slag
2206	Chemical admixture, additive	KONWAZAI	Admixture of which volume is not to be added to the mixed volume of concrete or the like in usual case, or is capable of substituting with mixing water.	chemical admixture, additive
2207	Surface active agent	HYŌMEN KASSEIZAI	Chemical admixture to change the properties of concrete or the like according to surface active actuation.	surface active agent
2208	AE agent	ĒIZAI	Chemical admixture to distribute many minute bubbles of air uniformly in concrete or the like.	air entraining agent
2209	Water reducing agent	GENSUIZAI	Chemical admixture to improve workability without increasing the quantity per unit volume of concrete or the like, or to decrease the water quantity per unit volume without changing the workability.	water reducing agent
2210	Set accelerating agent	KYŪKETSUZAI	Chemical admixture to be used to accelerate hydration reaction of cement and the decrease remarkably shorter the set period of time.	set accelerating agent

No.	Term	Reading	Definition	Reference
				Equivalent English
2211	Accelerator	KŌKA SOKUSHINZAI	Chemical admixture used for accelerating the reaction of hydration of cement to make the strength of primary age larger.	accelerator
2212	Retarder	GYŌKETSU CHIENZAI	Chemical admixture used for retardating the reaction of hydration to make the period of time required for set longer.	retarder

(c) Aggregate

No.	Term	Reading	Definition	Reference
				Equivalent English
2301	Aggregate	KOTSUZAI	Granular material, such as sand, gravel, crushed stone and the like mixed with cement and water to make mortar or concrete.	aggregate
2302	Fine aggregate	SAIKOTSUZAI	Aggregate entirely passing the 10 mm sieve and passing the 5 mm sieve by 85 % or more in mass.	fine aggregate
2303	Coarse aggregate	SOKOTSUZAI	Aggregate retaining on the 5 mm sieve by 85 % or more in mass.	coarse aggregate
2304	Sand	SUNA	Fine aggregate resulted from rock by natural action.	sand
2305	Gravel	JARI	Coarse aggregate resulted from rock by natural action.	gravel

No.	Term	Reading	Definition	Reference
				Equivalent English
2306	Cobble stone, boulder	TAMAISHI	A rounded stone of 10 to 30 cm in diameter.	cobble stone, boulder
2307	Crushed sand	SAISA	Fine aggregate made artificially by crushing rock by crusher or the like.	crushed sand
2308	Crushed stone	SAISEKI	Coarse aggregate made artificially by crushing rock by crusher or the like.	crushed stone
2309	Light-weight aggregate	KEIRYŌ KOTSUZAI	Aggregate having a smaller specific gravity than the normal rock for the purpose of reducing the mass of concrete.	lightweight aggregate
2310	Natural lightweight aggregate, pumice	TENNEN KEIRYŌ KOTSUZAI	Lightweight aggregate resulted naturally according to volcanic action or the like.	natural lightweight aggregate, pumice
2311	Artificial lightweight aggregate	JINKŌ KEIRYŌ KOTSUZAI	Lightweight aggregate made artificially using shale, cinder, blast-furnace slag, fly-ash, etc. as principal raw materials.	artificial lightweight aggregate
2312	Heavy-weight aggregate	JŪRYŌ KOTSUZAI	Aggregate with a larger specific gravity than that of the normal rock to be used for radiation shielding concrete.	heavy-weight aggregate
2313	Standard sand	HYŌJUNSA	The specified sand to be used for mortar for cement-strength test and the natural silicate sand resulted from TOYOURA specified in JIS R 5201.	standard sand

(d) Reinforcement

No.	Term	Reading	Definition	Reference Equivalent English
2401	Rein-forcement	TEKKIN	Steel bar embedded in concrete at a proper position to reinforce.	rein-forcement
2402	Rein-forcing bar	TEKKIN KONKURĪTO YŌ BŌKŌ	Steel bars to be used for concrete reinforcement and specified in JIS G 3112.	rein-forcing bar
2403	Deformed reinforcing bar	IKEIBŌKŌ	Reinforcement provided with protrusions and others on the surface to improve adhesion to concrete and specified in JIS G 3112.	deformed reinforcing bar

(3) Properties of Concrete and Materials

No.	Term	Reading	Definition	Reference Equivalent English
3001	Set	GYŌKETSU	The condition to become hard by gradual loss of fluidity due to action of hydration after a certain lapse of time since mixing the cement with adding water. The test method of set time is specified in JIS R 5201.	set
3002	False set	GI GYŌKETSU	Phenomenon to indicate the state of set tem-porarily while adding water to cement or immediately thereafter without normal action of hydration.	false set
3003	Hardening	KŌKA	Phenomenon to increase the hardness and strength following the lapse of time after set of cement.	hardening

No.	Term	Reading	Definition	Reference: Equivalent English
3004	Heat of hydration	SUIWANETSU	Heat evolved by action of hydration of cement. The testing method is specified in JIS R 5203.	heat of hydration
3005	Fineness test	FUNMATSUDO SHIKEN	The test to examine the fineness of particles such as cement, fly ash, etc. and specified in JIS R 5201.	fineness test
3006	Soundness test (cement)	ANTEISEI-SHIKEN (SEMENTO NO)	The test to examine whether or not the stable action of hydration is carried out without causing abnormal volume change of cement and is specified in JIS R 5201.	soundness test (cement)
3007	Soundness test (aggregate)	ANTEISEI SHIKEN (KOTSUZAI NO)	The test to judge the durability of aggregate from the state of damaged aggregate by repeating the drying operation in a drying furnace by specified number of times after immersing the aggregate in the saturated solution of sodium sulfate and it is specified in JIS A 1122.	soundness test (aggregate)
3008	Ignition loss test	KYŌNETSU GENRYO SHIKEN	The test to obtain the loss of mass by igniting the sample at a definite temperature in order to confirm the degree of weathering in the case of cement and the completeness of burning in the case of artificial lightweight aggregate, and it is specified in JIS R 5202 concerning the cement.	ignition loss test

No.	Term	Reading	Definition	Reference
				Equivalent English
3009	Absolute dry-condition (aggregate)	ZETTAI KANSŌ JOTAI (KOTSUZAI NO)	The condition removed of the water contained in the aggregate particles by drying until constant mass at a temperature of 100 to 110°C.	absolute dry-condition (aggregate)
3010	Saturated surface-dry condition (aggregate)	HYŌMEN KANSŌ HŌSUIJOTAI (KOTSUZAI NO)	The condition where the aggregate has no surface moisture and the voids inside the aggregate particle are filled with water.	saturated surface-dry condition (aggregate)
3011	Surface moisture (aggregate)	HYŌMENSUI (KOTSUZAI NO)	The water adhering on the surface of aggregate and it is the whole water contained in the aggregate subtracted by the water inside the aggregate particles.	surface moisture (aggregate)
3012	Percentage of water absorption (aggregate)	KYŪSUIRITSU (KOTSUZAI NO)	The mass percentage of whole amount of water contained in aggregate under the saturated surface-dry condition to the mass of aggregate under the absolute-dry condition.	percentage of water absorption (aggregate)
3013	Percentage of water content (aggregate)	GANSUIRITSU (KOTSUZAI NO)	The percentage of total amount of sum of water contained in voids inside the aggregate particles and the surface moisture to the mass of aggregate under the absolute-dry condition.	percentage of water content (aggregate)

No.	Term	Reading	Definition	Reference Equivalent English
3014	Specific gravity in saturated surface-dry condition (aggregate)	HYŌKAN HIJU (KOTSUZAI NO)	The value of mass of aggregate in saturated surface-dry condition divided by the mass of water of the same volume. The test methods are specified in JIS A 1109 and JIS A 1110.	specific gravity in saturated surface-dry condition (aggregate)
3015	Specific gravity in absolute dry condition (aggregate)	ZEKKANHIJŪ (KOTSUZAI NO)	The value of mass of aggregate in absolute-dry condition divided by the mass of water of the same volume.	Specific gravity in absolute dry condition (aggregate)
3016	Percentage of absolute volume (aggregate)	JISSEKIRITSU (KOTSUZAI NO)	Percentage of absolute volume of aggregate filled in a vessel to the volume of the vessel. The test method is specified in JIS A 1104.	percentage of absolute volume (aggregate)
3017	Test for unit weight (aggregate)	TANIYŌSEKI SHITSURYŌ SHIKEN (KOTSUZAI NO)	The test for measuring unit weight (aggregate) and it is specified in JIS A 1104.	test for unit weight (aggregate)
3018	Fineness modulus (aggregate)	SORYŪRITSU (KOTSUZAI NO)	The value of sum of mass percentages of the total samples retained on each sieve divided by 100 when the sieve analysis is carried out by using a set of sieves of 80, 40, 20, 10, 5, 2.5, 1.2, 0.6, 0.3, 0.15 mm.	fineness modulus (aggregate)
3019	Sieve analysis	FURUIWAKE SHIKEN	The test to obtain mass percentage of the sample passed each sieve or that retained on each sieve when screening by using a set of standard sieves to obtain the grading distribution of aggregate, and it is specified in JIS A 1102.	sieve analysis

No.	Term	Reading	Definition	Reference Equivalent English
3020	Standard (test) sieve	HYŌJUNFURUI	The sieve specified in JIS Z 8801.	standard (test) sieve
3021	Maximum size (coarse aggregate)	SAIDAI SUMPŌ (SOKOTSUZAI NO)	The size of coarse aggregate indicated by size of sieve of the minimum size of the sieves through which mass of 90 % or more passes.	maximum size (coarse aggregate)
3022	Test for percentage of soft particles (coarse aggregate)	NANSEKIRYŌ SHIKEN (SOKOTSUZAI NO)	The test to judge the amount of soft particles contained in aggregate and it is specified in JIS A 1126.	test for percentage of soft particles (coarse aggregate)
3023	Test for amount of material passing standard sieve 74 μm in aggregates	ARAI SHIKEN (KOTSUZAI NO)	The test to screen on sieve while flowing water to measure the amount of min particles contained in aggregate and it is specified in JIS A 1103.	test for amount of material passing standard sieve 74 μm in aggregates
3024	Abrasion test (coarse aggregate)	SURIHERI SHIKEN (SOKOTSUZAI NO)	The test to judge the abrasion resistance of aggregate by measuring abrasion loss of aggregate at a specified number of revolution with applying friction to the aggregate in a rotating drum and it is specified in JIS A 1121.	abrasion test (coarse aggregate)
3025	Test for clay lumps (in aggregate)	NENDOKAI SHIKEN (KOTSUZAICHU NO)	The test to obtain the amount of clay lumps contained in aggregate and it is specified in JIS A 1137.	test for clay lumps (in aggregate)

No.	Term	Reading	Definition	Reference Equivalent English
3026	Organic impurities test (sand)	YŪKI FUJUNBUTSU SHIKEN (SUNA NO)	The test to determine the approximate harmful amount of organic impurities contained in sand to be used in mortar or concrete and it is specified in JIS A 1105.	organic impurities test (sand)
3027	Test for chloride content (sand)	ENKABUTSU NO SHIKEN (SUNA NO)	The test to carry out the quantitative analysis of chlorides contained in sand by using reagent and it is specified in JIS A 5002.	test for chloride content (sand)
3028	Workability	WĀKABIRICHĪ	The property of not yet solidified concrete indicated by degree of difficulty of working depending on consistency and the resistance against separation of material required for making uniform concrete.	workability
3029	Consistency	KONSHISUTENSHĪ	The property of not yet solidified concrete indicated by degree of softness depending mainly on unit water quantity.	consistency
3030	Slump	SURANPU	The degree of softness of not yet solidified concrete or the like expressed by lowering (cm) from the top measured immediately after raising slump cone. The test method is specified in JIS A 1101.	slump
3031	Test for unit weight (concrete)	TAN'IYOSEKI SHITSURYŌ SHIKEN (KONKURĪTO NO)	The test to measure the unit weight of concrete and it is specified in JIS A 1116.	test for unit weight (concrete)

No.	Term	Reading	Definition	Reference Equivalent English
3032	Flow	FURŌ	The measure to determine the fluidity depending on the spreading of diameter of concrete and the like when impacts of specified number of times are given with removing upward the cone after filling, while tamping by specified number of times, not yet solidified mortar, cement paste, concrete, etc. in the specified cone placed on a steel sheet table.	flow
3033	Finishability	FINISSHA-BIRITI	The property of not yet solidified concrete indicating difficulty of workability in the case of finishing the surface of concrete to the required flatness and smoothness.	finishability
3034	Bleeding	BURĪJINGU	Phenomenon for a portion of mixing water to raise by liberation due to settling or segregation of solid substances in not yet solidified concrete or mortar.	bleeding
3035	Segregation	BUNRI	Phenomenon for the distribution of several materials to become non uniform during transportation, placing or after placing of fresh concrete.	segregation
3036	Air content	KŪKI RYŌ	Percentage of volume of air bubbles contained in cement paste or mortar in the concrete to the total volume of concrete.	air content

No.	Term	Reading	Definition	Reference Equivalent English
3037	Entrapped air	ENTORAPPUTO-EĀ	Air bubbles contained in concrete originally, not brought in concrete artificially.	entrapped air
3038	Entrained air	ENTORENDO-EĀ	Independent min bubbles of air made artificially in concrete by using air entraining agent or chemical admixture having entraining action.	entrained air
3039	Test piece, specimen	KYŌSHITAI	Sample of concrete prepared to carry out each test.	test piece, specimen
3040	Cylindrical test piece, cylindrical specimen	ENCHŪKEI KYŌSHITAI	Cylindrical specimen to be used for strength test or the like of concrete and others specified in JIS A 1132.	cylindrical test piece, cylindrical specimen
3041	Capping	KYAPPINGU	Finishing the surface of specimen for compressive strength test to flatness and smoothness by using proper material.	capping
3042	Compressive strength	ASSHUKU KYŌDO	The value of the maximum compressive load to which the specimen is able to withstand divided by the sectional area perpendular to compressive load of the specimen. The test method is specified in JIS A 1108.	compressive strength
3043	Tensile strength	HIPPARI KYŌDO	The value of the maximum tensile load to which the specimen is able to withstand divided by sectional area perpendicular to tensile load of the specimen or the value to be obtained according to JIS A 1113.	tensile strength

No.	Term	Reading	Definition	Reference
				Equivalent English
3044	Flexural strength, modulus of rupture	MAGE KYŌDO	The value of the maximum bending moment to which the specimen is able to withstand divided by section modulus of the specimen. The test method is specified in JIS A 1106.	flexural strength, modulus of rupture
3045	Shear strength	SENDAN KYŌDO	The value of the maximum load along the shearing section divided by the sectional area of the shearing section.	shear strength
3046	Bearing strength	SHIATSU KYŌDO	The value of the maximum compressive load endurable when received partially the compressive load divided by the load-working area.	bearing strength
3047	Bond strength	FUCHAKU KYŌDO	The value of force endurable at the jointing surface of two materials such as reinforcement and concrete, mortar and concrete, etc. divided by the area of jointing surface.	bond strength
3048	Non-destructive test	HIHAKAI SHIKEN	The test to judge several properties of concrete without breakage.	non-destructive test
3049	Creep	KURĪPU	Phenomenon where the strain excluding elastic strain and drying shrinkage strain increases depending on time in the condition applied with stress.	creep
3050	Drying shrinkage	KANSŌ SHŪSHUKU	Phenomenon where the length of hardened concrete shrinks by drying.	drying shrinkage

No.	Term	Reading	Definition	Reference Equivalent English
3051	Shrinkage crack	KANSŌ HIBIWARE	Crack caused in concrete accompanied by drying shrinkage.	shrinkage crack
3052	Neutrali-zation	CHŪSEIKA	Phenomenon for the hardened concrete to lose gradually the alkalinity by receiving the action of carbon dioxide gas in air.	neutralization
3053	Durability	TAIKYŪSEI	Property of concrete able to resist weathering action, chemical attack, mechanical damage, etc.	durability
3054	Freezing and thawing test	TŌKETU YŪKAI SHIKEN	The test to examine the resistance when the concrete is applied with repeated action of artificial freezing and thawing.	freezing and thawing test
3055	Alkali-aggregate reaction	ARUKARI KOTSUZAI HANNO	Phenomenon where concrete blisters to cause cracks or rupture due to reaction in long term of certain kind of aggregate with cement and other alkalies.	alkali-aggregate reaction
3056	Water-tightness	SUIMITSUSEI	Resistance to intrusion or transmission of water into inside of concrete.	water-tightness
3057	Permeability test	TŌSUI SHIKEN	The test to obtain the velocity of water travelling inside the concrete by pressure difference.	permeability test
3058	Water cement ratio	MIZU SEMENTOHI	Mass ratio or mass percentage of water quantity to cement quantity in the paste contained in concrete or mortar immediately after mixing.	water cement ratio

No.	Term	Reading	Definition	Reference Equivalent English
3059	Cement water ratio	SEMENTO MIZUHI	Mass ratio of cement quantity to water quantity in the paste contained in concrete or mortar immediately after mixing.	cement water ratio
3060	Laitance	REITANSU	A layer of non-hardening substances formed on the surface of concrete by rise of inner min particles together with bleeding water accompanied by bleeding after placing concrete.	laitance
3061	Efflorescence	EFURORESSENSU	White substances formed on a surface of hardened concrete.	efflorescence
3062	Proportion, mix	HAIGŌ CHŌGŌ	Using proportion or amount of using of each material when making concrete.	proportion, mix
3063	Design strength	SEKKEI KIJUN KYODO	Strength of concrete used as reference in design calculation.	design strength
3064	Proportioning strength	HAIGŌ KYŌDO, CHŌGO KYŌDO	Strength to be target in the case of deciding proportion of concrete.	proportioning strength
3065	Designated strength	SHITEI KYODO	The value of design reference strength corrected with atmospheric temperature.	designated strength
3066	Nominal strength	YOBI KYŌDO	Division of strength of concrete specified in JIS A 5308.	nominal strength
3067	Specified mix	SHIHŌ HAIGŌ, KEIKAKU CHŌGŌ	Proportion to be able to obtain the concrete of specified quality and designated by specification or by the engineer in charge. It is expressed by using amounts of materials in 1 m^3 of finished mixed concrete.	specified mix

No.	Term	Reading	Definition	Reference Equivalent English
3068	Field mix, job mix	GENBA HAIGŌ, GENBA CHŌGO	Proportion specified depending on the condition of materials in the field or measuring method in order to be able to obtain concrete of specified mix.	field mix, job mix
3069	Quantity of material per unit volume of concrete	TAN'I RYŌ	Quantity of material to be used for making 1 m^3 of concrete. Quantity of cement, quantity of water, quantity of coarse aggregate respectively per unit volume of concrete, and the like.	quantity of material per unit volume of concrete
3070	sand percentage	SAIKOTSUZAI RITU	The value expressed by percentage of absolute volume ratio of amount of fine aggregate to total aggregates in the concrete.	sand percentage
3071	washing analysis (concrete)	ARAI BUNSEKI SHIKEN (KONKURĪTO NO)	The test to obtain proportion ratio of each material by washing with water the fresh concrete through sieve and it is specified in JIS A 1112.	washing analysis (concrete)
3072	Precooling	PUREKŪRINGU	Cooling the materials of concrete to lower the mixing finish temperature of concrete.	precooling
3073	Prewetting	PUREUETCHI-NGU	Allowing to absorb water sufficiently by spraying water or immersing in water preliminarily at the time of using lightweight aggregate.	prewetting

(4) Equipment and Execution of Works

No.	Term	Reading	Definition	Reference Equivalent English
4001	Batch mixer	BATCHI MIKISA	A mixer to mix concrete materials for each batch.	batch mixer
4002	Continuous mixer	RENZOKUNERI MIKISA	A mixer into which the concrete materials are fed successively and mixed continuously and from which the mixed product is able to be discharged.	continuous mixer
4003	Gravity type mixer	JŪRYOKUSHIKI MIKISA	A mixer of the type in which the concrete is sucked up by rotation of mixing shell of the mixer and then fallen by self weight to be mixed.	gravity type mixer
4004	Tilting mixer	KAKEISHIKI MIKISA	A mixer of the type in which the concrete is mixed by rotation of mixing shell of concaved square shape and from which the mixed concrete is discharged by tilting the mixing shell. A kind of gravity type mixers and it is specified in JIS A 8602.	tilting mixer
4005	Drum mixer	DORAMU MIKISA	A mixer of the type in which the concrete is mixed by rotation of mixing shell of circular cylinder shape and from which the mixed concrete is discharged without tilting the mixing shell. It is a kind of gravity type mixers and is specified in JIS A 8601.	drum mixer
4006	Forced mixing type mixer	KYŌSEINERI MIKISA	A mixer of the type to mix forcedly concrete by rotating the vane by power. It is specified in JIS A 8603.	forced mixing type mixer

No.	Term	Reading	Definition	Reference Equivalent English
4007	Mixing	NERIMAZE	Mixing the concrete materials to make uniform.	mixing
4008	Remixing	NERINAOSHI	Mixing again in the case where concrete does not begin to harden but a certain period of time has elapsed after mixing or where the materials have segregated.	remixing
4009	Retempering	NERIKAESHI	The working to mix again when the concrete has begun hardening.	retempering
4010	Trial mixing	TAMESHINERI	Mixing to be carried out to examine whether the specified concrete can be obtained or not at the designed proportion.	trial mixing
4011	Ready-mixed concrete	REDĒMIKUSOTO KONKURĪTO	Concrete in unhardened state able to be purchased at any time from factory having arranged concrete manufacturing equipment. It is specified in JIS A 5308.	ready-mixed concrete
4012	Agitator	AJITĒTA	A machine to mix by agitation to prevent segregation before placing the unhardened concrete.	agitator
4013	Concrete pump	KONKURĪTO PONPU	An apparatus which forces unhardened concrete mechanically and feeds continuously through a pipeline.	concrete pump
4014	Concrete placer	KONKURĪTO PURĒSA	An apparatus which sends out the unhardened concrete by compressed air through a pipeline.	concrete placer

No.	Term	Reading	Definition	Reference Equivalent English
4015	Chute	SHŪTO	A device of trough or tube shape to conduct the unhardened concrete by flowing from a higher to a lower place.	chute
4016	Placing	UCHIKOMI	Throwing the fresh concrete in the specified place to fill.	placing
4017	Compaction	SHIMEKATAME	The process to make compact with reducing voids by tamping, tapping, or vibrating the placed concrete.	compaction
4018	Vibrator	SHINDŌKI	A machine to compact the fresh concrete by giving oscillation. It is specified in JIS A 8610 and JIS A 8611.	vibrator
4019	Tamping	TANPINGU	The operation of compacting by blowing the surface of concrete from the time of placing concrete for floor or pavement until hardening.	tamping
4020	Honeycomb	MAMEITA	An ununiform part having many voids caused by collection of only coarse aggregates in a part of hardened concrete.	honeycomb
4021	Precast concrete	PUREKYASUTO-KONKURĪTO	Concrete made able to be used as member, which is produced in a factory or the working field.	precast concrete
4022	Prepacked concrete	PUREPAKKUDO-KONKURĪTO	Concrete produced by filling coarse aggregate preliminarily in a form and then injecting mortar between the coarse aggregates.	prepacked concrete

No.	Term	Reading	Definition	Reference Equivalent English
4023	Shotcrete	FUKITSUKE KONKURĪTO	Concrete produced by spraying to the specified place with pneumatically feeding in a hose by using compressed air.	shotcrete
4024	Con-struction joint	UCHITSUGIME	Joint of new and old concrete produced at newly placing concrete in contact with hardened or commenced to harden concrete.	construction joint
4025	Expansion joint	BŌCHŌ MEJI	Concrete joint provided against compressive stress due to expansion.	expansion joint
4026	Con-traction joint	SHŪSHUKU MEJI	Concrete joint provided against tensile stress due to shrinkage.	contraction joint
4027	Dummy joint	MEKURAMEJI	A joint created by forming only a groove in the surface of concrete.	dummy joint
4028	Grout	GURAUTO	Cement paste or mortar improved of filling property by adding admixture in order to fill in a thin clearance.	grout
4029	Grouting	GARAUCHINGU	Work to inject grout.	grouting
4030	Curing	YŌJŌ	Procedure to secure proper temperature and humidity and to protect from outer force in order to develop sufficiently the hardening action of concrete.	curing
4031	Wet-curing	SHITSUJUN YŌJŌ	Curing with maintaining the surface and inside of concrete in wet state.	wet-curing

No.	Term	Reading	Definition	Reference Equivalent English
4032	Standard curing	HYOJUN YŌJŌ	Curing with maintaining mortar and concrete in water at about 20°C or in air near 100 % in humidity.	standard curing
4033	Water curing	SUICHŪ YŌJŌ	Curing with concrete immersing in water.	water curing
4034	Membrane curing	MAKU YŌJŌ	Curing with protecting evaporation of water content by making membrane on the surface after placing concrete.	membrane curing
4035	Accelerated curing	SOKUSHIN YŌJŌ	Curing accelerated in hardening and development of strength of concrete by raising temperature and adding pressure.	accelerated curing
4036	Steam curing	JŌKI YŌJŌ	Accelerated curing by use of steam at a high temperature.	steam curing
4037	Atmospheric pressure steam-curing	JŌATSU JŌKI YŌJŌ	Steam curing to be carried out under atmospheric pressure.	atmospheric pressure steam-curing
4038	High pressure steam curing, autoclave-curing	KŌATSU JŌKI YŌJŌ	Steam curing to be carried out by using high temperature steam at 1 or more atmospheric pressure in a high pressure vessel.	high pressure steam curing, autoclave-curing
4039	Pipe cooling	PAIPU-KŪRINGU	Procedure to cool concrete by passing cool water in the pipe embedded in the concrete.	pipe cooling

No.	Term	Reading	Definition	Reference: Equivalent English
4040	Vacuum concrete	SHINKŪ KONKURĪTO	Concrete produced by lowering the inside pressure with setting a vacuum mat or the like on the surface after placing concrete so that water in excess is sucked out and pressure is applied by atmospheric pressure.	vacuum concrete
4041	Formwork, shuttering	KATAWAKU	General term of temporary constructions to maintain the placed concrete at the specified shape and dimensions and to support until the concrete reaches a proper strength.	formwork, shuttering
4042	Sheathing	SEKIITA	A part of formwork of plates of wood, metal or the like in direct contact with concrete.	sheathing
4043	Support	SHIHOKŌ	A temporary construction to fix the sheathing at the specified position which is a part of formwork.	support
4044	Cover (rein-forcement)	KABURI (TEKKIN NO)	The minimum distance between the surface of reinforcecment and the surface of concrete at its outside.	cover (rein-fofcement)

Applicable Standards:

JIS A 1101-Method of Test for Slump of Concrete

JIS A 1102-Method of Test for Sieve Analysis of Aggregate

JIS A 1103-Method of Test for Amount of Material Passing Standard Sieve 74 μm in Aggregates

JIS A 1104-Method of Test for Unit Weight of Aggregate and Solid Content in Aggregate

JIS A 1105-Method of Test for Organic Impurities in Fine Aggregate

JIS A 1106-Method of Test for Flexural Strength of Concrete

JIS A 1108-Method of Test for Compressive Strength of Concrete

JIS A 1109-Method of Test for Specific Gravity and Absorption of Fine Aggregate

JIS A 1110-Method of Test for Specific Gravity and Absorption of Coarse Aggregate

JIS A 1112-Method of Test for Washing Analysis of Fresh Concrete

JIS A 1113-Method of Test for Spliting Tensile Strength of Concrete

JIS A 1116-Method of Test for Unit Weight and Air Content (Gravimetric) of Fresh Concrete

JIS A 1121-Method of Test for Abrasion of Coarse Aggregate by Use of the Los Angeles Machine

JIS A 1122-Method of Test for Soundness of Aggregate by Use of Sodium Sulfate

JIS A 1126-Method of Test for Soft Particles in Coarse Aggregate by Use of Scratch Tester

JIS A 1132-Method of Making and Curing Concrete Specimens

JIS A 1137-Method of Test for Clay Contained in Aggregate

JIS A 5002-Light Weight Aggregates for Structural Concrete

JIS A 5308-Ready-Mixed Concrete

JIS A 6201-Fly Ash

JIS A 8601-Drum Type Mixers

JIS A 8602-Tilting Mixers

Applicable Standards:

JIS A 8603-Forced Mixing Type Mixers

JIS A 8610-Internal Vibrators for Concrete

JIS A 8611-Form Vibrators for Concrete

JIS G 3112-Steel Bars for Concrete Reinforcement

JIS R 5201-Physical Testing Methods of Cement

JIS R 5202-Method for Chemical Analysis of Portland Cement

JIS R 5203-Testing Method for Heat of Hydration of Cement

JIS R 5210-Portland Cement

JIS R 5211-Portland Blast-furnace Slag Cement

JIS R 5212-Portland Pozzolan Cement

JIS R 5213-Portland Fly-ash Cement

JIS Z 8801-Test Sieves

(A2)

UDC 666.972.2:620.163

JAPANESE INDUSTRIAL STANDARD

J I S

Method of Test for Slump of Concrete

A 1101-1975
(Reaffirmed: 1989)

1. Scope

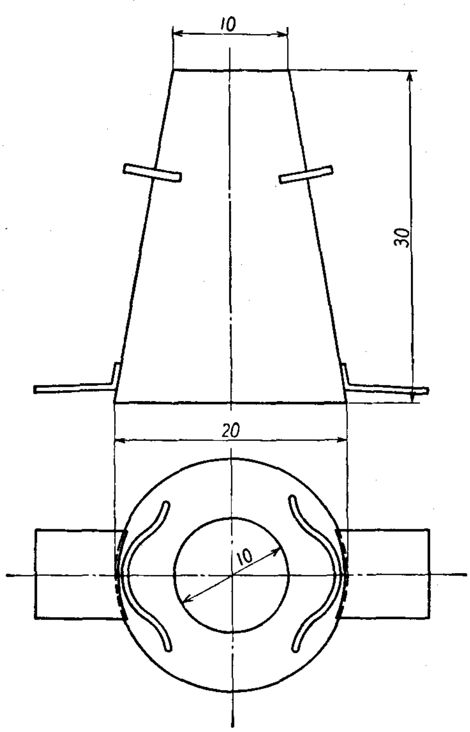
This Japanese Industrial Standard specifies the method of test for slump of concrete.

2. Test Appliances

2.1 The slump cone used shall be a cone made of iron having 10 cm in upper end inner diameter, 20 cm in lower end inner diameter, and 30 cm in height, with holding handles and grips at suitable positions, as shown in Fig. 1.

Fig. 1

Unit: cm



Applicable Standards:

JIS A 1115-Method of Sampling Fresh Concrete

JIS A 1138-Method of Making Test Sample of Concrete in the Laboratory

2.2 The tamping rod used shall be a round steel rod of 16 mm in diameter and 50 cm in length with a hemispherical end.

3. Sample

The sample shall be taken in accordance with JIS A 1115 or prepared in accordance with JIS A 1138.

4. Test

4.1 The slump cone with its inner surface wiped with a wet cloth or the like shall be placed on a watertight flat plate installed horizontally, and the sample shall be packed in the slump cone in three layers of almost equal quantities. Each layer shall be levelled with a tamping rod and then picked uniformly 25 times. Where there is the risk of segregation occurring in the packed material when picked at this rate, the number of times of picking shall be reduced to the extent that no segregation occurs.

The depth of picking with the tamping rod for each layer shall be such that the tamping rod end almost reaches the underlying layer.

4.2 The time duration from starting the packing of concrete in the slump cone to the end of the packing operation shall be within 3 min.

4.3 After making the upper surface of the concrete packed in the slump cone flush with the upper end of the slump cone and levelling it, the slump cone shall immediately be quietly pulled up vertically ([1]), and the lowering height of the concrete surface at the centre shall be measured and this shall be taken as the slump.

Note ([1]) The time duration for pulling up the slump cone shall be 2 to 3 sec for a height of 30 cm.

5. Test Result

The slump shall be measured to the nearest 0.5 cm.

Remarks 1. In the case of concrete whose maximum size of coarse aggregate is 40 mm or larger, those particles of coarse aggregate of 40 mm or larger in size shall be removed.

2. Where the form of the concrete has become eccentric about the central axis of the slump cone or the form has become irregular due to crumbling or the like, the test shall be performed again by using a separate sample.

6. Report

Those required information items from the following shall be written in the report:

(1) Date and time

(2) Weather

(3) Atmospheric temperature

(4) Batch number

(5) Maximum size of coarse aggregate

(6) Temperature of concrete

(7) Slump

(8) Others

(A3) UDC 666.972.017:620.174

JAPANESE INDUSTRIAL STANDARD — J I S

Method of Test for Flexural Strength of Concrete

A 1106-1976
(Reaffirmed: 1979)

1. Scope

This Japanese Industrial Standard specifies method of test for flexural strength of concrete by third-point loading.

Remark: In this standard, the particulars in { } are in accordance with the International System of Units (SI) and given for reference only.

Applicable Standards:

JIS A 1132-Method of Making and Curing Concrete Specimens

JIS B 7733-Compression Testing Machines

2. Testing Machine and Apparatus

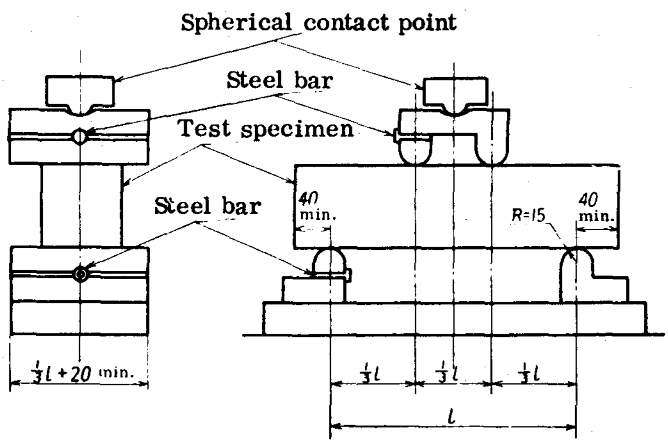
2.1 The compression testing machine shall conform to JIS B 7733.

2.2 The apparatus used for testing shall be such as to ensure third-point loading to be applied vertically and evenly without eccentricity. Further, when test specimen is positioned, it shall be stable with sufficient rigidity. Fig. 1 indicates an example of the principle of a suitable testing equipment ([1]).

Note ([1]) On the actual equipment, a consideration of a pin for the crosshead of the upper pressure application device will be required. Also, substitution of steel ball for spherical contact point, or suitable curved surface such as a bilge in place of steel pin may be permitted.

Fig. 1

Unit: mm



3. Test Specimen

3.1 The test specimen shall be prepared by the method specified in JIS A 1132 ([2]).

Note ([2]) The age of test specimen to be tested shall, as a standard, be one week and four weeks.

3.2 The test specimen shall be prepared in such a manner that it can be tested under the condition of immediately after the curing period ([3]).

Note ([3]) Since the strength of concrete varies at times considerably in the state of dryness and temperature, the test shall be carried out under the condition of immediately after the curing period.

4. Method of Testing

4.1 The testing machine shall be used over the range from 1/5 to full of weighing capacity. When the setting of the weighing capacity is able to be varied in the same testing machine, the weighing capacity shall be regarded as the individual for each varied setting.

4.2 The sides of the concrete specimen when cast into mould shall be used as upper and lower surfaces. The test specimen shall be placed at the centre of the width of the supports and the upper pressure application device shall contact the specimen at third points of the span. In this case, the gap(4) between the contact surfaces of the loading apparatus and surfaces of the test specimen, in anywhere, shall not be observed.

Note (4) When any gap is found between the contact surface of the loading apparatus and surface of the test specimen, good contact shall be ensured by grinding the surface of the test specimen evenly.

4.3 The span shall be 3 times the height (5) of the test specimen.

Note (5) For the height of test specimen the nominal value shall be used.

4.4 The load shall be applied evenly avoiding impact.

The loading speed shall be so made that the increase of extreme fibre stress (6) becomes, as a standard, 8 to 10 kgf/cm^2 {0.78 N/mm^2 to 0.98 N/mm^2} per minute (7).

Notes (6) The calculation of extreme fibre stress shall conform to the formula shown in 5.1.

(7) A comparatively high loading speed may be applied up to about 50 % of the maximum load.

4.5 The value of maximum load up to the fracture of the test specimen, indicated by the testing machine, shall be read to three significant figures.

4.6 The width of fractured cross-sections shall be measured to the nearest 0.2 mm at 3 places and the mean value shall be obtained to four significant figures.

4.7 The height of fractured cross-sections shall be measured to the nearest 0.2 mm at 2 places and mean value shall be obtained to three significant figures.

5. Calculation of Results

5.1 If the test specimen should break within the central 1/3 of the span on the tension side, the flexural strength shall be calculated from the following formula and obtained to three significant figures.

$$\sigma_b = \frac{Pl}{bd^2}$$

where, σ_b : flexural strength (kgf/cm^2) {N/mm^2}

P : maximum load indicated by testing machine (kgf) {N}

l : length of span (cm) {mm}

b : width of fractured cross-section (cm) {mm}

d : height of fractured cross-section (cm) {mm}

5.2 If the fracture should take place outside the central 1/3 portion of the span on the tension side, and should the distance between the third point and the intersection of fractured cross-section and centre line be within 5 % of the span length, the fractural strength shall be calculated from the following formula and obtained to three significant figures.

$$\sigma_b = \frac{3Pa}{bd^2}$$

where, a : mean distance between fractured cross-section and nearest outside support measured at 2 places on the tension side of the span in the direction of the span (cm) {mm}, and be obtained to four significant figures.

5.3 If the fracture should take place outside the centre 1/3 position of the tension side and the distance between load point and the fractured cross-section be more than 5 % of span length, the test shall be considered void.

6. Report

Necessary items of the following shall be included in the report.

(1) Identification number of test specimen

(2) Age of specimen

(3) Width of test specimen (cm)

(4) Height of test specimen (cm)

(5) Span (cm)

(6) Maximum load (kgf) {N}

(7) Flexural strength (kgf/cm^2) { N/mm^2 }

(8) Method of curing and curing temperature

(9) State of fracture of test specimen

(10) Other particulars

(A4) UDC 666.972:620.113.41:620.173

JAPANESE INDUSTRIAL STANDARD JIS

Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete

A 1107-1978
(Reaffirmed: 1983)

1. Scope

This Japanese Industrial Standard specifies the tests on the compressive strength of cores drilled from the concrete and flexural strength of beams sawed from the concrete, as well as on the compressive strength using portions of beams broken in flexure.

Remark: In this standard, units and numerical values given in { } are in accordance with the International System of Units (SI), and are appended for reference.

2. Time and Methods of Cutting Out Specimens

The time and methods of cutting out specimens shall be as follows:

(1) The cores or beams shall not be cut out until the time ([1]) the concrete has become hard enough to permit cutting out operation without disturbing the bond between the coarse aggregate and the mortar.

Furthermore, the cutting out operation shall be so made as neither to cause damage of specimens nor to loosen the coarse aggregate in cutting.

Note ([1]) In general, the age of concrete should be 14 days or older.

(2) A core drill for concrete shall be used to cut out the cores.

Applicable Standards:

JIS A 1106-Method of Test for Flexural Strength of Concrete

JIS A 1108-Method of Test for Compressive Strength of Concrete

JIS A 1114-Method of Test for Compressive Strength of Concrete Using Portions of Beams Broken in Flexure

JIS A 1132-Method of Making and Curing Concrete Specimens

(3) In cutting out a piece of concrete to prepare the core specimen or beam specimen, the sample shall be cut out large enough so that the specimen of required dimensions can be obtained from the portion which has not been damaged in cutting process.

A concrete cutter shall be used to cut out the beam specimen from the concrete piece obtained. Care shall be taken particularly so that the side faces of the test specimen obtained by the cutter are parallel to each other and the cross-sections are made square.

(4) Test specimens which have been damaged or of which coarse aggregate have been loosened in cutting process shall not be used in testing.

3. Dimensions of Test Specimen

The dimensions of core and beam specimens shall be as follows:

(1) Diameter of the core specimen and one side of the beam specimen section shall generally be three times or more of the maximum size of the coarse aggregate, and in no case these shall be two times or less of that.

(2) Height of the core specimen shall generally be two times the diameter.

(3) Section of the beam specimen shall generally be 15 cm x 15 cm and the length be 53 cm or more. However, if two flexural strength tests are to be made on one piece of test specimen, the length shall be 81 cm or more.

4. Arrangements for Tests

The arrangements for the tests shall be carried out as follows:

(1) If any unevenness of 5 mm or more is found on an end surface of the core specimen, or if the angle of the end surface to the core axis is not more than 85 deg, the end surface shall be corrected using a cutter and the like to a smooth surface as well as to make right angles to the axis of the core specimen.

(2) Both end surfaces of the core specimen shall be capped in accordance with 4.4 of JIS A 1132 or be finished to a prescribed flatness by polishing.

(3) The portion of the beam specimen which contacts with the loading apparatus shall be finished to have well contact with that by capping ([2]).

Note ([2]) The capping shall be made in conformance with 4.4 of JIS A 1132.

(4) The core and beam specimens shall generally be submerged in water (20 ± 3°C) for 40 to 48 h before testing (3).

Note (3) These are not necessary be submerged in water according to the object of testing.

(5) The core specimen shall be measured to the nearest 0.25 mm in diameters at both ends near the upper and lower end surfaces and at midheight, in two directions at right angles to each other, the average value shall be taken as the average diameter of the test specimen.

Respective heights shall be measured to the nearest 0.25 mm at side faces on both ends of a diameter passing through the center of the core specimen, and the average value shall be taken as the average height of the test specimen.

5. Tests

5.1 The method of compressive strength test for the core specimens shall be in accordance with JIS A 1108. However, where the height of the test specimen is less than two times the diameter, the compressive strength obtained from the test shall be converted to that of test specimen, having height twice the diameter by multiplying the correction factor given in following Table 1.

Table 1

Height-to-diameter ratio $\frac{h}{d}$	Correction factor	Remark
2.00	1.00	Where a value $\frac{h}{d}$ comes between the values given in this Table, the correction factor shall be determined by interpolation.
1.75	0.98	
1.50	0.96	
1.25	0.93	
1.00	0.89	

5.2 The method of flexural strength test for the beam specimen shall be in accordance with JIS A 1106.

The method of compressive strength test using portions of a beam broken in flexure shall be in accordance with JIS A 1114.

6. Report

Required items, among the following information, shall be stated in the report:

(1) No. of test specimen

(2) Location from which the test specimen has been cut out

(3) Method with which the test specimen has been cut out

(4) Age of concrete

(5) In the case of core specimen, its average diameter, average height and correction factor (cm)

(6) The maximum permissible load (tf) {kN}

(7) Span (cm)

(8) Compressive strength (kgf/cm^2) {N/cm^2} computed to the nearest 1 kgf/cm^2 {9.81 N/cm^2}

(9) Flexural strength (kgf/cm^2) {N/cm^2} computed to the nearest 0.1 kgf/cm^2 {0.98 N/cm^2}

(10) Direction of application of the load with respect to the direction of the concrete as placed ([4])

(11) Method of curing and curing temperature

(12) Appearance of the test specimen, conditions of failure and others

Note ([4]) For instance, state as at right angles or as parallel to the direction as placed.

(A5) UDC 666.97.017:620.173

JAPANESE INDUSTRIAL STANDARD JIS

Method of Test for Compressive Strength of Concrete

A 1108-1976
(Reaffirmed: 1986)

1. Scope

This Japanese Industrial Standard specifies method of test for compressive strength of concrete.

Remark: In this standard, the particulars in { } are in accordance with the International System of Units (SI) and given for reference only.

Applicable Standards:

JIS A 1132-Method of Making and Curing Concrete Specimens

JIS B 7733-Compression Testing Machines

2. Testing Machine and Apparatus

2.1 The compression testing machine shall be those specified in JIS B 7733.

2.2 The pressing surfaces of upper and lower bearing blocks shall be finished by polishing with flatness (1) of not more than 0.02 mm and Shore hardness not less than Hs 70.

Note (1) For the purpose of this standard, the term "flatness" means the distance between two parallel planes of which one plane passes the highest place, and another plane passes the lowest place on a surface.

3. Test Specimen

3.1 The test specimen shall be prepared by the method specified in JIS A 1132 (2).

Note (2) The age of test specimen to be tested shall, as a standard, be one week, 4 weeks or 13 weeks.

3.2 The test specimen shall be prepared in a manner that it can be tested under the condition of immediately after prescribed curing period (3).

Note (3) Since the strength of concrete varies at times considerably according to the state of dryness and temperature, the test shall be carried out under the condition of immediately after the curing period.

4. Method of Testing

4.1 The diameter of the test specimen shall be measured to the nearest 0.2 mm in two directions at right angles to each other at about mid-height of specimen.

4.2 The compression testing machine shall be used in the range between 1/5 to full of weighing capacity. When the variation of setting of the weighing capacity is provided in the same testing machine, the weighing capacity shall be regarded as the individual one for each varied setting.

4.3 The upper and lower end surfaces of the test specimen and the pressing surfaces of upper and lower bearing blocks shall be cleaned.

4.4 Place the test specimen so that its centre axis coincides the centre of the bearing blocks. The bearing blocks of the testing machine and end surfaces of the test specimen shall contact each other directly, and any cushioning materials shall not be inserted between them.

4.5 The load shall be applied evenly avoiding impact. The loading speed shall be so made that the increase of compressive stress will become, as a standard, 2 to 3 kgf/cm^2 {0.19 to 0.29 N/mm^2} per second(4).

Note (4) A comparatively high loading speed may be applied up to about 50 % of the maximum load.

4.6 When the abrupt deformation occurred on the test specimen, stop the adjustment (5) of loading speed and still continue loading.

Note (5) In the case of motor-driven testing machine, the loading speed may be left as it is.

4.7 The maximum load up to the fracture of the test specimen indicated by the testing machine shall be read to the three significant digits.

5. Calculation of Results

5.1 The diameter of test specimen shall be calculated from the following formula and obtained to the four significant digits.

$$d=\frac{d_1+d_2}{2}$$

where, d: diameter of test specimen (cm)

d_1, d_2: diameter of two directions obtained in accordance with 4.1 (cm)

5.2 The compressive strength shall be calculated from the following formula and obtained to the three significant digits.

$$\sigma_c=\frac{P}{\pi\left(\frac{d}{2}\right)^2}$$

where, σ_c: compressive strength (kgf/cm^2) {N/mm^2}

P: maximum load obtained in accordance with 4.7 (kgf) {N}

6. Report

Necessary items of the following shall be included in the report.

(1) Identification number of test specimen

(2) Age of specimen

(3) Diameter of test specimen (cm)

(4) Maximum load (kgf) {N}

(5) Compressive strength (kgf/cm^2) {N/mm^2}

(6) Method of curing and curing temperature

(7) State of fracture of test specimen

(8) Other particulars

(A6) UDC 666.972:620.168.3:621.928.4

JAPANESE INDUSTRIAL STANDARD J I S

Method of Test for Washing Analysis of Fresh Concrete

A 1112-1989

1. Scope

This Japanese Industrial Standard specifies the method of test for washing analysis of fresh concrete.

2. Test Apparatus

2.1 The balances, containers and tamping rod specified in JIS A 1116 shall be used for the determination of unit volume weight of concrete.

2.2 A balance having a capacity not less than 10 kg and sensitive to 1 g shall be used for the washing analysis of mortar.

2.3 A watertight container with a rounded bottom having a capacity of 5 *l* or more shall be used for measuring the virtual mass of mortar in water.

2.4 Sieves (1) of 5 mm, 0.6 mm and 0.09 mm meshes shall be used.

Note (1) These sieves correspond to the 4.75 mm, 600 μm, and 90 μm standard sieves specified in JIS Z 8801 respectively. The frame size of the 5 mm sieve should be larger than the standard size for easy handling.

Applicable Standards:

JIS A 1103-Method of Test for Amount of Material Passing Standard Sieve 74 μm in Aggregates

JIS A 1109-Method of Test for Specific Gravity and Absorption of Fine Aggregate

JIS A 1115-Method of Samping Fresh Concrete

JIS A 1116-Method of Test for Unit Weight and Air Content (Gravimetric) of Fresh Concrete

JIS A 1134-Method of Test for Bulk Specific Gravity and Absorption of Light Weight Fine Aggregate for Structural Concrete

JIS A 1138-Method of Making Test Sample of Concrete in the Laboratory

JIS R 5201-Physical Testing Methods of Cement

JIS Z 8801-Test Sieves

3. Measurement of Specific Gravity

The following tests on cement and fine aggregate shall be conducted in order to determine their specific gravities in advance.

(1) Test for Specific Gravity of Cement This test shall be conducted in accordance with JIS R 5201.

(2) Test for Specific Gravity of Fine Aggregate This test shall be conducted in accordance with JIS A 1109 and JIS A 1134.

4. Sampling

4.1 The method of sampling concrete shall be as specified in JIS A 1115 or JIS A 1138.

4.2 The amount of the sample concrete shall be approximately 20 l for coarse aggregate having a maximum size of 50 mm or less, and approximately 35 l for coarse aggregate having a maximum size of more than 50 mm.

5. Test Procedure

5.1 For the washing analysis, take from the sample described in 4. approximately 5 kg of typical sample for coarse aggregate having a maximum size of 50 mm or less and approximately 6 kg of typical sample for coarse aggregate having a maximum size of more than 50 mm.

Using the remaining sample, determine the unit weight of concrete in accordance with JIS A 1116 indicating it as m_B (kg/m^3).

5.2 Place all the sample used for the determination of the unit weight of concrete on the 5 mm sieve, and screen in order to separate it into coarse aggregate and mortar.

5.3 Wash the coarse aggregate obtained by the procedured of 5.2 with water, weigh its mass in a saturated surface-dry condition ([2]) indicating it as m_G (kg/m^3).

Note ([2]) Lightweight aggregate shall be weighed in a dry surface condition.

5.4 Accurately weigh the sample for washing analysis taken in 5.1 to the nearest 1 g, and place it on the 5 mm sieve to screen it into coarse aggregate and mortar sample while pouring water over it. Weigh the coarse aggregate retained on the 5 mm sieve in a saturated surface-dry condition ([2]), subtract its mass from the unit volume mass of the sample determined in advance, and indicate the mass of mortar thus obtained as m_m (g).

5.5 Place the mortar sample obtained in 5.4 in the container designed for gauging mass in water, pour approximately 2 l of water into the container, and mix the sample and water by stirring in order to completely expel the air entrapped in the sample (3). After completing the stirring, remove all bubbles from the water surface, adding isopropyl alcohol as required for theat purpose. Allow the sample to stand for approximately 10 min, then submerge the sample in water without taking it out of the container, and measure its virtual mass in water to indicate as m_m' (g) (4).

Notes (3) Complete removal of air is very important for minimizing test errors.

(4) In this weighing, ensure that air bubbles adhering to the outside of the container are thoroughly removed.

5.6 Screen the mortar sample through with weighing in water on the 0.6 mm sieve and the 0.09 mm sieve successively while washing with water poured over it (5). Measure and sum up the virtual mass of materials retained on the respective sieves and indicate the sum as m_s' (g).

Note (5) To conduct the washing analysis on the 0.09 mm sieve, it is reccommeded that, before screening on the sieve, adequate water should be added to and mixed with the sample into a suspension state by stirring.

6. Calculation of Results

The results of the test shall be calculated from the following formulas:

Mass of cement in the mortar sample: m_C

$$m_C = (m_m' - m_s') \times \frac{g_C}{g_C - 1}$$

Mass of fine aggregates (retained on the 0.09 mm sieve) in the mortar sample: W_s

$$m_s = m_s' \times \frac{g_s}{g_s - 1}$$

Mass of water in the mortar sample: m_w

$$m_w = m_m - (m_C + m_s)$$

Unit quantity of coarse aggregates: m_G (kg/m³)

$$m_G = \frac{m_G}{V} \times 1\,000$$

Unit quantity of mortar: m_m (kg/m³)

$$m_m = m_B - m_G$$

Unit quantity of cement: m_C (kg/m³)

$$m_C = m_m \times \frac{m_C}{m_m}$$

Unit quantity of fine aggregates: m_S (kg/m³)

$$m_S = m_m \times \frac{m_S}{m_m}$$

Unit quantity of water: m_w (kg/m³)

$$m_w = m_m \times \frac{m_w}{m_m}$$

where g_C: specific gravity of cement

g_S: specific gravity of fine aggregates

V: internal capacity of the container used for the test for determining the unit weigth of concrete (l)

If necessary, the amount of fine aggregates passing the 0.09 mm sieve expressed in percentage shall be determined in advance in accordance with JIS A 1103 and used for correction of the mass of cement and fine aggregates.

Remark: When a check on the test results is required, the dry mass of materials having passed the 0.09 mm sieve in 5.6 shall be used.

7. Report

Items in the following as required shall be included in the report.

(1) Unit quantity of cement

(2) Unit quantity of water

(3) Unit quantity of fine aggregates

(4) Unit quentity of coarse aggregates

(5) Ratio of water to cement

(6) Slump and air content

(7) Other particulars

Informative Reference: Examples of calculation of unit quantities of cement, water, fine aggregates and coarse aggregates, and ratio of water to cement are shown below.

Specific gravity of cement $g_C=3.15$	Specific gravity of fine aggregates $g_S=2.59$
Unit weight of concrete (kg/m^3)	$\mathbf{m}_B=\frac{m_B}{V}=\frac{23.833}{9.955}\times 1\,000=2\,394$
Unit quantity of coarse aggregates (kg/m^3)	$\mathbf{m}_C=\frac{m_C}{V}=\frac{11.156}{9.955}\times 1\,000=1\,121$
Unit quantity of mortar (kg/m^3)	$\mathbf{m}_m=\mathbf{m}_B-\mathbf{m}_C=1\,273$
Mass of concrete sample for washing analysis (g)	$m_0=5\,998$
Mass of coarse aggregates in m_0 (g)	$m_a=2\,848$
Mass of mortar sample in air (g)	$m_m=m_0-m_a=3\,150$
Virtual mass of mortar sample in water (g)	$m_m'=1\,696$
Virtual mass of fine aggregates in mortart sample in water (g)	$m_S'=1\,087$
Mass of cement in mortar sample (g)	$m_C=(m_m'-m_S')\times\frac{g_C}{g_C-1}=892$
Mass of fine aggregates in mortar sample (g)	$m_S=m_S\times\frac{g_S}{g_S-1}=1\,771$
Mass of water in mortar sample (g)	$m_w=m_m-(m_C+m_S)=487$
Unit quantity of cement (kg/m^3)	$\mathbf{m}_C=\mathbf{m}_m\times\frac{m_C}{m_m}=360$
Unit quantity of fine aggregate (kg/m^3)	$\mathbf{m}_S=\mathbf{m}_m\times\frac{m_S}{m_m}=716$
Unit quantity of water (kg/m^3)	$\mathbf{m}_w=\mathbf{m}_m\times\frac{m_w}{m_m}=197$
Ratio of water to cement (%)	$\frac{\mathbf{m}}{C}=\frac{\mathbf{m}_w}{\mathbf{m}_C}\times 100=54.7$

The above test results as compared with the specified mix are as follows.

Unit: kg/m^3

Materials	Unit quantities in specified mix	Results of washing analysis test
Cement	364	360
Water	182	197
Fine aggregates	709	716
Coarse aggregates	1101	1121
Water-cement ratio %	50.0	54.7

Remark: Concrete using coarse aggregates 25 mm in maximum size.

UDC 620.172.666.97

JAPANESE INDUSTRIAL STANDARD — JIS

Method of Test for Splitting Tensile Strength of Concrete

A 1113-1976
(Reaffirmed: 1979)

1. Scope

This Japanese Industrial Standard specifies method of test for splitting tensile strength of concrete.

Remark: In this standard, the particulars in { } are in accordance with the International System of Units (SI) and given for reference only.

2. Testing Machine and Apparatus

2.1 Testing machine shall conform to JIS B 7733.

2.2 The compressive surfaces of upper and lower pressure plates shall be finished by polishing, the flatness (1) shall be 0.02 mm and Shore hardness shall be Hs 70 or more.

Note (1) Flatness, herein referred to, means the distance between two parallel planes passing through the highest point and the lowest point of the surface.

3. Test Specimen

3.1 The test specimen shall be prepared according to JIS A 1132 (2).

Note (2) The age of specimens to be tested shall be 1 week, 4 weeks and 13 weeks as standard.

3.2 The test specimens shall be prepared to enable tests to be conducted in the condition (3) found immediately after the specified period of curing.

Note (3) Since the determination of strength of concrete varies materially at times according to the drying condition and temperature of the specimen, it is important to conduct the test in the condition prevailing immediately after the end of the curing period.

4. Method of Test

4.1 The diameter of the test specimen shall be measured to the nearest 0.2 mm at not less than 2 places in the direction the specimen will be subjected to load, and the mean of the values found shall be considered as the diameter of the specimen.

Applicable Standards:

JIS A 1132-Method of Making and Curing Concrete Specimens

JIS B 7733-Compression Testing Machines

4.2 The testing machine shall be used within the range from $\frac{1}{5}$ weighing capacity to a whole weighing capacity. In the case when the weighing capacity is able to change with the same testing machine, each weighing capacity shall be regarded as the separate weighing capacity.

4.3 The sides of the test specimen and the compressive surfaces of the upper and lower pressure plates shall be cleaned.

4.4 The specimen shall be placed on the pressure plate of the testing machine as shown in Fig. 1, so that there shall be no eccentricity (4) in loading. In this case, there shall be no gap (5) found in the line of contact between the specimen and the pressure plate everywhere. The upper and lower pressure plates shall be maintained parallel during application of load (6).

Notes (4) In advance of the test, select the suitable contacting lines so that there produces no gap, and mark the lines to connect the top and bottom contacting lines on both end faces of the specimen, and also mark the contacting lines on the center of the upper and lower pressure plates, it is recommended to set the specimen to align exactly the both marked contacting lines. And also it is to be able to set the specimen by using a suitable jig. It shall be so arranged that there is no eccentricity on the axial direction of the cylinder.

(5) Should a clearance exist between a portion of specimen and pressure plate, uneven loading will result and be liable to cause localized failure in the specimen. Gaps will often occur when the parts of the specimen at the joint of the mould are made to contact pressure plates.

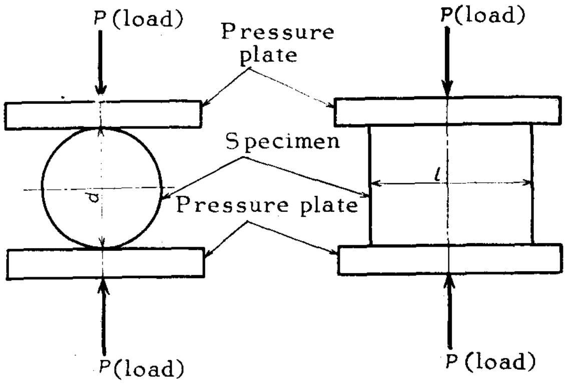
(6) By stopping the increase of load for a while, at the condition of loading within 500 kgf{4.90 kN}, the parallelism shall be confirmed by measuring distance between the upper and the lower pressure plates at 2 or more portions. If not parallel, it shall be adjusted by tapping lightly the pressure plate having the spherical contact surface with a mallet.

4.5 The load shall be applied evenly to avoid shock. The speed of application of load shall be such that the increase in tensile stress (7) will be as a standard 4 to 5 kgf/cm^2 {0.39 to 0.49 N/mm^2} per minute (8).

Notes (7) Calculation of tensile stress shall follow the formula given in 5.

(8) Up to about 50 % of the maximum load, the load may be applied relatively rapidly.

Fig. 1



4.6 The maximum load to fracture the specimen indicated by the testing machine shall be read to 3 significant figures.

4.7 The length of the surface of the fratured face of the specimen shall be measured to the nearest 0.2 mm at two or more places and the mean value of the measurements shall be the length of the specimen, and be obtained to 4 significant figures.

5. Calculation of Result

The tensile strength shall be calculated from the following formula, and be obtained to 3 significant figures.

$$\sigma_t = \frac{2P}{\pi d l}$$

where, σ_t : tensile strength (kgf/cm^2) {N/mm^2}

P : maximum load (kgf) {N}

d : diameter of specimen (cm) {mm} obtained by 4.1

l : length of specimen (cm) {mm} obtained by 4.7

6. Report

On the report, among the following, necessary items shall be mentioned.

(1) No. of specimen

(2) Age of specimen

(3) Diameter of specimen (cm)

(4) Length of specimen (cm)

(5) Maximum load (kgf) {N}

(6) Tensile strength (kgf/cm^2) {N/mm^2}

(7) Method of curing and curing temperature

(8) Failure condition of specimen

(9) The others

UDC 620.173:666.97

JAPANESE INDUSTRIAL STANDARD

JIS

Method of Test for Compressive Strength of Concrete Using Portions of Beams Broken in Flexure

A 1114-1976
(Reaffirmed: 1986)

1. Scope

This Japanese Industrial Standard specifies method of test for compressive strength of concrete using portions of beams broken in flexure.

Remark: In this standard, the particulars in { } are in accordance with the International System of Units (SI) and given for reference only.

2. Testing Machine and Apparatus

2.1 The compression tester shall conform to JIS B 7733.

2.2 Bearing plate used for test shall be steel plate (1) of 20 mm or more in thickness and shall be made so that the compressive surface of the specimen will become a square of width (2) of the beam.

The compressive surface of the bearing plate shall be polished and its flatness (3) shall be within 0.02 mm immediately after manufactured, and shall not exceed 0.05 mm throughout the test.

Notes (1) The steel plate shall be hard steel quenched and polished, and its Shore hardness shall be Hs 70 or more.

(2) For the width of beam shall be used the nominal value.

(3) Flatness, herein referred to, means the distance between two considered parallel planes passing through the highest point and the lowest point of the surface.

3. Test Specimen

3.1 The test specimen shall be the broken piece of a beam used for flexural strength tests specified in JIS A 1106 or JIS A 1107, the length of which shall be at least 5 cm longer than the height of the beam.

Applicable Standards:

JIS A 1106-Method of Test for Flexural Strength of Concrete

JIS A 1107-Method of Obtaining and Testing Drilled Core and Sawed Beams of Concrete

JIS A 1132-Method of Making and Curing Concrete Specimens

JIS B 7733-Compression Testing Machines

3.2 The compressive surface of specimen used for the test shall be finished flat (4), and the flatness of the finished surface shall be within 0.05 mm.

Note (4) The surface shall either be polished or be finished according to 4.4 in JIS A 1132. However, in the case of specimens made according to JIS A 1106, usually no finishing is required.

3.3 During the period between completion of flexural strength tests and the commencement of compressive strength tests, no change in the condition of the test specimen shall be allowed to take place (5).

Note (5) For example, if the flexural test is to be carried out in a wet condition, the test specimen shall be maintained in the same wet condition until the time of the compressive strength test.

4. Method of Testing

4.1 The upper and lower compressive surfaces close to both ends shall be measured to the nearest 0.2 mm for the width of the specimen and the mean value shall be obtained to 4 significant figures as the width of the specimen.

4.2 The height of the specimen at both side surfaces shall be measured to the nearest 1 mm, and the mean value shall be obtained to 3 significant figures as the height of the specimen.

4.3 The compression tester shall be used within the range from $\frac{1}{5}$ weighing capacity to a whole weighing capacity. In the case when the weighing capacity is able to change with the same tester, each weighing capacity shall be regarded as the separate weighing capacity.

4.4 The compressive surfaces of the specimen and the compressive surfaces of respective pressure plates and bearing plates shall be cleaned.

4.5 The bearing plates shall be placed at centers of top and bottom surfaces of the test specimen as shown in Example Fig., and these shall be placed at the central part of the pressure plates of the testing machine. When a broken portion of a beam made according to JIS A 1132 is used as the specimen, the side surface at the time of making of the specimen shall be used as the compressive surface.

The top and bottom bearing plates shall be arranged so that the parallel sides of the set are maintained at right angles with the axial direction of the beam, and also shall be kept in alignment in an up and down direction.

The bearing plate and compressive surface of the specimen shall be made closely contact and shall not insert cushion between them.

4.6 The load shall be applied evenly avoiding impact. The speed of load application shall, as a standard, be 2 to 3 kgf/cm^2 {0.19 to 0.29 N/mm^2} per second (6).

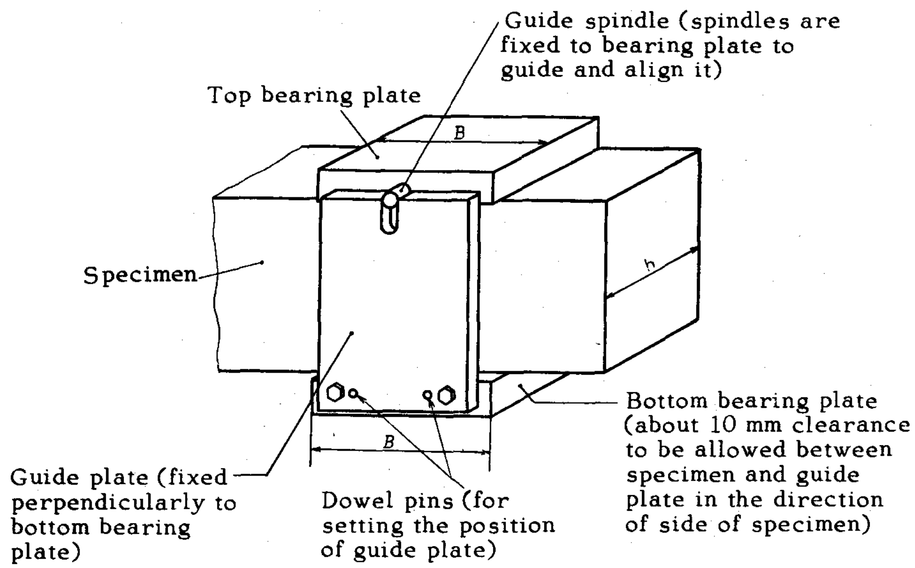
Note (6) Up to 50 % of the maximum load, the load may be applied relatively rapidly.

4.7 After commencement of abrupt deformation of the specimen, the adjustment (7) of loading speed shall be ceased, and the load shall be applied continuously.

Note (7) For the testing machine of power driven type, it may be loaded continuously intact.

4.8 The maximum load indicated by the testing machine at the time of failure of the specimen shall be read to 3 significant figures.

Example Fig.



5. Calculation of Result

The compressive strength shall be calculated from the following formula, and shall be obtained to 3 significant figures.

$$\sigma_c = \frac{P}{bB}$$

where,

σ_c : compressive strength (kgf/cm^2) {N/mm^2}

P : maximum load obtained by 4.8 (kgf) {N}

b : width of specimen obtained by 4.1 (cm) {mm}

B : width of bearing plate obtained by 2.2 (cm) {mm}

6. Report

On the report, among the following, necessary items shall be mentioned.

(1) No. of specimen

(2) Class of concrete

(3) Age of specimen

(4) Width of specimen (cm)

(5) Height of specimen (cm)

(6) Maximum load (kgf) {N}

(7) Compressive strength (kgf/cm^2) {N/mm^2}

(8) Method of curing and curing temperature

(9) Failure conditions of specimen

(10) The others (8)

Note (8) State the relation between the direction of placing of concrete and direction of loading and appearance of specimen etc.

UDC 666.972.2:620.113.4

JIS

Method of Sampling Fresh Concrete

A 1115-1975
(Reaffirmed: 1978)

1. Scope

This Japanese Industrial Standard specifies method of sampling fresh concrete from mixer, hopper or concrete conveying equipment, or out of concrete in place.

2. Test Specimen

Specimen to be furnished to test shall be prepared by collecting partial samples (1) taken in accordance with a method prescribed in 4. and then by mixing them with a shovel to homogeneous condition so that the specimen be representative of the concrete to be tested. Immediately after the mixing above-mentioned, the specimen shall be used for the test(2)(3).

Notes (1) The partial samples mean the individual ones taken from several different places of the concrete to be tested. They shall be approximately equal to each other in amount.

(2) The specimen during the period from the sampling and the finish of use shall be handled so rapidly as not to be affected by sun and wind. If necessary, it shall be protected from them. For slump test, particular care above-mentioned shall be taken.

(3) Concrete of which aggregates exceeding 50 mm or 40 mm size have been removed through a sieve of 50 mm or 40 mm mesh, may be furnished to the test, if the test requires it.

Applicable Standard:

JIS A 1119-Method of Test for Variability of Constituents in Freshly Mixed Concrete

3. Quantity of Specimen

The specimen shall amount to 20 ℓ or more and, at the same time, it shall be over the quantity the test requires by 5 ℓ or more.

4. Method of Taking Partial Samples

4.1 From Mixer Take partial samples from the middle portion of concrete discharged from a mixer at three or more different places of the stream(4). Or take them with a shovel from the inside of the mixer, after stopping, at three or more different places(5). Or take them from the inside of a container, into which one batch of concrete has been put, at three or more different places(5).

Notes (4) In this case, particular attention shall be paid not to take samples of which constituents have segregated.

(5) The sample to be used for the test for variability of constituents (mortar and aggregates) of freshly mixed concrete in a mixer, shall be taken in accordance with 3.2 in JIS A 1119.

4.2 From Truck Mixer or Agitator Take partial samples from concrete discharged from a mixer or an agitator thrice or more at a definite interval(5). Never take at the beginning and the end of the discharge.

The partial samples to be taken shall cover overall section of the stream of the discharged concrete. In this case, the discharge speed of the concrete shall be adjusted by regulating the rotation of mixer.

4.3 From Concrete Pump Take partial samples thrice or more from the overall section of the concrete stream discharged from the discharge pipe end of the pump.

They shall be taken from a quantity of concrete equivalent to a mixer car or to a batch. Or take them, at three or more locations, from a lot of discharged concrete.

4.4 From Hopper or Bucket Take partial samples, at three or more locations, from the mid portion of concrete stream discharged from a hopper or a bucket(4).

4.5 From Dump Truck, etc. Take partial samples, at three or more locations, from the mid portion of concrete, except its surface, put on the platform. Or take them, at three or more locations, from a lot of discharged concrete(6).

Note (6) Since there is a possibility of the lot of discharged concrete having caused the constituents to segregate. sampling shall be made at locations as many as possible.

4.6 From Hand Cart Take partial samples, at a place as near as possible to concrete placing site, from three or more hand carts carrying the mid portion of one batch concrete(7).

Note (7) When there is found segregation of concrete constituents in the hand carts, the sampling shall be done after the concrete has been mixed uniformly with a shovel or the like.

4.7 From Concrete after Placement Take partial samples, at three or more locations with a shovel, from concrete not yet compacted immediately after the concrete is placed in the forms.

5. Record

The record of the sampling shall include the particulars described below, as required:

(1) Date and time

(2) Weather

(3) Atmospheric temperature

(4) Sampling method

(5) Batch number

(6) Truck number

(7) Concrete sampling location positioning in structure, when sampling is applied in accordance with 4.7

(8) Mixing proportion of concrete

(9) Temperature of concrete

(10) Sampler's name

(11) Others

UDC 666.972.05:620.168.4:531.755

JAPANESE INDUSTRIAL STANDARD — JIS

Method of Test for Unit Weight and Air Content (Gravimetric) of Fresh Concrete

A 1116-1975
(Reaffirmed: 1989)

1. Scope

This Japanese Industrial Standard specifies the test for determining the unit weight* and air content (gravimetric) of fresh concrete by weight.

Note * For the purpose of this standard, "weight" means mass.

2. Test Apparatus

2.1 A container which is a metal cylinder with a machined inside, watertightness, and adequate strength shall be provided. The dimensions of the container in relation to the maximum size of coarse aggregate shall conform to Table 1.

Handles shall be provided for easy handling.

The capacity of the container shall be calculated by accurately weighing (1) the weight of water required for filling the container.

Note (1) In filling the container with water, pour water until it overflows a little, then put a polished glass plate on the container to remove excessive water. At this time no bubbles shall be seen under the glass plate. The capacity of the container shall be calculated by dividing the weight of water required for filling the container by the density of water (for example, 0.999 kg/l at 13 ~18 °C).

2.2 Scales with sensitivity as shown in Table 1 shall be used.

Table 1

Max. size of coarse aggregate mm	Dimension of container cm		Sensitivity of scale g
	Inside diameter	Inside height	
10 and under	14	13	2
50 and under	24	22	10
Over 50	35	29	25

2.3 A tamping rod of round steel, 16 mm in diameter, 50 cm in length, and having a hemispherical end, shall be used.

2.4 A vibrator as specified in JIS A 8610 shall be used.

3. Sample

The sampling method of concrete shall be as specified in JIS A 1115, or JIS A 1138.

Applicable Standards:

JIS A 1115–Method of Sampling Fresh Concrete

JIS A 1138–Method of Making Test Sample of Concrete in the Laboratory

JIS A 8610–Internal Vibrators for Concrete

4. Test Procedure

4.1 When Using Tamping Rod for Compacting

(1) Place the sample in the container to a depth approximately one third of it. After leveling the surface of the sample, evenly plunge the tamping rod into the sample by the number of times indicated in Table 2. Then tap the outside of the container 10 to 15 times with a wooden hammer so that the plunged holes and large bubbles on the surface of the sample disappear. Next, add the sample to a depth approximately two-thirds of the container, and repeat the leveling, plunging, and tapping operations as described above. Lastly place the sample into the container to the extent it overflows a little, repeat the plunging and tapping, and level the surface by removing excessive sample with a metal rule. The depth of plunging the tamping rod into the sample shall approximetely be the thickness of each layer of the sample.

(2) Remove concrete adhered to the outside of the container, then weigh the weight of the sample in the container.

Table 2

Inside dia. of container cm	Number of plunging tamping rod into each layer of test sample
14	10
24	25
35	50

4.2 When Using Vibrator for Compacting

(1) Fill half the container with the sample, and make vibration compacting of the sample in the container by operating the vibrator. Next, add the sample into the container until it overflows, and repeat the vibration compacting as above. When using an internal vibrator (2), the tip of the vibrator shall be in such a position as to reach the lower layer of the sample concrete.

The vibration shall be given for the minimum time required for large bubbles to disappear.

After finishing the vibration compacting of the upper layer, level its surface by removing excessive sample with a metal rule.

(2) Wipe concrete adhered to the outside of the container, then measure the weight of the sample in the container.

Note (2) The size of the internal vibrator shall be not too large as compared with the capacity of the container. When using a container 14 cm in inside diameter, a vibrator 27 mm in nominal diameter should be used.

5. Calculation of Results

5.1 Unit Weight Unit weight shall be determined by dividing the weight of the sample in the container by the capacity of the container.

5.2 Air Content Air content shall be determined by the following formula:

$$A\,(\%) = \frac{T-W}{T} \times 100$$

where, A : Air content in concrete (%)
T : Unit weight of concrete calculated assuming it contains no air (kg/m^3) (3)

W: Unit weight of concrete determined by section 5.1 above (kg/m^3)

Namely $T = \frac{W_1}{V}$

where, W_1 : Total weight of concrete materials per 1 m^3 (kg)

V : Total absolute volume (4) of concrete materials per 1 m^3 (m^3)

Notes (3) Unit weight of concrete (T) calculated assuming it contains no air is greatly affected by the specific gravities of cement and aggregate, and is likely to cause errors in the air content obtained. Accordingly the values obtained by the test for the respective specific gravities shall be used.

(4) Absolute volume of each concrete material (m^3) is a value obtained by dividing their respective weight (kg) by their respective specific gravity (kg/m^3) multiplied by 1000.

6. Report

Necessary items of the following shall be included in the report.

(1) Unit weight

(2) Air content

(3) Proportion of concrete

(4) Kind of admixture

(5) Slump

(6) Temperature of concrete

(7) Other particulars

UDC 666.972.05:620.168.334

JAPANESE INDUSTRIAL STANDARD — JIS

Method of Test for Air Content of Fresh Concrete by the Volumetric Method

A 1118-1975
(Reaffirmed: 1983)

1. Scope

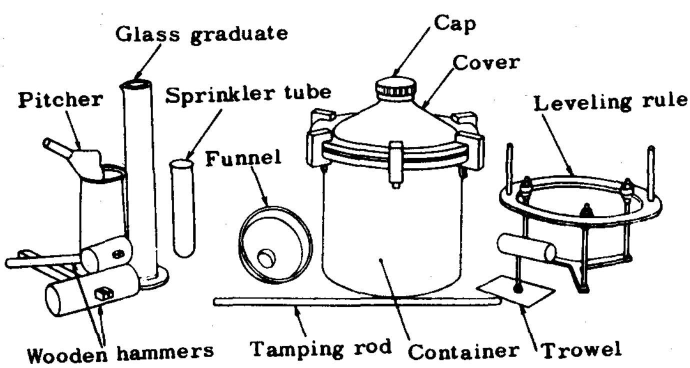
This Japanese Industrial Standard specifies the test for determining the air content of fresh concrete by the volumetric method (1).

Note (1) This test method is also applicable to concrete using porous aggregate such as artificial light-weight aggregate concrete.

2. Test Apparatus

Test apparatuses as shown in Fig. 1 shall be used.

Fig. 1



2.1 The container shall be a metal cylinder with a flange, watertightness, and adequate strength (2). The diameter of the container shall approximately be equal to its depth.

The interior surface of the container and the upper surface of its flange shall be smoothly machined. The minimum capacity of the container shall be as shown in Table 1 depending on the minimum size of coarse aggregate.

Note (2) The container shall generally be required to have a thickness of 8 mm or more.

Applicable Standards:

JIS A 1115–Method of Sampling Fresh Concrete

JIS A 1138–Method of Making Test Sample of Concrete in the Laboratory

JIS A 8610–Internal Vibrators for Concrete

Fig. 2

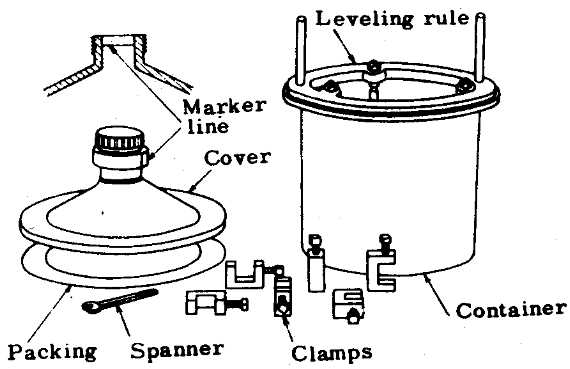


Table 1

Max. size of coarse aggregate mm	Min. capacity of container l
50 and under	11
80 and under	23

2.2 The cover shall be a flanged cone made of the same material with the container. The inside of the cover shall be inclined at 30 degrees or more to the horizontal, and be finished smoothly. The back surface of the cover flange shall also be finished smoothly. The top inside of the cover shall have a marker line running parallel with the top edge of the cover. The cap shall be installed on the top of the cover so as to maintain watertightness.

2.3 The leveling rule (3) shall be a steel rule capable to level the concrete placed in the container in order to accurately obtain its fixed volume (4).

Notes (3) The construction of the leveling rule shall be such that the back surface of the rule, when installed on the container, will be in parallel with the upper surface of the container flange.

(4) The volume of the container below the underside of the leveling rule installed on the container, V, shall be determined by section 4 below.

2.4 The tamping rod shall be a round steel rod, 16 mm in diameter, 50 cm in length, having a hemispherical end.

2.5 A vibrator as specified in JIS A 8610 shall be used.

2.6 The minimum graduation of the glass graduate shall be 5 milliliters or less when used for the container with a capacity of approximately 12 liters, and 10 milliliters or less when used for the container with a capacity of approximately 24 liters.

2.7 Two kinds of the wooden hammer, namely small and large sized ones used for light tapping and hard hitting of the container respectively, shall be provided.

3. Sample

The method of sampling of concrete shall be as specified in JIS A 1115, or the sample shall be made in accordance with JIS A 1138.

4. Calibration of Container

Place the flange of the container in a horizontal position, and install the leveling rule on it. Slowly fill the container with water until the water level reaches the underside of the leveling rule, then weigh the weight * of the water in the container. The volume of the container below the underside of the leveling rule, V (5) shall be calculated based on the weight of the water obtained.

Note (5) The volume V shall be approximately one half the capacity of the container.

Note * For the purpose of this standard, "weight" means mass.

5. Measurement of Aggregate Correction Factor

5.1 The weight of fine and coarse aggregates contained in the sample concrete of the volume V to be tested for obtaining the air content in it shall be calculated by the following formula:

$$w_f = \frac{V}{B} \times W_f$$

$$w_c = \frac{V}{B} \times W_c$$

where, w_f : Weight of fine aggregate in the sample concrete of volume V (kg)

V : Volume of the sample concrete (l)

B : Completed volume of concrete of one batch (l)

W_f : Weight of fine aggregate used in one batch (kg)

w_c : Weight of coarse aggregate in the sample concrete of volume V (kg)

W_c : Weight of coarse aggregate used in one batch (kg)

5.2 Typical samples of fine aggregate and coarse aggregate, w_f and w_c in weight respectively, shall be collected. The sample fine and coarse aggregates shall be separately immersed in water (6) to make the moisture condition of the sample aggregate particles equivalent to that of the aggregate particles in the sample concrete.

Feed the sample aggregates into the container approximately one third filled with water. In feeding, a scoopful of the fine aggregate shall be put in the container to be followed by two scoops of the coarse aggregate, and this sequence shall be repeated. Caution shall be taken to assure that the amount of air entering with the aggregates is minimized, and that all the aggregates are completely immersed. Emerging air bubbles shall be removed quickly. To release air, the side of the container shall be tapped, and whenever the fine aggregate is added, the tamping rod shall be plunged approximately ten times into it to a depth of 25 mm or so.

Note (6) Five minutes or so will be appropriate for the immersion period.

5.3 After putting all the aggregates in the container, remove all bubbles on the surface of the water, cleanly wipe the flanges of the container and cover, insert the rubber packing between the flanges, and then clamp the cover onto the container.

5.4 Operations specified in sections 6.4 to 6.6 shall be performed.

5.5 Aggregate correction factor A_2 shall be calculated by the following formula:

$$A_2 (\%) = 1.02 \frac{V_a}{V} \times \frac{1}{10}$$

where, A_2 : Aggregate correction factor (percentage of concrete volume)

V_c : Total quantity of water required for raising the lowered water level to the marker line after rolling the container (ml) (See Fig. 3 (3) and (4))

V : Volume of concrete (l)

Remark: This aggregate correction factor is a factor for considering the effect exercised upon the test results by the water absorption of aggregate particles during the period of measuring air content of concrete. With concrete using aggregate with a heavy absorption, aggregate correction factor shall be calculated.

6. Measurement of Air Content of Concrete

6.1 Place the sample, approximately one third of the volume V calculated in section 4 in volume, in the container, and level the surface. Evenly plunge the tamping rod into the sample 25 times when V is 7 liters or so, and 50 times when V is 14 liters or so, then tap the side of the container with the wooden hammer 10 to 15 times so that the plunged holes and large bubbles on the surface disappear. Next, add the sample, approximately one third of the capacity V, on the sample in the container, and repeat the leveling, plunging and tapping operations as above. Lastly, put the sample into the container so that the total volume of the sample concrete exceeds the volume V a little, and repeat similar operations as above. After that, place the container flange in a level position, and remove excessive concrete by leveling with the steel leveling rule. The plunging depth of the tamping rod shall approximately be equal to the thickness of each layer. When measuring air content of concrete to be compacted with a vibrator, the vibrator may be used (7).

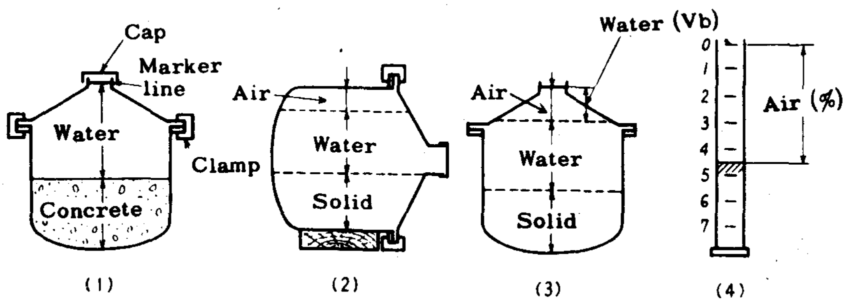
Note (7) The size of the internal vibrator shall not be too large as compared with the capacity of the container.

6.2 Pour water in the container up to a level a little below the container flange by using the funnel and sprinkler tube, and by taking precaution so as not to disturb the surface of concrete.

6.3 Cleanly wipe the flanges of the container and cover, install the cover on the container by inserting the rubber packing between them, then tighten the cover with the clamps so as to prevent water leakage.

6.4 Fill the container with water (8), and tap the cover with the wooden hammer to oust air bubbles clinging to the inside of the cover. Place the unit so that the top edge of the cover is in a level position, and bring the water level to the marker line of the cover as shown in Fig. 3 (1).

Fig. 3

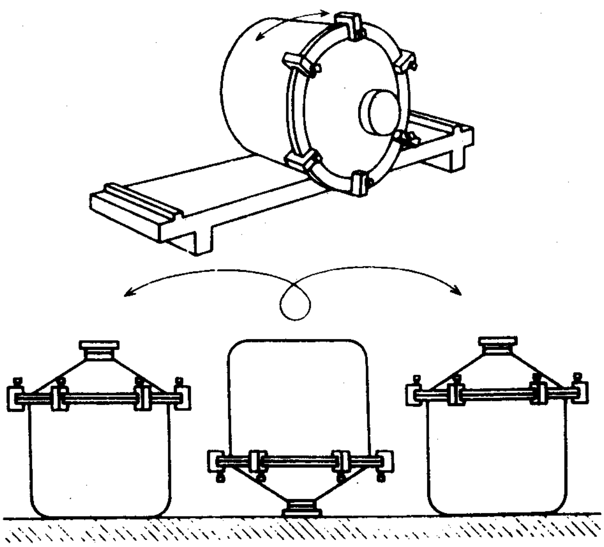


6.5 After tightly installing the cap, violently roll the container by the methods indicated in Fig. 4 (9) in order to mix the concrete with water and discharge air contained in the concrete. After rolling approximately 20 times, place the container in an upright position, strike the side of the container hard with the large wooden hammer to break air bubbles. Remove the cap, and place the top edge of the cover in a precisely level position. Next, add water (8) and raise the water level to the marker line.

Notes (8) The temperature of the water used in the test shall be within the temperature of the concrete ± 3 °C.

(9) A mechanical device may be used for the rolling operations.

Fig. 4



6.6 The operation of section 6.5 shall be repeated until no bubbles will appear on the surface and no change be seen in the height of the water level even by rolling the container (10).

Note (10) If the quantity of water added for raising the water level to the marker line after rolling the container becomes within 0.05% of the volume V, the rolling operation may be discontinued.

7. Calculation of Result

Air content A (%) of concrete shall be calculated by the following formula:

$$A\,(\%) = 1.02\frac{V_b}{V} \times \frac{1}{10} - A_2$$

where, A : Air content of concrete (percentage of volume of concrete)

V_b : Total quantity of water required for raising the lowered water level to the marker line after rolling the container (ml) (See Fig. 3 (3) and (4))

V : Volume of concrete (l)

A_2 : Aggregate correction factor
For concrete using common aggregate: $A_2 = 0$

8. Report

Necessary items of the following shall be included in the report.

(1) Air content

(2) Proportion of concrete

(3) Kind of admixture

(4) Slump

(5) Temperature of concrete

(6) Other particulars

(A12)

UDC 666.971:666.972.12:
666.972.031.3:620.168

JAPANESE INDUSTRIAL STANDARD

J I S

A 1119-1989

Method of Test for Variability of Constituents in Freshly Mixed Concrete

1. Scope

This Japanese Industrial Standard specifies the method of test for variability of unit weight of air-free mortar and unit weight of coarse aggregates in freshly mixed concrete.

2. Testing Apparatus

2.1 The apparatus for measuring the air content shall be one specified either in JIS A 1118 or in JIS A 1128.

2.2 The accuracy of the balance used shall be 0.1 % or finer of net weight of concrete for the test indicated in 4.2.

2.3 The sieve used shall be the 5 mm mesh sieve (1).

Note (1) The standard wire cloth sieve of 4.75 mm specified in JIS Z 8801.

3. Sample

3.1 The sample of the concrete shall be taken from the batch immediately after mixing in accordance with the method specified in 3.2.

Applicable Standards:

JIS A 1110-Method of Test for Specific Gravity and Absorption of Coarse Aggregates

JIS A 1118-Method of Test for Air Content of Fresh Concrete by the Volumetric Method

JIS A 1128-Method of Test for Air Content of Fresh Concrete by Pressure Method

JIS A 1135-Method of Test for Bulk Specific Gravity and Absorption of Light Weight Coarse Aggregate for Structural Concrete

JIS A 8603-Forced Mixing Type Mixers

JIS Z 8801-Test Sieves

3.2 The sample shall be taken from the first and the last portions (2) of the concrete stream discharged from the mixer. However, in the case where the quality of the concrete present in the mixer when the mixing has been completed and the mixer has stopped running is regarded as equal to the quality of the concrete discharged from the mixer, the sample may be taken from the front and rear portions (3) or from two different portions (4) of the concrete in the mixer.

In this case, the sample shall representative of the concrete of each individual portion.

Notes (2) The first and the last portions mean two out of the three stages in which the concrete stream is discharged from the mixer, that is, at the beginning, in the middle and towards the end.

(3) The front and the rear portions mean two out of the three parts when locations of concrete in the mixer are roughly divited into the front, the middle and the rear.

(4) Two different portions mean two portions on the concentric circles of different radii when the concrete is distributed circularly in the mixer, and two portions of the center and the end or the right half and the left half when the concrete is distributed squarely or rectangularly in the mixer.

3.3 The amount of the samples to be taken from each portion of concrete shall, as a rule, be the figure expressed in liter (l) which is the same as the maximum size of coarse aggregates indicated in millimeter (mm). When the maximum size of the coarse aggregates is not more than 20 mm, however, the amount of the sample shall be 20 l.

4. Test Methods

4.1 The samples taken from individual portions shall be treated separately in accordance with 4.2 to 4.4. The treating time for individual samples shall be approximately equal.

4.2 The air content of the sample shall be tested by either of the methods (5) (6) specified in 2.1. In advance, the mass of the concrete filling the container shall be measured.

Notes (5) In the case of lightweight aggregate concrete, the test shall be conducted by the volumetric method.

(6) Air content of samples taken from individual portions shall be tested by the same method.

4.3 The sample used for the test of 4.2 shall be poured on the 5 mm mesh sieve, and the grains less than 5 mm shall be removed by washing with water.

4.4 The aggregates retained on the 5 mm mesh sieve shall be weighed (7) in the saturated surface-dry condition. The surface-dry specific gravity shall be measured by the method specified in JIS A 1110 or JIS A 1135.

Note (7) Weights of aggregates retained on 5 mm mesh sieve may be measured in water to obtain the virtual mass.

5. Calculation of Results

5.1 The variation in unit weight of air-free mortar shall be calculated as follows.

$$M = \frac{m - m_S}{V - \left(V_A + \frac{m_S}{B}\right)} \times 1\,000$$

where M : unit weight of air-free mortar (kg/m³)

m : weight of concrete sample obtained by the method of 4.2 (kg)

m_S : saturated surface-dry weight of aggregates retained on 5 mm sieve (kg) (8)

V : volume of container used in air-content test of 4.2 (l)

V_A : volume of air as the product of the volume of container V and the percentage of air divided by 100 (l)

B : 1 kg/l x surface-dry specific gravity of coarse aggregate (kg/l)

Note (8) When the virtual mass of aggregates retained on 5 mm mesh sieve is measured in water, the value shall be calculated from the following formula:

$$m_S = m_W \times \left(\frac{D_S}{D_S - 1}\right)$$

where m_W : weight of aggregates in water (kg)

D_S : surface-dry specific gravity of aggregates

Variation in unit weight of air-free mortar in concrete (%) $= \frac{M_1 - M_2}{M_1 + M_2} \times 100$ (9)

where M_1 : higher value of M obtained from the two different portions of concrete

M_2 : lower value of M obtained from the two different portions of concrete

Note (9) This formula indicates the deviation of unit weight of air-free mortar of various parts from their mean value

viz. $$\frac{M_1 - M_2}{M_1 + M_2} = \frac{\frac{M_1 + M_2}{2} - M_2}{\frac{M_1 + M_2}{2}}$$

5.2 The variation in unit weight of coarse aggregates in concrete shall be calculated as follows.

$$G=\frac{m_S}{V}\times 1\,000$$

where G : unit weight of coarse aggregates in concrete (kg/m^3)

Variation in unit weight of coarse aggregates in concrete (%)

$$=\frac{G_1-G_2}{G_1+G_2}\times 100$$

where G_1: higher value of G obtained from the two different portions of concrete

G_2: lower value of G obtained from the two different portions of concrete

6. Report

Items in the following as required shall be included in the report.

(1) Type and capacity of mixer

(2) Size of batch

(3) Maximum size of coarse aggregates (mm), class and grading of aggregates

(4) Mix proportion

(5) Mixing time of mixer

(6) Sampling method and sample size

(7) Test method for air content and amount of air (%)

(8) Slump (cm)

(9) Variation in unit weight of air-free mortar in concrete (%)

(10) Variation in unit weight of coarse aggregates in concrete (%)

Informative Reference

1. Calculation examples of variation in unit weight of air-free mortar and of unit weight of coarse aggregates in concrete are as shown below.

Informative Reference Table

	When air content is measured by volumetric method				When air content is measured by air chamber pressure method			
	Test value of sample taken from front portion, outer side of concentric circle of concrete in mixer or beginning portion of concrete stream discharged from mixer		Test value of sample taken from rear portion, inner side of concentric circle of concrete in mixer or end portion of concrete stream discharged from mixer		Test value of sample taken from front portion, outer side of concentric circle of concrete in mixer or beginning portion of concrete stream discharged from mixer		Test value of sample taken from rear portion, inner side of concentric circle of concrete in mixer or end portion of concrete stream discharged from mixer	
	Weight (kg)	Volume (l)	Weight (kg)	Volume (l)	Weight (kg)	Volume (l)	Weight (kg)	Volume (l)
Volume of container (V) used for volumetric method		5.970		5.970		7.079		7.079
Air content by air meter	4.22 %		3.57 %		3.85 %		3.16 %	
Volume of air (V_A): Product of volume of container (V) and air content (%) divided by 100		0.252		0.213		0.273		0.224
Weight (m) and air-free volume of concrete obtained in 4.2	13.939	5.718	14.130	5.757	16.607	6.806	16.862	6.855
Weight (m_s) and volume of aggregates retained on 5 mm mesh sieve	7.373	2.784	7.821	2.951	8.785	3.315	9.335	3.515
Weight and volume of mortar in concrete	6.566	2.934	6.319	2.806	7.822	3.491	7.527	3.340
Unit weight (M) of mortar in concrete	2 238		2 252		2 241		2 254	
Unit weight (G) of coarse aggregates in concrete	1 235		1 310		1 241		1 319	
Variation in unit weight of air-free mortar in concrete	$\frac{2252 - 2238}{2252 + 2238} \times 100 = 0.31$ %				$\frac{2254 - 2241}{2254 + 2241} \times 100 = 0.29$ %			
Variation in unit weight of coarse aggregates in concrete	$\frac{1310 - 1235}{1310 + 1235} \times 100 = 3.0$ %				$\frac{1319 - 1241}{1319 + 1241} \times 100 = 3.1$ %			

2.

(1) The variation in unit weight (%) of air-free mortar in concrete and the variation in unit weight (%) of coarse aggregates in concrete obtained in 5.1 and 5.2 shall serve as an index to the mixing performance of the mixer.

Generally, concrete should be considered to have been mixed uniformly when the values shown below are not exceeded.

Variability of unit weight of air-free mortar in concrete: 0.8 %

Variability of unit weight of coarse aggregates in concrete: 5 %

Moreover, these requirements are shown in JIS A 8603.

(2) Although it is specified that measurement of air content is to be conducted either by the volumetric method of JIS A 1118 or the air chamber pressure method of JIS A 1128, the volumetric method is preferable for the concrete whose air content is more than 4 %.

(3) The following precautions indicated in 3., 4. and 5. shall be fully observed in this test since various factors may lead to errors accompanying the performance of test or errors in measured values.

3. The specification for the sampling place in 3.2 is provided for the forced mixing type mixer, the variable incline mixer and drum mixer of which the rotating shaft of the vane or the like is vertical. For other types of mixers, suitable places shall be selected for sampling, taking into account the type of mixer, mixing mechanism, etc., as shown in the following example.

Example: For the forced mixing type mixer of which vanes rotate around the horizontal axis in the horizontal drum, it is recommended to conduct sampling from the central part and the end part, the right half part and the left half part or from two different places.

4. In this test, if an unsuitable sampling method were taken, the result might be misconceived as if it indicated the variability of mixing performance of mixer, instead of the variability of unit weight of air-free mortar or variability of unit weight of coarse aggregates caused by the method of sampling. Especially, in the case of concrete with coarse aggregates of large maximum size or large slump concrete, the sampling should be conducted with utmost care.

Moreover, the amount of sample taken sometimes may be more than the value indicated in 3.3 depending upon the size of batch.

5. The sample taken from various parts shall be turned over on the mixing board so as not to fall asunder. It is necessary to use the concrete which will represent the sample for the test of air content.

UDC 666.972.015.4

JAPANESE INDUSTRIAL STANDARD

JIS

Method of Test for Bleeding of Concrete

A 1123-1975
(Reaffirmed: 1983)

1. Scope

This Japanese Industrial Standard specifies the bleeding test for concrete containing coarse aggregate with a maximum size not greater than 50 mm.

2. Test Apparatus

2.1 A container which is a metal cylinder with a machined inside, watertightness, and adequate strength shall be provided. The container shall be 25 cm in inside diameter, and 28.5 cm in inside height (1).

Handles shall be provided for easy handling.

Note (1) The container (24 cm in inside diameter, 22 cm in inside height) as specified in JIS A 1104, and JIS A 1116 may be used.

2.2 A scale sensitive to 10 g shall be used.

2.3 Glass graduates of 10 ml, 50 ml, and 100 ml shall be used. To draw off water seeping out to the top surface of concrete by bleeding, a pipet or syringe (2) shall be used.

Note (2) A pipet or syringe of a suitable size should be selected in accordance with the bleeding volume.

2.4 A tamping rod of round steel, 16 mm in diameter, and 50 cm in length, having a hemispherical end shall be used.

3. Sample

The method of sampling of concrete shall be as specified in JIS A 1115. The temperature of the sample concrete shall be 20 ± 3 °C.

4. Test Procedure

4.1 During the test, the room temperature of the test area shall be maintained at 20 ± 3 °C.

4.2 Concrete shall be placed in accordance with section 4.1 of JIS A 1116 so that its top surface is 3 ± 0.3 cm below the edge of the container when leveled. The top surface shall be smoothed with a minimum amount of troweling work (3).

Note (3) Excessive troweling at this stage will cause water to seep out, resulting in a dispersion of the test results.

4.3 Immediately after finishing the troweling, record the time. Then place the container containing the sample on the floor or a level platform free from vibrations, and cover the container with a suitable lid. Keep the lid in place during the test except when drawing off water.

Applicable Standards:

JIS A 1104–Method of Test for Unit Weight of Aggregates

JIS A 1115–Method of Sampling Fresh Concrete

JIS A 1116–Method of Test for Unit Weight and Air Content (Gravimetric) of Fresh Concrete

4.4 Draw off the water seeping out on the top surface of the sample concrete at 10 minute intervals during the first 60 minutes following the time recording, and at 30 minute intervals afterthere, until the bleeding becomes unnoticeable. To facilitate the drawing off of the water, tilt the container carefully by inserting a block approximately 5 cm thick under one side of the bottom of the container 2 minutes before drawing off the water. After the water is drawn off, gently replace the container into a level position.

Transfer the withdrawn water into the glass graduate, and record the total amount of the water collected by measuring it to the nearest one milliliter after every transfer.

4.5 Immediately after the bleeding becomes unnoticed, measure the weight * of the container and the sample in it (4).

Note * For the purpose of this standard, "weight" means mass.

Note (4) The weight of the water collected shall be added as a part of the weight of the sample.

The container and the sample may be weighed immediately after troweling the top surface of the sample providing there is no fear of giving vibrations to them.

5. Calculation of Results

5.1 The bleeding volume shall be calculated to two places of decimals by the following formula:

$$\text{Bleeding volume } (cm^3/cm^2) = \frac{V}{A}$$

where, V : Final total volume of water collected from bleeding (cm^3)

A : Top surface area of sample concrete (cm^2)

5.2 The volume of the water collected from bleeding expressed as a percentage of the water contained in the sample (bleeding rate) shall be calculated to two places of decimals by the following formula:

$$\text{Bleeding rate } (\%) = \frac{B}{C} \times 100$$

provided: $$C = \frac{w}{W} \times S$$

where, B : Final total quantity of water collected from bleeding (kg)

C : Quantity of water in sample (kg)

W : Weight of concrete per 1 m^3 (kg)

w : Quantity of water in concrete per 1 m^3 (kg) (5)

S : Weight of sample (kg)

Note (5) To be calculated assuming the aggregate is in saturated surface-dry condition.

6. Report

Necessary items of the following shall be included in the report (6).

(1) Quality and kind of materials used

(2) Proportion

(3) Bleeding volume and bleeding rate

When required, however, a chart showing the relation of the time and the quantity of bleeding accumulated by the time shall be prepared.

(4) Temperature of sample and room temperature during the test

(5) Other particulars

Note (6) When the container mentioned in Note (1) of section 2.1 is used, its dimensions shall be indicated.

UDC 539.41:620.179.16:666.97

JAPANESE INDUSTRIAL STANDARD

J I S

Method of Test for Dynamic Modulus of Elasticity, Rigidity and Dynamic Poisson's Ratio of Concrete Specimens by Resonance Vibration.

A 1127-1976
(Reaffirmed: 1986)

1. Scope

This Japanese Industrial Standard specifies the method of obtaining the dynamic modulus of elasticity, dynamic modulus of rigidity, and dynamic Poisson's ratio of concrete by measuring the primary resonance frequencies of longitudinal vibration, flexural vibration, and tortional vibration of columner and prismatic concrete specimens.

Remark: The units and numerical values given in { } in this standard are in accordance with the International System of Units (SI), and are appended for reference.

2. Test Apparatus

The test apparatus shall consist of the following (refer to Fig. 1).

2.1 Driving Circuit The driving circuit shall consist of an oscillator of variable frequency, amplifier, and driving terminal. The oscillator shall have a frequency range of 500 to 10000 Hz as standard and be capable of adjusting the frequency with an error of within ±2 %. The frequency verification in this adjustment shall be performed by using a cathode-ray oscilloscope and a reference oscillator ([1]).

Where an oscillator and an amplifier are combined, the driving circuit shall be capable of producing the required output and controlling it properly.

The driving terminal for producing vibration in the specimen shall work satisfactorily even when the outputs of the oscillator and amplifier are made the maximum. The mass of the vibrating part of the driving terminal shall be sufficiently small to prevent any influence on the test results.

The output voltage where an oscillator and amplifier are combined shall not vary by ±20 % or more in the whole frequency range of the oscillator. In addition, countermeans shall be provided so that no false resonance ([2]) occurs when the driving terminal is contacted with the specimen.

Applicable Standards:

JIS A 1107-Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete

JIS A 1132-Method of Making and Curing Concrete Specimens

The support of the driving terminal shall not restrict the vibration of the specimen so much as to influence the test results.

Notes (1) It is convenient to use a standard tuning fork controlled oscillator of 1000 Hz.

(2) The false resonance referred to herein means the resonance having no relation to the primary resonance vibration of the specimen.

2.2 Pickup Circuit The pickup circuit shall consist of a pickup, amplifier, and indicator. The pickup shall generate a voltage proportional to the amplitude, vibration speed, or vibration acceleration of the specimen, and the mass of its vibrating part shall be sufficiently small in comparison with the mass of the specimen.

The amplifier shall have an output sufficient to actuate the indicator and be capable of controlling the output. The indicator (3) shall be a voltmeter or a microammeter.

The output voltage of the pickup shall be proportional to the vibration of the specimen. In addition, the characteristic curve of the pickup shall be flat in the range of frequencies at which the pickup (4) is used.

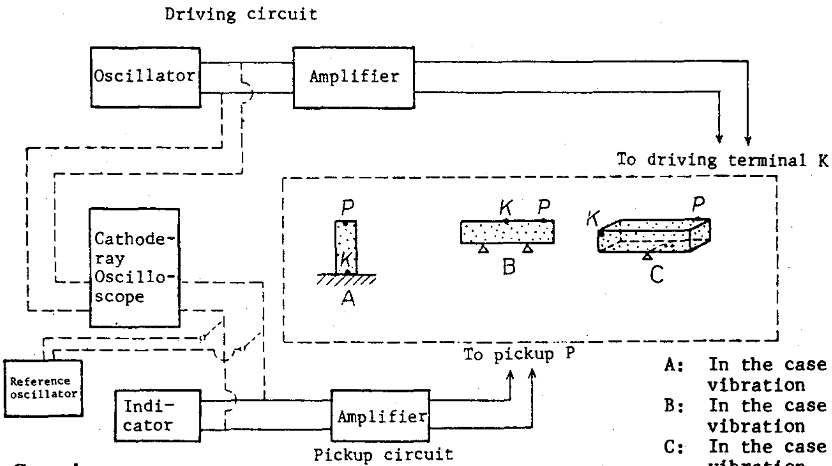
Notes (3) Although a cathode-ray oscilloscope may be used as the indicator, it is generally more convenient to use a meter type indicator. However, for the purpose of identifying the primary resonance frequency, the use of a cathode-ray oscilloscope is preferable.

(4) The primary resonance frequency of a specimen varies remarkably with the dimensions of the specimen and the like, and therefore a pickup corresponding to such factors shall be used.

2.3 Supporting Base for Specimen The supporting base shall allow the specimen to vibrate without appreciable restriction (5). The dimensions of the supporting base shall be such that the natural frequency of the supporting base is outside the frequency range used.

Note (5) It is recommended that the specimen is supported by a knife edge at a position close to the nodal point of vibration or by a thick sponge rubber block. In the case of longitudinal vibration, the specimen may be placed on a horizontal supporting base and the driving terminal may be contacted with the end surface of the specimen.

Fig. 1. Example of arrangement of Test Apparatus



A: In the case of longitudinal vibration
B: In the case of flexural vibration
C: In the case of tortional vibration

3. Specimen

3.1 Preparation of Specimen The specimen shall be prepared according to JIS A 1132 or JIS A 1107. However, the dimensions of the specimen may be other than those specified in these standards if they satisfy the requirements of 3.3.

3.2 Measurement of Mass and Dimensions The mass and length of the specimen shall be measured with a precision of within ±0.5 %. The value of the cross-sectional dimensions shall be obtained with a precision of within ±1 %. The length and cross-sectional dimension shall be represented by the average of the values obtained at several positions.

3.3 Limitation of Dimensions and Dimensional Ratio

3.3.1 In the case of longitudinal vibration, the cross-sectional dimension (6) of the specimen shall be not smaller than 10 cm, and the ratio of length to cross-sectional dimension of the specimen shall be not smaller than 2 (7).

Notes (6) The cross-sectional dimension means the diameter in the case of a columner specimen, and the length of one side in the case of a prismatic specimen (in the case of an oblong rectangular cross-section, the shorter side).

(7) If the cross-sectional dimension of the specimen is very small or the length to cross-sectional dimension ratio of the specimen is very small, the primary resonance frequency becomes difficult to obtain or it becomes outside the frequency range of the oscillator.

3.3.2 In the case of flexural vibration, the ratio of the length to the thickness in the direction of vibration of the specimen shall be in the range of from 3 to 5 as the standard (8).

Note (8) If the ratio of the length to the thickness in the vibrating direction of the specimen is very large or very small, it is difficult to obtain the primary resonance frequency in many cases. In order to use the calculation formula of 5., this ratio shall be at least 2.

4. Test Methods

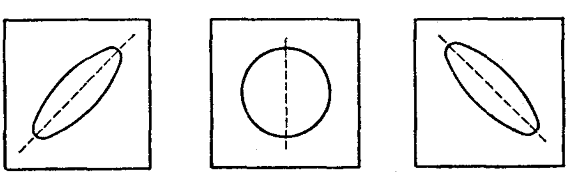
4.1 Determination of Resonance Frequency in the Case of Longitudinal Vibration

4.1.1 The specimen shall be placed on the supporting base in such a manner that a longitudinal vibration with both ends in free condition is allowed to take place without appreciable restriction. The driving force shall be applied perpendicularly to an end surface of the specimen. The pickup shall be contacted with the other end of the concrete specimen so that it actuate in the vibrating direction of the specimen.

4.1.2 While varying the frequency of the oscillator and applying the driving force so that the specimen vibrates in response to the changing frequency, the amplified output voltage of the pickup shall be observed. When the indicator shows a distinct maximum deflection and the primary resonance longitudinal vibration is identified as a result of measuring the nodal point of vibration ([9]), the frequency at this moment shall be taken as the primary resonance frequency of the longitudinal vibration.

Note ([9]) The positions of the nodal point and abdominal point of vibration can be identified by moving the pickup in the longitudinal direction of the specimen and reading the deflection of the indicator. The deflection of the indicator shows the minimum value at the nodal point and the maximum value at the abdominal point. In the case of an apparatus having a cathode-ray oscilloscope, the above position may also be identified by confirming by use of the oscilloscope that the phase of the Lissajous' figure changes at the nodal point (refer to Fig. 2). In the primary resonance vibration of longitudinal vibration, the nodal point of vibration occurs only one at the centre of the specimen and the abdominal points occur showing the maximum amplitude at both ends of the specimen.

Fig. 2. Change in Phase in Lissajous' Figure



4.2 Determination of Resonance Frequency in the Case of Flexural Vibration

4.2.1 The specimen shall be placed on the supporting base in such a manner that it is allowed to vibrate without appreciable restriction during the flexural vibration with both ends free ([5]). The driving force shall be applied in the direction giving flexural vibration to the specimen. The position at which the driving force is applied shall be apart from the nodal point of vibration (normally the central part or a position near one end of the specimen). The pickup shall be contacted with the surface of the concrete in such a manner that it acts in the vibrating direction of the specimen.

4.2.2 While varying the frequency of the oscillator and applying the driving force so that the specimen vibrates in response to the changing frequency, the amplified output voltage of the pickup shall be observed. When the distinct maximum deflection is shown by the indicator and the primary resonance flexural vibration is identified as the result of measuring the nodal point of vibration (10), the frequency at this moment shall be taken as the primary resonance frequency of the flexural vibration.

Note (10) Refer to Note (9). In the primary resonance vibration of a flexural vibration,the nodal point of vibration occurs at a position apart from the end of the specimen by 1/4 (strictly 0.224 time) of its length. Therefore, the deflection of the indicator also shows the maximum value at both ends of the specimen and shows the minimum value at the nodal point. On this case, also, identification may be made by means of a cathode-ray oscilloscope.

4.3 Determination of Resonance Frequency in the Case of Tortional Vibration

4.3.1 The specimen shall be placed on the supporting base in such a manner that it is allowed to vibrate without appreciable restriction during the torsional vibration with both ends free (5). The driving force shall be applied so as to give a torsional vibration at a position close to one end of the specimen. The pickup shall be contacted with the surface of the specimen so that it acts in the vibrating direction of the specimen.

4.3.2 While varying the frequency of the oscillator and applying the driving force so that the specimen vibrates in response to the changing frequency, the amplified output voltage of the pickup shall be observed. When the distinct maximum deflection is shown by the indicator and the primary resonance torsional vibration is identified as a result of measuring the nodal point of vibration (11), the frequency at this moment shall be taken as the primary frequency of the tortional vibration.

Note (11) Refer to Note (9). In the primary resonance vibration of a torsional vibration, the nodal point of vibration occurs only one at the centre and the amplitude becomes maximum at both ends.

5. Calculation of Results

5.1 Calculation of Dynamic Modulus of Elasticity The dynamic modulus of elasticity shall be calculated as follows:

5.1.1 In the Case of Longitudinal Vibration

$$E_D = C_1 W f_1^2$$

wherein $C_1 = 408 \times 10^{-5} \frac{L}{A} (s^2/cm^2) \{s^2/mm^2\}$

where E_D: dynamic modulus of elasticity (kgf/cm²) {N/mm²}

W: weight of specimen (kgf){N}

f_1 : primary resonance frequency of longitudinal vibration (Hz)

L : length of specimen (cm){mm}

A : cross-sectional area of specimen (cm^2){mm^2}

5.1.2 In the Case of Flexural Vibration

$$E_D = C_2 W f_2^2$$

wherein

$$C_2 = 164 \times 10^{-5} \times \frac{L^3 T}{d^4} (s^2/cm^2)\{s^2/mm^2\} \quad \text{(Columner specimen)}$$

$$C_2 = 966 \times 10^{-6} \times \frac{L^3 T}{bt^3} (s^2/cm^2)\{s^2/mm^2\} \quad \text{(Prismatic specimen)}$$

where

E_D : dynamic modulus of elasticity (kgf/cm^2){N/mm^2}

W : weight of specimen (kgf){N}

f_2 : primary resonance frequency of flexural vibration (Hz)

L : length of specimen (cm){mm}

d : diameter of columnar specimen (cm){mm}

b, t : lengths of respective sides of prismatic specimen (cm){mm}

t means the length of the side in vibrating direction

T : correction coefficient depending on radius of gyration k ($\frac{d}{4}$ for columner specimen, and $\frac{t}{3.464}$ for prismatic specimen), length L, and dynamic Poisson's ratio μ_D (refer to the Table).

Table. Values of Correction Coefficient T

k/L	T(12)	k/L	T(12)
0.00	1.00	0.09	1.60
0.01	1.01	0.10	1.73
0.02	1.03	0.12	2.03
0.03	1.07	0.14	2.36
0.04	1.13	0.16	2.73
0.05	1.20	0.18	3.14
0.06	1.28	0.20	3.58
0.07	1.38	0.25	4.78
0.08	1.48	0.30	6.07

Note (12) Values calculated by giving the dynamic Poisson's ratio as $\frac{1}{6}$. Where the dynamic Poisson's ratio is μ_D, T' shown by the following formula, represented by the product of T and the correction factor, shall be used.

$$T' = T\left[\frac{1 + (0.26\mu_D + 3.22\mu_D^2)\,k/L}{1 + 0.1328\,k/L}\right]$$

5.2 Calculation of Dynamic Modulus of Rigidity The dynamic modulus of rigidity shall be calculated as follows:

$$G_D = C_3 W f_3^2$$

wherein $C_3 = 408 \times 10^{-5} \frac{LR}{A}$ (s²/cm²) {s²/mm²}

where

G_D : dynamic modulus of rigidity (kgf/cm²){N/mm²}

W : weight of specimen (kgf){N}

f_3 : primary resonance frequency of torsional vibration (Hz)

L : length of specimen (cm){mm}

R : form coefficient

= 1 (Columner specimen)

= 1.183 (Prismatic specimen of square cross-section)

$$= \frac{a/b + b/a}{4a/b - 2.52(a/b)^2 + 0.21(a/b)^6}$$

(for prismatic specimen of rectangular cross-section, $b > a$)

A : cross-sectional area of specimen (cm^2){mm^2}

5.3 Calculation of Dynamic Poisson's Ratio The dynamic Poisson's ratio shall be calculated as follows:

$$\mu_D = \frac{E_D}{2G_D} - 1$$

where μ_D : dynamic Poisson's ratio

6. Report

Those required information items among the following shall be written in the report:

(1) Dimensions and mass of specimen

(2) Method of measuring resonance frequency and result of measurement

(3) Measured values of dynamic moduli of elasticify (kgf/cm^2){N/mm^2}

Reference (1) This standard has been established to specify the method for measuring the changes in dynamic moduli of concrete specimens under environmental conditions causing changes to concrete, such as meteorological actions, freezing and melting actions, and chemical actions.

(2) The values obtained by the method specified in this standard are influenced by the water content of the specimen and the like, and the values obtained with specimens prepared from the same concrete vary with the difference in their shape and dimensions, so that care must be taken in the handling of the measured values.

UDC 666.971/.972.017:620.192.5

JAPANESE INDUSTRIAL STANDARD

JIS

Methods of Test for Length Change of Mortar and Concrete

A 1129-1975
(Reaffirmed: 1986)

1. Scope

This Japanese Industrial Standard specifies the test for measuring a length change of mortar or concrete test pieces by the comparator method, contact gauge method, or dial gauge method as indicated in 1.1 and 1.2 below.

1.1 **Methods of measuring change in side length of test piece**

(1) Method in which a comparator equipped with a microscope is used (Comparator Method).

(2) Method in which a contact strain gauge, hereinafter referred to as a "contact gauge", is used (Contact Gauge Method).

1.2 **Method of measuring change in length of center axis of test piece**

(1) Method in which a measuring device equipped with a dial gauge is used (Dial Gauge Method).

2. Test Apparatus

2.1 Comparator Method The test apparatus used in the comparator method shall be as follows:

(1) Milky Glass for Marker Line for Measurement The milky glass shall be inlaid in or stuck to a test piece in order to mark marker lines on it for the measurement. Dimensions of the milky glass plate shall be approximately 10 mm long, 10 mm wide, and 1 to 2 mm thick for mortar, and approximately 15 mm long, 15 mm wide, and 1 to 2 mm thick for concrete. Its surface shall be smooth, and the other side should preferably be rough.

(2) Line Marking Device This device shall be capable of marking a fine straight line on the surface of each of two milky glass plates installed on a test piece so that the two straight lines run almost parallel to each other, and the distance between them constitutes a gauge length (see 4 below). Fig. 1 shows an example of the line marking device.

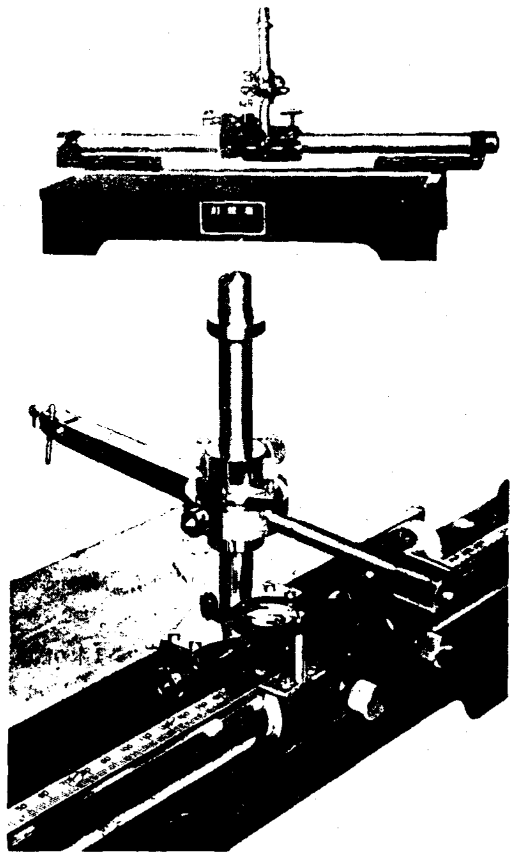
Applicable Standards:

JIS B 7503-Dial Gauges Reading in 0.01 mm

JIS B 7509-Dial Gauges Reading in 0.001 mm

JIS R 5201-Physical Testing Method of Cement

Fig. 1. An Example of the Line Marking Device



(3) Measuring Device This device shall have two microscopes and a micrometer installed on one of them. The construction of the device shall be such that it allows to read the distance between the two marker lines on the milky glass plates with the micrometer when one of the marker lines is adjusted to the cross wire in one of the microscopes. The device shall further meet the following requirements. (See Fig. 2)

(a) The cradle for installing a test piece shall be so constructed that it will always support a test piece at the same position of the unit while measuring length change of the test piece, and have adequate rigidity to prevent any deformation due to a weighty test piece.

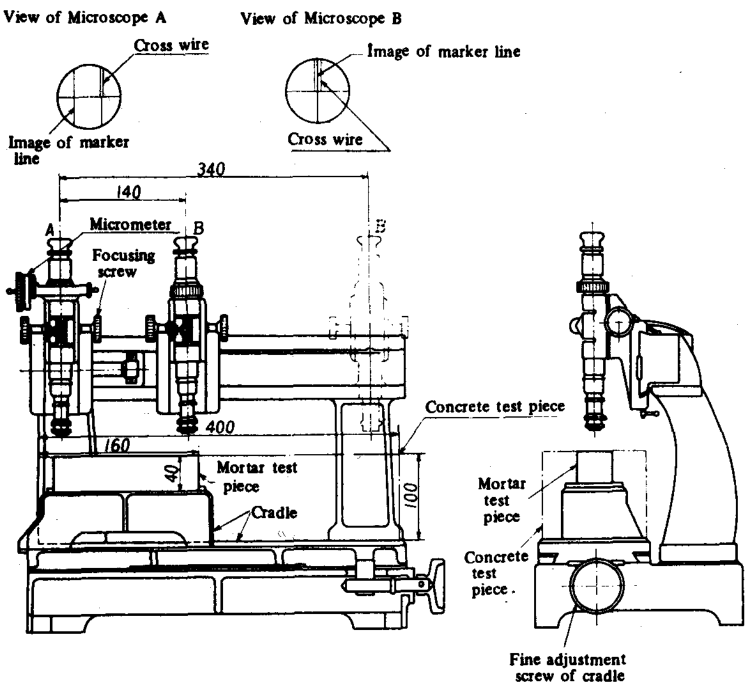
(b) Of the two microscopes, one shall be equipped with an ocular micrometer having a minimum scale value of 0.001 to 0.005 mm, hereinafter referred to as "microscope A", and the other shall have a magnification of 30 to 100 to give a clearcut image of the marker line on the milky glass plate, hereinafter referred to as "microscope B".

(c) The microscope A shall have such a measuring range as will allow to easily measure a change in the length of each test piece to some extent.

(d) The measuring device shall be equipped with a standard scale which allows to easily check the distance between the two microscopes. Fig. 2 shows an example of the measuring device used in the comparator method.

Fig. 2. An Example of the Measuring Device used in the Comparator Method

Unit: mm

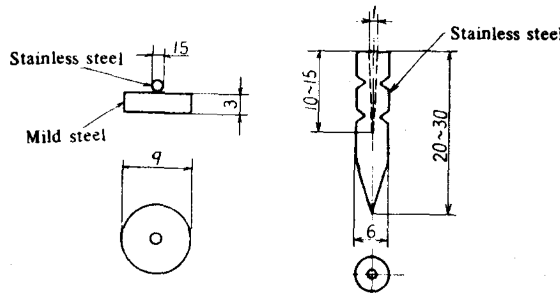


2.2 Contact Gauge Method The test apparatus used in the contact gauge method shall be as follows:

(1) Gauge Plug This plug shall be made of rust preventive metal, and inlaid in or stuck to a test piece, as a marker point for measuring a change in the length of the test piece.
Fig. 3 shows an example of the gauge plug.

Fig. 3. Examples of the Gauge Plug used in the Contact Gauge Method

Unit: mm



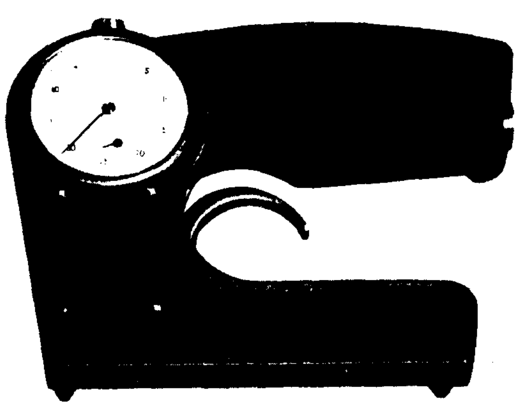
(2) Measuring Device The measuring device shall be so constructed that it will allow to read the scale of a dial gauge attached to it when pressed upon the gauge plug. This device shall further meet the following requirements.

(a) To allow measurement to be made in a fixed condition whenever the measurement is repeated.

(b) To have such a measuring range as to allow easy measurement even when there is some difference in the distance between the gauge plugs on each test piece.

(c) To be equipped with a standard scale allowing easy checking of the distance between its measuring legs. Fig. 4 shows an example of the measuring device.

Fig. 4. An Example of the Measuring Device used in the Contact Gauge Method

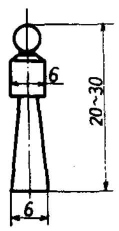


2.3 Dial Gauge Method The test apparatus used with the dial gauge method shall be as follows:

(1) Gauge Plug This plug shall be made of rust proof metal, and inlaid in or stuck to a test piece as a marker point for the measurement of a change in the length of the test piece. Fig. 5 shows an example of the gauge plug.

Fig. 5. An Example of the Gauge Plug used with the Dial Gauge Method

Unit: mm



(2) Measuring Device This device shall be so constructed that it has, as its main part, a frame with a dial gauge for measuring the length of a test piece, and if necessary also a cradle in order to permit to read the scale of the dial gauge by setting a test piece, supported or not supported by the cradle, in the frame. This device shall further meet the following requirements:

(a) The cradle shall be able to support a test piece so that the major axis of the test piece is in a vertical position or at a fixed angle to the vertical. It shall also be arranged so as to prevent free movement of the test piece supported by it.

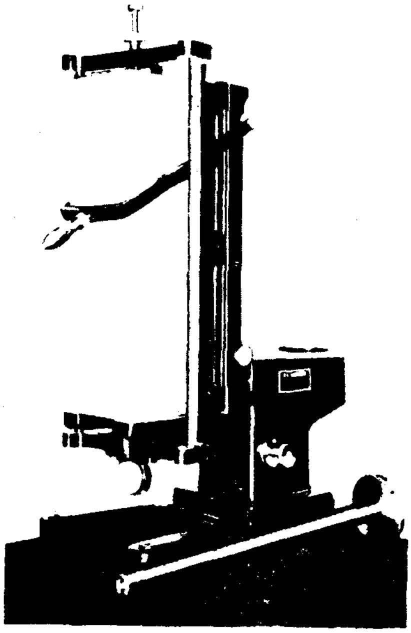
(b) The frame, when measuring a change in the length of a test piece, shall be able to accurately align the axis joining the contacting point of the frame and the tip of the spindle of the dial gauge to the axis joining the gauge plugs at both ends of the test piece. The frame shall also allow measurement to be made in an invariable condition whenever the measurement is repeated.

(c) The dial gauge attached to the device shall meet the requirements given in JIS B 7509 or JIS B 7503.

(d) The device shall have a standard scale allowing easy checking of the distance between the contacting point of the length measuring frame and the tip of the spindle of the dial gauge.

Fig. 6 shows an example of the measuring device.

Fig. 6. An Example of the Measuring Device used in the Dial Gauge Method



3. Test Piece

3.1 Dimensions of Test Piece Dimensions of a mortar test piece shall, in general, be 4 x 4 x 16 cm. The width and height of a concrete test piece shall be equal, and more than 3 times the maximum size of coarse aggregate used in it, and its length shall be more than 3.5 times its width or height. When the maximum size of coarse aggregate is 30 mm or less, dimensions of a concrete test piece shall in general, be 10 x 10 x 40 (or 50) cm.

3.2 Number of Test Pieces The number of test pieces shall be three or more for each test conducted in the same conditions.

3.3 Storage of Test Pieces During a storage period, precautions shall be taken to prevent damage to the milky glass or gauge plugs on test pieces, to equalize the environmental and storing conditions of each test pieces, and to leave a clearance of more than 1 cm around each mortal test piece and approximately 2.5 cm or more around each concrete test piece.

The positions of supporting a test piece shall be such that when a test piece is supported at two places, a maximum negative and positive bending moments caused due to its own weight become approximately equal (1).

Note (1) A mortar test piece shall be supported at positions approximately 3 cm from each end of the test piece, and a concrete test piece having dimensions of 10 x 10 x 40 cm at positions approximately 8 cm from each end of the test piece.

4. Determination of Gauge Length

4.1 The distance between the preestablished marker lines or points is called "gauge length". With the dial gauge method, the gauge length shall be the distance between the inside ends of the gauge plugs.

4.2 The gauge length shall be determined by considering the measuring range of the measuring device, length of the standard scale (in the comparator method, the distance between marker points installed on the standard scale), minimum scale of the comparator or dial gauge, maximum size of coarse aggregate, and the provisions given in 5. below.

4.3 In case of a concrete test piece the gauge length shall be four times the maximum dimension of coarse aggregate.

4.4 The gauge length shall be 10 cm or more (2) when the minimum scale of the comparator or dial gauge is 0.001 mm, and 20 cm or more (3) when the minimum size is 0.01 mm.

Notes (2) Corresponds to 0.001 % or less in the rate of length change.

(3) Corresponds to 0.005 % or less in the rate of length change.

5. Method of Installation of Milky Glass or Gauge Plugs

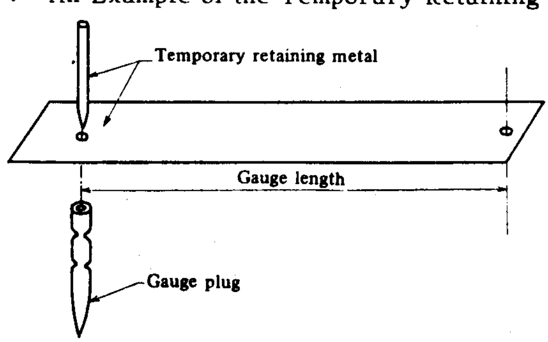
5.1 Milky Glass used in Comparator Method The milky glass for the marker lines shall be so installed on a test piece that the distance from each end of the test piece to each marker line on the milky glass, measured along the center line of the side of the test piece, becomes 8 mm or more for a mortal test piece, and 25 mm or more for a concrete test piece.

The milky glass shall be installed by such a method that it is stuck to the inside of the molding box with clay or grease, and then concrete or mortar is molded in the box, or that it is stuck to the surface of a completed test piece with adhesive so as not to shift its position.

5.2 Gauge Plug used in Contact Gauge Method The gauge plugs shall be so installed on a test piece that the distance from each end of the test piece to the marker point of each gauge plug, measured on the center line of the side or the upper surface of the test piece, becomes 8 mm or more for a mortar test piece, and 25 mm or more for a concrete test piece.

A gauge plug of such a type as to be stuck to the side of a test piece shall be stuck with adhesive to insure against shifting. A gauge plug of such a type as to be inlaid in a test piece shall be inlaid in such a method that it, at the time of molding a test piece, is supported in place on the center line of the upper surface of the test piece to be molded with a temporary retaining device to prevent a change in the distance between the marker points, or that after a test piece is molded and hardened, a small hole is drilled in the side of the test piece and the gauge plug is inlaid in the hole with adhesive. Fig. 7 shows an example of the temporary retaining device.

Fig. 7. An Example of the Temporary Retaining Device



5.3 Gauge Plug used in Dial Gauge Method The gauge plug shall have its leg portion inlaid in the center of each end face of a test piece at the time of molding the test piece, or have its leg portion inlaid with adhesive in a small hole drilled in a hardened test piece.

6. Method of Measurement of Length

6.1 The measuring device, standard scale, and test piece shall be maintained at the temperature specified for each test for 3 hours prior to the measurement. When the temperature is not specified, they shall be maintained at 20 ± 1 °C.

6.2 Prior to the measurement of the length of a test piece, foreign materials adhering to the milky glass or gauge plugs shall be cleanly wiped off.

6.3 Comparator Method

(1) Prior to measuring the length of a test piece, mark the marker lines on the milky glass.

(2) Put the standard scale on the cradle, accurately adjust the zero scale mark to the cross wire of the microscope B (4). Next, move the cross, wire of the microscope A to the scale mark corresponding to the gauge length of the test piece. Read the scale of the micrometer and indicate the reading by x_{i_1}.

(3) Carefully put the test piece on the cradle with the milky glass surface facing upward. Put a suitable mark on the test piece in order to assure the test piece placed in the same direction every time.

(4) Align one of the marker lines on the glass accurately with the cross wire of the microscope B (4). Next, move the cross wire of the microscope A to the other marker line. Read the scale of the micrometer, and denote the reading by x_{i_2}.

Note (4) This adjustment may be easily made by moving the cradle sideways.

6.4 Contact Gauge Method

(1) Put the standard scale on a level base, press the measuring point of the contact gauge upon the gauge plug of the standard scale, and read the scale of the dial gauge. Next, repeat the above by reversing the right and left of the contact gauge, and read the dial gauge. Take an average of the two readings, and let x_{i_1} represent the mean value.

(2) Put the test piece on a level base with the surface having the gauge plug facing upward, press the contact gauge upon the gauge plug of the test piece, repeat operations as described in (1) above, and let x_{i_2} be the mean value obtained.

6.5 Dial Gauge Method

(1) Place the length measuring frame in the same position with that for measuring a test piece (a vertical position or a position at a fixed angle to the vertical).

(2) Let the contacting point of the above frame contact with one of the gauge plugs on the standard scale, allow the tip of the spindle of the dial gauge to move along the axis of the standard scale. Let-off the spindle gradually to have it contact with the other plug (5), and read the scale of the dial gauge. Move the spindle back, repeat the above operations, take an average of the readings obtained after the second trial, and let x_{i_1} represent the mean value.

(3) Repeat the same operations as described in (2) above on the test piece, calculate the mean from the readings of the dial gauge, and let x_{t_2} be the mean value.

Note (5) In this case, handle and operate the spindle carefully, and make sure that the contacting portion is correctly fitted.

7. Calculation of Rate of Length Change

The rate of length change shall be calculated by the following formula:

$$\text{Rate of length change (\%)} = \frac{(x_{01} - x_{02}) - (x_{t_1} - x_{t_2})}{L_0} \times 100$$

where, L_0 = gauge length (6)

x_{01}, x_{02} = measured value at reference time respectively (6)

x_{t_1}, x_{t_2} = measured value at the time i respectively (6)

Note (6) The same unit of length shall be used for L_0, x_{01}, x_{02}, x_{t1} and x_{t2}.

8. Report

Necessary items of the following shall be included in the report.

(1) Kind and quality of materials used

(2) Proportion

(3) Method of making test piece

(4) Dimensions of test piece, and gauge length

(5) Kind of test method and the minimum scale of the measuring device

(6) Method of curing until the reference time for measurement

(7) Environmental conditions during storage period (temperature, humidity, wind direction, and solar radiation, etc.)

(8) Temperature and humidity at the time of measurement

(9) Rate of length change at each time of measurement (%)

(10) Weight of test piece at each time of measurement (g)

(11) Other particulars

Informative Reference

In measuring a length change of cement due to its hardening and drying by using mortar, the standard methods of molding and curing of its test piece shall be as follows:

1. Method of Molding

The test piece shall be made in accordance with the method of making a strength test piece as specified in (10) of JIS R 5201, and after molding the test piece in the molding box shall be maintained in a humid condition in a room temperature of 20 + 1 °C. It shall be taken out of the molding box after approximately 24 hours following the molding.

2. Time of Measurement

2.1 The first measurement shall be conducted just after removing the molding box.

2.2 After the first measurement, the test piece shall be cured in water of 20 ± 1 °C, and when its age reaches 7 days the second measurement shall be conducted. The time of the second measurement shall constitute the reference time.

2.3 After the second measurement, the test piece shall be stored in accordance with the requirements given in 3. below, and measurements shall be made whenever the storage period reaches 1, 4, and 8 weeks, and 3, 6, 9, and 12 months.

3. Storage of Test Pieces

During the storage period, test pieces shall be left intact in accordance with the requirements given in 3.3 of this standard, and ambient temperature and humidity shall be maintained at 20 ± 1 °C and 60 ± 5 % respectively.

For maintaining the temperature and humidity as above, a room or tank provided with a device for securing a constant temperature and humidity shall be used, or test pieces shall be put in a constant humidity storing box using a saturated solution of sodium bromide, and then the box shall be placed in a constant-temperature room or tank.

(A16) UDC 666.97.017:620.11

JAPANESE INDUSTRIAL STANDARD JIS

Method of Making and Curing Concrete Specimens

A 1132-1976
(Reaffirmed: 1986)

1. Scope

This Japanese Industrial Standard specifies the method of making and curing concrete specimens for the compressive strength test (JIS A 1108), tensile strength test (JIS A 1113) and flexural strength test (JIS A 1106) of concrete.

Remark: The units and numerical values given in { } in this standard are in accordance with the International System of Units (SI), and are appended for reference.

2. Sample of Concrete

2.1 In the case where the sample of concrete is made in the laboratory, it shall be in accordance with the requirements of JIS A 1138.

2.2 In the case where the samples of concrete are sampled from a mixer, hopper, transporting equipment of concrete and placed site, etc., the sampling method shall be in accordance with JIS A 1115.

3. Number of Specimens

3.1 In the case where the specimens are made from the mixed sample in accordance with 2.1, number of necessary specimens for the test of the identical conditions ([1]) shall be not less than three pieces. These specimens of not less than three pieces shall be made from the concrete of not less than two batches.

Note ([1]) Within these conditions, the test age of the specimens is included.

Applicable Standards:

JIS A 1106-Method of Test for Flexural Strength of Concrete

JIS A 1108-Method of Test for Compressive Strength of Concrete

JIS A 1113-Method of Test for Splitting Tensile Strength of Concrete

JIS A 1115-Method of Sampling Fresh Concrete

JIS A 1138-Method of Making Test Sample of Concrete in the Laboratory

JIS A 8610-Internal Vibrators for Concrete

3.2 In the case where the specimens are made from the sample taken in accordance with 2.2, number of specimens shall be determined according to the objects of test.

4. Specimens for Compressive Strength Test

4.1 Dimensions of Specimen The specimen shall be of cylindrical shape having a height of two times the diameter.

The diameter of the specimen shall generally be 15 cm, in the case where the maximum size of coarse aggregates is 50 mm or under. In the case where the specimen of under 15 cm in diameter is used, its diameter shall be three times or over the maximum size of coarse aggregates, as well as be 10 cm or over.

In the case where the maximum size of coarse aggregates exceeds 50 mm, the diameter of the specimen shall be three times or over the maximum size of the coarse aggregates.

Reference: In the case where the maximum size of the coarse aggregates exceeds 50 mm, specimens of 15 cm in diameter may be used, eliminating grains of 50 mm or 40 mm or over by screening the concrete with a sieve of 50 mm or 40 mm. Care must be taken that the compressive strength of this specimen differs in strength to some degree with that of the specimen having a diameter of three times or over the maximum size of coarse aggregates.

4.2 Appliances for Manufacturing Specimens

4.2.1 Formworks shall be of metallic cylinders, consisting of side plates having one or two longitudinal joints and bottom plates, and be assembled with suitable fittings.

4.2.2 Formworks shall be those which are free from deformation and leakage of water, when specimens are manufactured.

4.2.3 Dimensional errors of formworks shall be not more than 1/200 in diameter and 1/100 in height.

The flatness (2) of the face of the bottom plate of the formwork shall be within 0.02 mm.

When it has been assembled, axes of side plates (cylinders) of the formwork shall be at right angles with the bottom plate.

Note (2) The flatness mentioned here shall be expressed by a distance between the planes, when two parallel planes passing through the highest and lowest points of a plane are considered.

4.2.4 Formworks shall be assembled smearing thin films of oily clay, hard grease, and the like on the joints.

Inside of the formwork shall be smeared with mineral oil before placing the concrete.

4.2.5 In the case of compaction with a tamping rod, the tamping rod shall be a round steel of 16 mm in diameter and 50 cm in length, and the extreme end of which has been made semi-spherical.

4.2.6 In the case of compaction with an internal vibrator, the vibrator shall be that specified in JIS A 8610 (3).

Note (3) For a specimen of 20 cm or under in diameter, a vibrator of 27 mm in nominal diameter should be preferable to use.

Remark: In the case of compaction with a vibrating table type vibrator or other methods, it shall be that having a performance of compacting the objective concrete sufficiently.

4.2.7 The push plate to be used for capping shall be a polished plate glass (4) or polished steel plate of 6 mm or over in thickness, and its size shall be made 25 mm or over larger than the diameter of the formwork.

The flatness (2) of the face of the push plate shall be within 0.02 mm.

Note (4) In the case where the capping is processed by using sulfur, no polished plate glass shall be used.

4.3 Placing of Concrete

4.3.1 In the Case Where a Tamping Rod Is Used Pack the concrete separating into nearly equal layers. Put the concrete in each layer, so that it becomes nearly symmetrical to the axis of the formwork, and level its upper face with the tamping rod. In the case of a specimen of 15 cm in diameter and 30 cm in height, pack with separating into three layers, and tamp each layer 25 times with the tamping rod. If it is suspected to cause segregation of materials by tamping at this rate, decrease the number of tamping to an extent not to cause segregation.

In the case of a specimen of other than 15 cm in diameter, make the thickness of each layer 10 to 15 cm, and tamp at a rate of once per about 7 cm^2 of upper surface. If it is suspected to cause segregation of materials, decrease the number of tamping to an extent not to cause segregation.

After the tamping has been finished, pat the formwork on the side face with a wooden hammer so that the hollows generated by the tamping rod are extinguished.

4.3.2 In the Case Where an Internal Vibrator Is Used For the specimen of 10 to 20 cm in diameter, pack the concrete with separating into nearly equal two layers. Put the concrete, in each layer, so that it becomes nearly symmetrical to the axis of the formwork, and compact it using the vibrator.

Insert the vibrator once per approximately 60 cm^2 of upper face for each layer. In the case of compacting the lower layer, the vibrator shall not be touched to the bottom of the formwork. In compacting the upper layer, insert the vibrator so that it is inserted approximately 3 cm into the lower layer. The concrete of the upper layer shall not be placed so fully that mortar could be spilled over in inserting the vibrator.

The time for vibrating compaction shall be determined so that the concrete could be compacted sufficiently corresponding to the qualities of concrete and performances of the vibrator.

Pull out the vibrator slowly, and after pulling out has been finished pat the formwork on its side face with a wooden hammer so that no hollow could be left.

Remark: In the case where a vibrating table type vibrator is used, the formwork shall be installed securely to the vibrating table, pack the concrete at once so that it becomes nearly symmetrical to the axis of the formwork, and compact with imparting vibration.

The concrete shall not be packed so fully that the mortar could be spilled over in imparting vibration.

The time for vibrating compaction shall be determined so that the concrete can be compacted sufficiently corresponding to the qualities of concrete and performances of the vibrator.

4.3.3 In the case of stiff-consistency concrete, pack the uppermost layer upto slightly under the top face of the formwork, and in the case of plastic concrete upto the top face, so that the finished upper face, when the compaction has been finished, remains slightly under the top face of the formwork.

4.4 Finishing of Upper Face of Specimen

4.4.1 The upper face of the specimen shall be finished by the following method, to a vertical plane, as far as possible, with respect to the axis of the specimen. The flatness ([2]) of the finished face shall be within 0.05 mm.

In the case of the capping, its thickness shall be taken as thinner as possible.

4.4.2 When the capping is to be processed before detaching the formwork, remove laitance at an appropriate time ([5]) after packing of the concrete has been finished, by washing the upper face with water, place cement paste after water has been wiped off, and push with a push plate uniformly down to the top face of the formwork.

The cement paste (water cement ratio 27 to 30 %, however, 34 to 37 % when ultra high-early-strength portland cement is used) shall have been mixed about 2 h before use (1 h and a half when ultra high-early-strength portland cement is used), and be used by retempering without adding water. However, in the case where the upper face is to be polished, after hardening, to exactly flat, the cement paste which has just been mixed may be used.

In order to prevent the push plate from being set with the cement paste, a sheet of strong thin paper shall be inserted below the push plate.

Note ([5]) In the stiff-consistency concrete, it shall be after 2 to 6 h, and in the plastic concrete it shall be after 6 to 24 h.

4.4.3 When the capping is to be processed under detached condition of formwork, a mixture of sulfur and mineral powders ([6]), hard gypsum or a mixture of hard gypsum and portland cement, or ultra high-early-strength portland cement shall be used. In this case, an appropriate device shall be used in order to keep the axis of the specimen at right angles with the face of the capping. In addition, before the paste of the capping hardens, the specimen shall be covered with wet cloth to prevent from drying.

Remarks 1. In processing capping by using sulfur, use a mixture of sulfur and mineral powders. Heat this mixture to 130 to 145°C ([7]), spread over a polished steel plate, and push the specimen uniformly.

In the case where capping has been processed by using sulfur, a lapse of 2 h or over shall be taken before the strength test.

Notes([6]) As the mineral powders, those which will not change chemically when heated together with sulfur, such as powder of fire clay, fly ash and rock powder, shall be used. The mixing ratio of the sulfur to the mineral powder of 3:1 to 6:1 in weight shall be appropriate.

([7]) If it is heated to a higher temperature than this, it turns to rubber like, and the strength also becomes weaker.

Remarks 2. In the case where the compressive strength of concrete is suspected to be 300 kgf/cm^2{29.42 N/mm^2} or under, capping may be processed by using hard gypsum or a mixture of hard gypsum and portland cement. In this case, it shall have been confirmed that the compressive strength of a broken piece of beam of 4 cm x 4 cm x 16 cm which has been manufactured from the hard gypsum or a paste of the same proportion of the mixture of hard gypsum and portland cement to be used for capping is 300 kgf/cm^2{29.42 N/mm^2} or over.

In processing the capping, add necessary amount of water to the hard gypsum or mixture of hard gypsum and portland cement, mix until it becomes uniform, spread on a push plate, and push the specimen uniformly.

Remarks 3. The paste of ultra high-early-strength portland cement shall be prepared in accordance with 4.4.2.

In processing the capping, spread the paste on the push plate, and push the specimen uniformly.

In the case where some allowance of time is left before the strength test ([8]), capping may be processed by using the paste of high-early-strength portland cement or ordinary portland cement.

Note ([8]) In the case where the portland cement is used, it shall be 3 days or over.

4.4.4 If no capping is processed, the end face shall be finished by polishing.

5. Specimen for Flexural Strength Test

5.1 Dimensions of Specimen The section of the specimen shall be square, and the length of its one side shall generally be 15 cm in the case where the maximum size of coarse aggregates is 50 mm or under. In the case where a specimen of which length of one side is under 15 cm is used, the length of its one side may be taken as 3 times or over the maximum size of coarse aggregates, and as 10 cm or over. The length of specimen shall be taken as by 8 cm or over longer than 3 times the length of one side of the section.

5.2 Appliances for Manufacturing Specimen

5.2.1 The formwork shall consist of metallic bottom plate and side plates, and be assembled with appropriate fittings.

5.2.2 The formwork shall be, in manufacturing the specimens, free from deformation and leakage of water.

5.2.3 The dimensional errors of the formwork shall be 1/100 or under of the dimension of the section.

The flatness ([2]) of the face of the side plate shall be within 0.05 mm, and faces of the two side plates when assembled shall be parallel, and be free from inclination and torsion.

5.2.4 The formwork shall be assembled applying thin films of oily clay, hard grease and the like to the joints.

To the inside faces of the formwork, mineral oil shall be applied before placing the concrete.

5.2.5 In the compaction by using a tamping rod, the tamping rod shall be that specified in 4.2.5.

5.2.6 In the case of compaction by using an internal vibrator, the vibrator shall be that specified in 4.2.6.

5.3 Placing of Concrete

5.3.1 The concrete shall be placed with keeping the longer axis of specimen in horizontal position.

5.3.2 The formwork shall be installed, in placing the concrete and until it hardens after placing, in a horizontal place.

5.3.3 In the Case Where a Tamping Rod Is Used Pack the concrete with separating into nearly the same two layers. In each layer, put the concrete so that it becomes nearly symmetrical with the axis of the formwork, level its upper face with the tamping rod, and tamp at a rate of once per approximately 10 cm^2. If any segregation of materials is anticipated, reduce tamping number of times to a degree not causing segregation.

In each layer, after completion of tamping carry out spadings, with a metallic trowel or similar device, along side faces and end faces of the formwork, and pat the formwork on the side faces so that hollows generated by the tamping rod will be extinguished.

5.3.4 In the Case Where an Internal Vibrator Is Used Pack the concrete in one layer. Quantity of concrete shall be such a degree that, when compaction has been finished, it is raised slightly from the upper face of the formwork, and shall not be so packed that the mortar will spill over when the vibrator is inserted.

Carry out the vibrating compaction with inserting the vibrator from one end of the formwork to the other end, in equal intervals, at a rate of once per 100 cm^2.

Determine the time for vibrating compaction so that the concrete can be compacted sufficiently, corresponding to the qualities of concrete and performances of vibrator.

Pull out the vibrator slowly so that no hollow will remain.

After the compaction has been finished, carry out spading in accordance with 5.3.3, as appropriate, and pat the formwork on the side faces.

5.3.5 After the placing has been finished, scrape off the excessive concrete from the upper face, and carry out finish with trowel ([9]).

Note ([9]) In the case of stiff consistency concrete, it should be preferable to finish again, after it has been finished with the metallic trowel immediately after placing, with a wooden trowel at an appropriate time.

6. Specimen for Tensile Strength Test

6.1 Dimensions of Specimen The specimen shall be cylindrical shape, and its diameter shall be 4 times or over of the maximum size of the coarse aggregates, and be 15 cm or over. The length ([10]) of the specimen shall be its diameter or over, and shall not exceed twice the diameter.

Note ([10]) The length of the specimen should be preferable to be determined considering the length of pressurizing plate of the tester.

Generally in the case of 15 cm in diameter, approximately 20 cm is appropriate for its length.

6.2 Appliances for Manufacturing Specimen The appliances to be used for manufacturing the specimen shall be in accordance with 4.2.

6.3 Placing of Concrete

6.3.1 The formwork shall be installed, when the concrete is placed and until it hardens after placing, in a horizontal place.

6.3.2 In the Case Where a Tamping Rod Is Used Pack the concrete with separating into nearly equal two layers of 7.5 to 10 cm in thickness. The placing method of each layer shall be in accordance with 4.3.1.

6.3.3 In the Case Where an Internal Vibrator Is Used The method of vibrating compaction shall be in accordance with 4.3.2.

6.3.4 When the placing has been finished, its upper face shall be levelled by applying a trowel lightly.

7. Detaching of Formwork and Curing

7.1 After the concrete has been finished on packing, detach the formwork with waiting its hardening. The time to detach the formwork shall generally be 24 h or over to within 48 h after completion of packing. During this time, cover the upper face of the specimen with plate glass, steel plate or wet cloth to prevent moisture from evaporation.

7.2 Temperature during manufacture and cure of the specimen shall be 20 ± 3°C ([11]) as the standard. In this case, the specimen, after its formwork has been detached, shall be cured, until the strength test is conducted, under wet condition.

For keeping the wet condition, the specimen shall be placed in a water tank, wet sand or saturated moisture ([12]).

The specimen shall not be cured in such a condition that it is continuously washed with fresh water.

Notes ([11]) In the case of other temperature range than this, temperatures during manufacture and curing shall be recorded.

([12]) In the case of curing in wet sand or covered with wet cloth, care shall be taken for the fact that the temperature in this case normally becomes lower than the ambient temperature due to evaporation of moisture.

8. Transportation of Specimen

The time, in the case where the specimen which has been manufactured at site is to be transported for curing in accordance with 7.2, shall be selected as earlier as possible within a range not impairing the specimen.

9. Report

In the report, necessary matters among those given in the following shall be recorded:

(1) Object of tests

(2) Number of specimens

(3) Types and qualities of materials used

(4) Proportion of concrete

(5) Date of preparation of specimen, age at the time of strength tests, and date of strength tests

(6) Method of manufacturing sample or sampling method

(7) Shape and dimensions of specimen and placing method

(8) Temperature and humidity at the time of preparing specimen

(9) Curing method

(10) Others

UDC 666.972.03:620.11

JAPANESE INDUSTRIAL STANDARD J I S

Method of Making Test Sample of Concrete in the Laboratory

A 1138-1975
(Reaffirmed: 1983)

1. Scope

This Japanese Industrial Standard specifies the method of making test sample of concrete used for performing various tests in the laboratory.

2. Preparation of Materials

2.1 The materials of concrete shall be maintained at 20±3°C as a rule before they are mixed.

2.2 Cement shall be kept in a sealed moisture-proof container.

Reference: Where the cement is likely to contain lumps, the lumps shall be removed by screening with a 1.2 mm wire sieve.

2.3 Coarse and fine aggregates shall be prepared so that the grading does not vary with each batch. Where the coarse and fine aggregates have a fear of segregation, they shall respectively be prepared by screening them into two or more particle groups.

The coarse and fine aggregates or screened particle groups shall respectively be adjusted to a uniform condition of water content ([1]).

Note ([1]) This condition shall be the saturated surface-dry condition or a condition close to it.

3. Measurement of Materials

3.1 The materials of concrete shall respectively measured by weight. However, water and liquid-form chemical admixtures or chemical admixtures in the form of aqueous solutions may be measured by volume.

3.2 The measurement shall be performed accurately by using a measuring apparatus capable of reading to 0.5 % of the quantity measured at one time.

3.3 The weighed aggregate shall not be dried until it is mixed in the concrete.

4. Mixing of Concrete

4.1 The concrete shall be mixed in a laboratory maintained at a temperature of 20±3°C and a relative humidity of 60 % or higher, as a rule.

4.2 The concrete shall be mixed by using a mixer, as a rule. In particular, AE concrete, concrete having a slump value of about 10 cm or less, and concrete in a quantity of about 20 ℓ or more shall necessarily be mixed by using a mixer.

4.3 The quantity of concrete mixed at one time shall be larger by 5 ℓ or more than the quantity required for the test, and in the case of mixing by a mixer, this quantity shall be not smaller than 1/2 of the nominal capacity of the mixer and shall not exceed its nominal capacity.

4.4 Where the concrete is mixed by using a mixer, a small quantity of concrete having the same proportion as the concrete to be mixed shall preliminarily be mixed in the mixer to give a condition in which mortar is attached on the inner surface of the mixer. The respective materials shall be introduced into the mixer in such a sequence of introduction as to prevent the concrete from adhering to the mixer as far as possible and make it uniform as rapidly as possible, and the mixing shall be continued until they become uniform ([2]). The mixed concrete shall be discharged on a mixing platform and remixed with a trowel or concrete shovel until uniformity is obtained.

Note ([2]) Although the mixing time varies with the capacity and type of the mixer, proportion of the concrete, and the like, it is generally preferable that the mixing time is 3 min or longer in the case of a tilting mixer, and 2 min or longer in the case of a forced mixing type mixer.

4.5 In the case of employing hand mixing, it shall be performed on a mixing platform by using a concrete shovel. First the cement and fine aggregate shall be mixed until they become uniform, then after adding a part of the water to be used for mixing, they shall be mixed into a plastic mass, and then the coarse aggregate and the remaining water shall be added and mixed until uniformity is attained.

4.6 The mixing platform used in 4.4 and 4.5 shall be watertight, and be preliminarily made into a condition in which mortar of a part of the concrete in the same proportion as the concrete to be mixed is attached, or be wetted by wiping with a wet cloth.

5. Report

Those information items required among the following shall be written in the report:

(1) Purpose of test

(2) Batch No.

(3) Date and time of preparing the sample

(4) Temperature and humidity in laboratory

(5) Name, kind, and name of manufacturer or locality of occurrence of each material used

(6) Temperature of each material used

(7) Maximum size, grading, specific gravity, water absorption, and water content of aggregate

(8) Proportion of concrete

(9) Type and capacity of mixer, and mixing quantity and mixing time at one time

(10) Sequence of introduction of materials

(11) Temperature of concrete

(12) Other required information

UDC 666.972.03/.05

JAPANESE INDUSTRIAL STANDARD

J I S

Ready-mixed Concrete

A 5308-1989

1. Scope

This Japanese Industrial Standard specifies the ready-mixed concrete([1]) which is to be delivered to the point of discharge.

Note ([1]) This Standard shall not specify transportation, placement and curing after the concrete has been delivered.

Remark: The units and numerical values given in { } in this Standard are based on the International System of Units (SI) and are appended for informative reference.

2. Materials

2.1 Cement The cement used shall conform to one of the followings Standards.

JIS R 5210

JIS R 5211

JIS R 5212

JIS R 5213

2.2 Aggregates The aggregates to serve shall conform to Annex 1.

When the aggregates of class B in Annex 1 are to be used, the measures for restraining the alkali reactivity of aggregates specified in 3, 4 and 5 of Annex 6 shall be selected and put into execution.

2.3 Water The water to serve shall be that which conforms to Annex 9.

2.4 Admixtures The admixtures shall conform to the following:

(1) The admixtures shall not be those which adversely affect the concrete and steel.

Fly ash, expansive additive, chemical admixture and corrosion inhibitor, if used, shall conform to the following Standards.

JIS A 6201

JIS A 6202

JIS A 6204

JIS A 6205

Applicable Standards and Reference Standards: See pages 61 and 62.

(2) The admixtures to serve shall be those which are approved by the purchaser.

3. Types and Designation

3.1 Types

3.1.1 Types and Special Division The ready-mixed concrete shall be categorized into ordinary concrete, lightweight concrete and road concrete, each classified into two types of the standard type concrete and the special order type concrete.

3.1.2 Standard Types The standard types shall be as follows:

(1) The standard types are those marked with ○ in Tables 1 to 4. The air contents shall be 4.0 % for the ordinary concrete and the road concrete, and 5.0 % for the lightweight concrete.

Further, in cold districts, the air contents shall be 4.5 % for the ordinary concrete and the road concrete, and 5.5 % for the lightweight concrete.

(2) The purchaser shall designate the standard type concrete according to the combinations of nominal strength and slump as specified in Tables 1 to 4.

Table 1. In the Case of Ordinary Concrete and Coarse Aggregates of Maximum Size 20 mm or 25 mm

Slump cm \ Nominal strength	150	160	180	195	210	225	240	255	270	300	350	400
5	●	●	●	●	●	●	●	●	●	○	○	○
8	○	○	○	○	○	○	○	○	○	○	○	○
10	●	○	●	●	●	●	●	●	●	●	●	●
12	○	○	○	○	○	○	○	○	○	○	●	●
15, 18	○	○	○	○	○	○	○	○	●	●	●	●
21	—	—	—	—	○	○	○	○	●	●	●	●

Table 2. In the Case of Ordinary Concrete and Coarse Aggregates of Maximum Size 40 mm

Slump cm \ Nominal strength	150	160	180	195	210	225	240	270	300
5, 8, 12	●	○	○	○	○	○	○	○	○
15, 18	○	○	○	○	○	○	○	●	●

Table 3. In the Case of Lightweight Concrete and Coarse Aggregates of Maximum Size 15 mm or 20 mm

Slump cm \ Nominal strength	150	180	195	210	225	240	255	270	300
5, 8	●	○	●	●	●	○	●	○	○
12, 15	●	○	○	○	○	○	○	○	○
18, 21	○	○	○	○	○	○	○	●	●

Table 4. In the Case of Road Concrete and Coarse Aggregates of Maximum Size 40 mm

Slump cm \ Nominal strength	Bending 45
2.5, 5, 6.5	○

(3) The purchaser shall designate upon agreement with the producer the following items, of which (e) and (f) shall be designated only as occasion needs.

(a) Type of cement

(b) Type of aggregates

(c) Maximum size of coarse aggregates

(d) In the case of the lightweight concrete, unit volume mass of concrete

(e) Highest or lowest temperature of the concrete

(f) Class of aggregates according to alkali reactivity. Method of restraining alkali reactivity of aggregates when class B aggregates are used.

3.1.3 Special Order Types The special order types shall be as follows.

(1) The special order types shall be those marked with ○ and ● in Tables 1 to 4.

(2) The purchaser shall designate the special order type concrete by means of the combinations of strength and slump given in Tables 1 to 4.

(3) The purchaser shall designate the following items upon agreement with the producer.

(a) Type of cement

(b) Type of aggregates

(c) Maximum size of coarse aggregates

(d) Mass limit of chlorides when it differs from that prescribed in 4.2

(e) Material age that guarantees nominal strength

(f) Upper limit of water-cement ratio

(g) Lower or upper limit of unit cement content

(h) Type of admixtures

(i) Air content

(j) Class of aggregates according to their alkali reactivity. Method of restraining alkali-aggregate reactivity of aggregates if class B aggregates are used.

(k) Unit volume mass of concrete in the case of the lightweight concrete

(l) In the case of the base concrete of flowing concrete(2), the maximum value of slump

(m) Highest or lowest temperature of concrete

(n) Other necessary items

Note (2) In the case where the purchaser designates the method based on the total alkali content in (j), he shall inform the producer of the alkali content (kg/m^3) to be intermixed through the use of a fluidizing agent.

3.2 Designation The ready-mixed concrete shall be designated by standard type or special order type, type of aggregates, nominal strength, slump, maximum size of coarse aggregates and type of cement.

Example: (Standard) Ordinary 210 8 20 N

(Special) Lightweight Class 2 270 21 15 H

- H — Type of cement
- 15 — Maximum size of coarse aggregates
- 21 — Slump
- 270 — Nominal strength
- Lightweight Class 2 — Type of aggregates
- (Special) — Standard type or special order type

The symbols to be used for designating the ready-mixed concretes shall be as follows according to the classification of materials used.

(1) Symbols by Types of Cement

(Type)	(Symbol)
Ordinary portland cement	N
Ordinary portland cement (low alkali type)	NL
High-early-strength portland cement	H
High-early-strength portland cement (low alkali type)	HL
Ultra high-early-strength portland cement	UH
Ultra high-early-strength portland cement (low alkali type)	UHL
Moderate heat portland cement	M
Moderate heat portland cement (low alkali type)	ML
Sulfate-resisting portland cement	SR
Sulfate-resisting portland cement (low alkali type)	SRL
Portland blast-furnace slag cement Class A	BA
Portland blast-furnace slag cement Class B	BB
Portland blast-furnace slag cement Class C	BC
Portland pozzolan cement Class A	SA
Portland pozzolan cement Class B	SB
Portland pozzolan cement Class C	SC
Portland fly ash cement Class A	FA
Portland fly ash cement Class B	FB
Portland fly ash cement Class C	FC

(2) Symbols by Types of Aggregates

	(Coarse aggregate)	(Fine aggregate)	(Symbol)
Ordinary concrete and road concrete	Gravel, crushed stone or blast-furnace slag coarse aggregates	Sand, crushed sand or blast-furnace slag fine aggregates	Ordinary
Lightweight concrete	Artificial light-weight coarse aggregates	Sand, crushed sand or blast-furnace slag fine aggregates	Lightweight Class 1

(Coarse aggregate)	(Fine aggregate)	(Symbol)
Artificial light-weight coarse aggregates	Artificial light-weight fine aggregates or artificial light-weight fine aggregates partially mixed with sand, crushed sand or blast-furnace slag fine aggregates	Lightweight Class 2

(3) Symbols According to Maximum Sizes of Coarse Aggregates

	(Symbol)
Maximum size 40 mm	40
Maximum size 25 mm	25
Maximum size 20 mm	20
Maximum size 15 mm	15

4. Quality

4.1 Strength, Slump and Air Content The strength, slump and air content of the ready-mixed concrete shall satisfy the following conditions at the point of discharge.

(1) Strength Strength of the concrete, when it is subjected to the strength tests(3) specified in 8.2, shall satisfy the following requirements:

(a) The results of one-time test shall be 85 % or over of the nominal strength(4) values designated by the purchaser.

(b) Mean values of the results of three-time tests shall be at least the nominal strength values(4) designated by the purchaser.

Notes (3) Material age of the specimen for the strength tests shall be 28 days for the standard type, and the number of days designated by the purchaser for the special order type.

(4) The values shall be expressed by kgf/cm^2 $\{N/cm^2\}$.

(2) Slump The slump shall be within the range specified in Table 5 relative to the values designated by the purchaser.

Table 5. Tolerances on Slump

Unit: cm

Slump	Tolerances on slump
2.5	± 1
5 and 6.5	± 1.5
8 or over up to and incl. 18	± 2.5
21	± 1.5

(3) Air Content Air content shall be within the range specified in Table 6 relative to the values designated by the purchaser.

Table 6. Tolerances on Air Content

Type of concrete	Tolerances on air content %
Ordinary concrete	± 1
Road concrete	
Lightweight concrete	± 1.5

4.2 Chloride Content The chlorides contained in the concrete shall be 0.30 kg/m^3 or under as chlorine ion at the point of discharge. However, it may be increased up to 0.60 kg/m^3 with the approval of the purchaser.

When a value other than those values is specified in 3.1.3, it shall be observed as the maximum value.

5. Volume

The volume of the ready-mixed concrete shall not fall short of the volume entered in the delivery sheet at the point of discharge.

6. Proportion

6.1 The proportion of the concrete for the standard type shall be determined by the producer so as to satisfy the quality specified in 4. as well as to pass the inspection of 9.

6.2 The proportion of the concrete for the special order type shall be determined by the producer so as to satisfy the quality specified in 4. upon agreement with the purchaser as well as to pass the inspection of 9.

6.3 The producer shall, prior to the delivery of the ready-mixed concrete, report to the purchaser the materials used in production and the proportions thereof, the limit of chloride content of the concrete, and the method of restraining alkali-reactivity of the aggregates([5]).

Note (5) The restraining method shall be reported by entering the symbol of Annex Table 6 in the corresponding column of Table 8. However, when the aggregates conforming to class A of Annex 1 are employed, enter symbol A in the said column.

6.4 The producer, as required by the purchaser, shall submit the data as a basis for planning concrete proportions, calculating the chloride content of the concrete and for formulating the measures for restraining alkali-reactivity of aggregates.

7. Manufacture

7.1 Manufacturing Equipment

7.1.1 Equipment for Storing Materials The equipment for storing the materials shall be as given in the following:

(1) The equipment for storing the cement shall, as divided by types, be capable of preventing the cement from weathering.

(2) The storing equipment for aggregates shall be comparted according to the types and classes, and be capable of preventing segregation of large and small particles. The floor shall be constructed of concrete and the like, and measures shall be taken for drainage as well as for prevention of ingress of foreign matters(6).

In addition, the equipment shall be capable of storing the amount of aggregates corresponding to the maximum delivery for one day or over of the concrete.

Note (6) In the case of storing artificial lightweight aggregates, it is necessary to provide a sprinkling equipment.

(3) The storing equipment and the equipment for transporting the aggregates from the storing equipment to the batching plant shall be capable of furnishing uniform aggregates.

(4) The storing equipment for admixtures shall be comparted according to the types and classes, and shall prelude the adulteration of the quality of the admixtures.

7.1.2 Batching Plant The batching plant shall be as follows:

(1) The plant shall generally be provided with separate storing bins for respective materials.

(2) The measuring devices shall have precision for weighing out respective materials within errors specified in 7.2.

In addition, they shall be provided with indicating devices capable of indicating the measured values with the precision mentioned above.

(3) All the indicating devices shall be located at places visible to operator, and the measuring devices shall ensure an easy operation.

(4) The measuring devices shall be capable of successively measuring the materials for concrete of different proportions.

(5) The measuring devices shall be provided with devices which readily correct the measured values by the surface water content of fine aggregates.

7.1.3 Mixer The mixer shall be as given in the following:

(1) The mixer shall be of a stationary type.

(2) The mixer, when mixing the concrete of a defined slump at the capacity specified in 7.3.2, shall be capable of mixing the materials thoroughly and discharging them under a uniform condition(7).

Note (7) The mixer may be considered to possess performance of mixing the concrete uniformly, when a defined volume is mixed for a defined time and the values obtained by the tests in accordance with JIS A 1119 do not exceed the values given below.

Mass difference in unit volume of mortar contained in concrete .... 0.8 %

Difference in unit coarse aggregate quantities contained in concrete .... 5 %

7.1.4 Transportation Unit The transportation unit shall be as given in the following:

(1) In the transportation of the ready-mixed concrete, a truck agitator having the following performances shall be used.

(a) The transportation unit shall be capable of maintaining a thorough uniformity of the mixed concrete, and of discharging it readily and completely without causing segregation of materials.

(b) The transportation unit, when the slump test is carried out on the samples taken(8) from about $\frac{1}{4}$ and $\frac{3}{4}$ of the depth of the heap of the load, shall exhibit a difference within 3 cm in slump of the two samples.

Note (8) In this case, samples shall be taken as in cutting the full sections of the entire parts in the flow of concrete being unloaded.

(2) The dump truck may be used only for transporting road concrete having a slump of 2.5 cm.

The bed of the dump truck shall be flat, smooth and waterproof and, as required, shall have a waterproof cover for protection from rain and wind.

7.2 Measurement of Materials

7.2.1 The cement, aggregates, water and admixtures shall be measured respectively with separate measuring devices.

7.2.2 Measurement of the cement shall be in mass, and its measuring error shall be within 1 % of one measuring quantity.

7.2.3 Measurement of the aggregates shall be in mass, and its measuring error shall be within 3 % of one measuring quantity.

7.2.4 Measurement of the water shall be in mass or in volume, and its measuring error shall be within 1 % of one measuring quantity.

7.2.5 Measurement of the admixtures shall be in mass, and its measuring error shall be within 2 % of one measuring quantity.

With the approval of the purchaser, measurement may be made by the number of bags. However, in the case where a quantity less than one bag is used, it shall be measured in mass without fail.

7.2.6 The chemical admixture shall be used in the form of solution, and be measured in mass or in volume, and its measuring error shall be within 3 % of one measuring quantity.

7.3 Mixing

7.3.1 The ready-mixed concrete shall be mixed uniformly in the factory with the mixer specified in 7.1.3.

7.3.2 Mixing quantity and mixing time of the concrete shall be determined after carrying out the test as specified in JIS A 1119(7).

7.4 Transportation

7.4.1 Transportation of the ready-mixed concrete shall be made by the transportation unit specified in 7.1.4.

7.4.2 The concrete shall be transported so as to be discharged within 1.5 h from the start of mixing. However, upon agreement with the purchaser, the limit of transporting time may be altered.

7.4.3 In the case of transportation of concrete with a dump truck, the limit of the transporting time shall be 1 h from the start of mixing.

7.5 Quality Control

7.5.1 The producer shall conduct necessary quality control for guaranteeing the quality of concrete specified in 4.

7.5.2 The producer, as requested by the purchaser, shall submit the test results of the quality control tests.

8. Test Methods

8.1 Sampling Method The sampling method shall be in accordance with JIS A 1115. However, when samples for quality inspection of the base concrete are to be taken from a truck agitator at the point of discharge, the samples shall be obtained, after the concrete is mixed for 30 s with the agitator, from a full section of the flow of concrete to the exclusion of approximately 50 l of concrete discharged first.

8.2 Strength Test

8.2.1 Compressive Strength Test The compressive strength test shall be performed in accordance with JIS A 1132 and JIS A 1108.

The dimensions of specimens shall generally be 10 cm in diameter and 20 cm in height for the aggregates having maximum size of 15 mm, 20 mm or 25 mm, and shall be 12.5 cm in diameter and 25 cm in height or 15 cm in diameter and 30 cm in height for the aggregates having maximum size of 40 mm.

The specimens shall be subjected to the water curing at 20 ± 3°C([9]).

8.2.2 Flexural Strength Test The flexural strength test shall be performed in accordance with JIS A 1132 and JIS A 1106.

The specimens shall be subjected to the water curing at 20 ± 3°C([9]).

Note ([9]) In the case where the accumulated temperature method is to be used for the winter concrete, the curing of the specimen shall be the water curing at 20 ± 2°C.

8.3 Slump Test The slump test shall be in accordance with JIS A 1101.

8.4 Air Content Test The air content test shall be in accordance with JIS A 1128, JIS A 1118 or JIS A 1116.

8.5 Chloride Content The chloride content of the concrete shall be determined as the product of the chlorine ion concentration in water in the freshly mixed concrete and the unit water content([10]) used in designing the proportion. The test of the chlorine ion concentration in water in the freshly mixed concrete shall be carried out in accordance with Annex 5. However, the chlorine ion concentration test for the purpose of inspection of chloride content in 9.4 may, by permission of the purchaser, be performed using a salt content measuring apparatus with known accuracy.

Note ([10]) This shall be the value shown in the recipe of the proportion report of the ready-mixed concrete in Table 8.

8.6 Volume The volume of the ready-mixed concrete shall be obtained by dividing a total loaded mass of one transportation unit by the unit volume mass. The total loaded mass of one transportation unit shall be calculated either as the total sum of the masses of all the materials used in its load, or from the difference of masses of the transportation unit before and after discharge.

For the concrete 10 cm or over in slump, where the individual volumes of the container, the receiving hopper and others of the transportation unit have been accurately obtained, the volume of the concrete may be measured by means of those values.

Remark: The test for unit volume mass shall be in accordance with JIS A 1116.

9. Inspection

9.1 The inspection shall be carried out on the strength, slump, air content and chloride content to judge acceptance.

9.2 The concrete shall be subjected to the strength tests of 8.2, with the size of an inspection lot determined by agreement between the parties concerned with delivery, and the product conforming to the requirements of 4.1 (1) shall be judged acceptable.

The number of tests shall generally be one per 150 m^3.

The results of one-time test shall be expressed by a mean test value of three specimens prepared from a sample taken from an arbitrary transportation unit.

9.3 Among the items designated by the purchaser in accordance with the specifications of 3.1, the slump test and the air content test shall be carried out in accordance with 8.3 and 8.4, as required, and the product conforming respectively to the specifications of 4.1 (2) and 4.1 (3) shall be judged acceptable.

9.4 The inspection method for the chloride content of the concrete shall be determined by agreement between the parties concerned with delivery, and the product conforming to the requirements of 4.2 shall be judged acceptable.

Remark: The inspection on the chloride content may be made at the time of delivery from the factory, because it should adequately safeguard the possibility of satisfying the specified conditions at the point of discharge.

9.5 Among the items specified in 3.1.2 (3) and 3.1.3 (3), the items designated by the purchaser shall be matters for inspection to be made by agreement between the parties concerned with delivery.

10. Report

10.1 The producer shall submit the delivery sheet to the purchaser on each occasion of transportation by each one transportation unit. The standard form of the delivery sheet shall be as shown in Table 7.

10.2 The standard form of the report sheet in accordance with the specifications of 6.3 shall be as shown in Table 8.

Table 7

<table>
<tr><td colspan="8">Delivery Sheet for Ready-mixed Concrete

No. ________
Month day year
Mr. ________
Name of factory ________</td></tr>
<tr><td colspan="3">Place of delivery</td><td colspan="5"></td></tr>
<tr><td colspan="3">Transportation unit number</td><td colspan="5"></td></tr>
<tr><td colspan="2" rowspan="2">Time of delivery</td><td>Departure</td><td colspan="5">(To the minute)</td></tr>
<tr><td>Arrival</td><td colspan="5">(To the minute)</td></tr>
<tr><td colspan="3">Delivery volume</td><td colspan="2">m^3</td><td>Total</td><td colspan="2">m^3</td></tr>
<tr><td rowspan="2">Designation</td><td>Division of standard type or special order type</td><td>Division by type of aggregates</td><td>Nominal strength</td><td>Slump</td><td>Division by maximum size of coarse aggregates</td><td colspan="2">Division by type of cement</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td colspan="2"></td></tr>
<tr><td>Designated items([11])</td><td colspan="7"></td></tr>
<tr><td>Remarks</td><td colspan="7"></td></tr>
<tr><td colspan="2">Receiving officer's signet</td><td colspan="2"></td><td colspan="2">Delivery person's signet</td><td colspan="2"></td></tr>
</table>

A5 (148 x 210) or B6 (128 x 182)

Note ([11]) Particularly designated items other than given in the column of designation are to be entered.

Table 8

Report on Composite Proportion of Ready-mixed Concrete

No. ______

Month day year

Name of factory ______

Mr. ______

Name of person in charge of proportioning	

Name of work	
Location	
Appointed time of delivery	
Applicable period of this proportion	
Placing point of concrete	

Designing conditions of proportion

	Division of standard type or special order type	Division by type of aggregates	Nominal strength	Slump	Division by maximum size of coarse aggregates	Division by type of cement
Designation						

Designated items([12])	Unit volume mass	(kg/m^3)(t/m^3)	Air content	%
	Temperature of concrete	Highest Lowest °C	Types of admixtures	
	Material age guaranteeing nominal strength	day	Method of restraining alkali reactivity of aggregate	
	Upper limit value of water-cement ratio	%	Upper or lower limit value of unit mass of cement	kg/m^3
	Maximum increase in slump value of flowing base concrete			cm

Materials used([13])

Cement		Name of manufacturing co.		Specific gravity			R_2O %([14])		
Fine aggregates	Source or name of goods		Type by ASR([15])		Fineness modulus		Specific gravity	Absolute dry	
								Surface dry	
Coarse aggregates	Source or name of goods		Type by ASR([15])		Percentage of absolute volume or fineness modulus		Specific gravity	Absolute dry	
								Surface dry	
Chemical admixture	Name of product		Type		Salt content of fine aggregates			%	
Admixture	Name of product		Type		Water	Type			

Proportion Table (kg/m^3)([16])

Cement	Water	Fine aggregates	Fine aggregates	Coarse aggregates	Coarse aggregates	Chemical admixture	Admixture
Water-cement ratio	%	Percentage of fine aggregates	%		Chloride content in concrete (as chlorine ions)		Under kg/m^3
Remarks							

A4 (210 x 297) or B5 (182 x 257)

Notes ([12]) particularly designated items other than those given in the column of designation shall be entered.
([13]) Materials used in proportion designing shall be entered.
([14]) Entered only when the portland cement is used.
([15]) The type of aggregate by the alkali-silica reactivity (ASR) and the test method used for determination shall be entered.
([16]) Regarding the aggregates, this shall be expressed by the mass of saturated surface dry condition for ordinary aggregates, and by the mass of absolute dry condition for artificial lightweight aggregates.

Annex 1. Aggregates for Ready-mixed Concrete

1. Scope

This Annex specifies the aggregates for ready-mixed concrete (hereafter referred to as the "aggregates").

2. Classification

The aggregates shall be classified into two kinds according to uses, i.e., aggregates for civil engineering and aggregates for architecture.

3. Aggregates for Civil Engineering

3.1 Artificial lightweight aggregates, crushed stone, crushed sand, blast-furnace slag coarse aggregates and blast-furnace slag fine aggregates shall conform to the following Standards:

(1) The artificial lightweight aggregates shall be those given below as specified in JIS A 5002.

Artificial lightweight fine aggregates	MA 317
Artificial lightweight fine aggregates	MA 417
Artificial lightweight coarse aggregates	MA 317
Artificial lightweight coarse aggregates	MA 417

Further, the limit for floating particle rate shall be 10.0 %.

(2) The crushed stones shall be those given below as specified in JIS A 5005.

Crushed stone	4005
Crushed stone	2505
Crushed stone	2005
Crushed stone	4020

Further, the limit of clay-lump content shall be 0.25 %.

In addition, the limit of abrasion loss for those to be used in pavement slabs shall generally by 35 %, and the limit of quantity of soft stone flake content shall generally be 5.0 %.

(3) The crushed sand shall be that specified in JIS A 5004.

Further, the limit of clay-lump content shall be 1.0 %.

In addition, for the pavement slabs and concrete of which surfaces undergo abrading action, the limit of loss in the washing test shall be 5.0 %.

(4) The blast-furnace slag coarse aggregates shall be those given below as specified in JIS A 5011.

Blast-furnace slag coarse aggregates	4005
Blast-furnace slag coarse aggregates	4020
Blast-furnace slag coarse aggregates	2505
Blast-furnace slag coarse aggregates	2005

Further, the limit of loss in the washing test shall be 5.0 %.

In addition, the limit of abrasion loss for those to be used in cement slabs shall be 35 %.

(5) The blast-furnace slag fine aggregates shall be those specified in JIS A 5012.

Further, the limit of loss in the washing test shall be 7.0 %.

In addition, the pavement slabs and concrete of which surfaces undergo abrading action, the limit of loss in the washing test shall be 5.0 %.

3.2 Fine Aggregates

3.2.1 The fine aggregates shall be clean, tough and durable, shall have appropriate grain sizes, and shall not include injurious amounts of dust, mud, organic impurities, salts or the like.

Remark: The durability of the fine aggregates shall be judged by the lost mass of the fine aggregates indicated in the stability test in which the same test procedure has been repeated five times. The limit of the lost mass shall generally be 10 %.

3.2.2 The grain size of the fine aggregates shall be such that the large and small particles are mixed properly, and the standards of the particle size shall be within the ranges of Annex 1 Table 1.

Annex 1 Table 1. Standard Grain Sizes of Fine Aggregates

Nominal size of sieve mm	Mass percentage of fine aggregates passing through sieve %
10	100
5	90 to 100
2.5	80 to 100
1.2	50 to 90
0.6	25 to 65
0.3	10 to 35
0.15	2 to 10

3.2.3 The limits of content of clay lumps, organic impurities and others included in the fine aggregates shall be as specified in the following respective clauses:

(1) The limits of content of clay lumps and the like included in the fine aggregates shall generally be as specified in Annex 1 Table 2.

Annex 1 Table 2. Limits of Content of Clay Lumps and the Like (Mass Percentage %)

Type		Maximum value
Clay lumps		1.0
Loss in the washing test	In the case where the concrete surface undergoes abrading action	3.0
	In other cases	5.0
Coal, lignite and the like which float in a liquid of 1.95 in specific gravity	In the case where the appearance of concrete is important	0.5
	In other cases	1.0

(2) Organic Impurities

(a) Organic impurities included in natural sand shall be judged in accordance with JIS A 1105.

In this case, the hue of the solution in the upper part of the sand shall be lighter than the standard color.

(b) Even in the case where the hue of the solution in the upper part of the sand is darker than the standard color, the sand may be used provided that the compressive strength ratio is 90 % or over in the method for testing sand by the compressive strength of mortar specified in Annex 3.

3.2.4 The permissible maximum limit of salt content included in the fine aggregates shall generally be 0.1 %, as converted into NaCl, relative to the absolute-dry mass of the fine aggregates.

The permissible maximum limit of salt content in the aggregates for the concrete used in pretension-prestressed concrete members shall generally be 0.03 %, as converted into NaCl, relative to the absolute-dry mass of the fine aggregates.

3.3 Coarse Aggregates

3.3.1 The coarse aggregates shall be clean, tough and durable, have appropriate particle sizes, and shall not include injurious amounts of thin stone flakes, organic impurities, salts, etc. Particularly in the case where fire resistance is required, fire-resistant coarse aggregates shall be used.

Remarks 1. The durability of the coarse aggregates shall be judged by the loss in mass of the coarse aggregates indicated in the stability test when the same test procedure has been repeated five times. The limit of loss in mass shall generally be 12 %.

2. The limit of the abrasion loss of the coarse aggregates to be used for pavement slabs shall generally be 35 %.

3.3.2 The particle size of coarse aggregates shall such that large and small particles are adequately mixed, and the standard particle size shall be within the range specified in Annex 1 Table 3.

Annex 1 Table 3. Standard Particle Sizes of Coarse Aggregates

Size of coarse aggregates mm \ Nominal size of sieve mm	Mass percentage of particles passing through the sieves %								
	50	40	30	25	20	15	10	5	2.5
40－5	100	95to100	—	—	35 to 70	—	10to30	0to 5	—
25－5	—	—	100	95to100	—	30to70	—	0to10	0to5
20－5	—	—	—	100	90to100	—	20to55	0to10	0to5

3.3.3 The limits of injurious matters included in the coarse aggregates shall generally be as specified in Annex 1 Table 4.

Annex 1 Table 4. Limits of Contents of Clay Lumps and Others in Coarse Aggregates (Mass Percentage %)

Type		Maximum value
Clay lumps		0.25
Soft stone flakes		5.0(1)
Loss in washing test		1.0
Coal, lignite and others which float in a liquid 1.95 in specific gravity	When appearance of concrete is deemed important	0.5
	In other cases	1.0

Note (1) This shall be applied to the pavement slabs or to the case where the surface hardness is particularly required.

3.4 The gravel, sand, crushed stone and crushed sand shall be classfied into A and B as shown in Annex 1 Table 5 by the results of alkali-silica reactivity test specified in Annex 7 or Annex 8.

Annex 1 Table 5. Classification by Alkali-silica Reactivity Test

Type	Remark
A	Those judged innocuous by the results of alkali-silica reactivity test.
B	Those not judged innoucuous by the results of alkali-slica reactivity test or not subjected to the test.

4. Aggregates for Architecture

4.1 The lightweight aggregates, crushed stones, crushed sand, blast-furnace slag coarse aggregates and blast-furnace slag fine aggregates shall conform to the respective Standards listed below.

(1) Artificial lightweight aggregates specified in JIS A 5002 with the quality given below.

Classification by concrete strength : 200, 300 and 400

Classification by specific gravity of aggregates in absolute dry condition : H and M

Floating particle rate of coarse aggregates: within 10 %

(2) Crushed stones given below as specified in JIS A 5005.

Crushed stone 4005
Crushed stone 2505
Crushed stone 2005
Crushed stone 4020

(3) Crushed sand specified in JIS A 5004

(4) Blast-furnace slag coarse aggregates given below as specified in JIS A 5011.

Blast-furnace slag coarse aggregates 4005
Blast-furnace slag coarse aggregates 4020
Blast-furnace slag coarse aggregates 2505
Blast-furnace slag coarse aggregates 2005

(5) Blast-furnace slag fine aggregates for concrete specified in JIS A 5012.

4.2 The gravel and sand shall not include injurious amounts of dust, mud, organic impurities or others, have fire resistibility and durability, and possess quality given in Annex 1 Table 6 and Annex 1 Table 7.

4.3 The gravel, sand, crushed stone, and crushed sand shall be classified into A and B as given in Annex 1 Table 5 by the results of alkali-silica reactivity test specified in Annex 7 or Annex 8.

Annex 1 Table 6. Qualities of Sand and Gravel

Type of aggregates \ Test item	Specific gravity under absolute-dry condition(2)	Percentage of water absorption %(2)	Amount clay lumps %	Loss in washing test %	Organic impurities	Salt (as NaCl) content(3) %
Sand	2.5 min.	3.5 max.	1.0 max.	3.0 max.	Not darker than the standard color	0.04 max.
Gravel	2.5 min.	3.0 max.	0.25 max.	1.0 max.	-	-

Notes (2) With the approval of the purchaser, specific gravity of 2.4 or over under absolute-dry condition and percentage of water absorption of 4.0 % or under may be assigned to both sand and gravel.

(3) For those exceeding 0.04 %, approval of the purchaser shall be obtained. However, the upper limit shall generally be 0.1 %.

Annex 1 Table 7. Standard Particle Sizes of Sand and Gravel

Type of aggregates \ Nominal size of sieve mm			Mass percentage of particles which pass through the sieves %												
			50	40	30	25	20	15	10	5	2.5	1.2	0.6	0.3	0.15
Sand			—	—	—	—	—	—	100	90to100	80to100	50to90	25to65	10to35	2to10
Gravel	Maximum size mm	40	100	95to100	—	—	35to 70	—	10to30	0to 5	—	—	—	—	—
		25	—	—	100	90to100	60to 90	—	20to50	0 to 10	0 to 5	—	—	—	—
		20	—	—	—	100	90to100	(4) (55to80)	20to55	0 to 10	0to 5	—	—	—	—

Note (4) Numerical values given in ( ) are values for informative reference.

5. In the Case Where Aggregates Are Mixed in Use

5.1 In the case where aggregates of the same type are mixed in use, the quality of the mixed aggregates shall conform to the requirements of 3. or 4. of Annex 1.

5.2 In the case where different types of aggregates are mixed in use, the quality of the aggregates before mixing shall respectively conform to the requirements of 3. or 4. of Annex 1. However, regarding the particle size and salt content, the product shall be deemed acceptable if the values of the mixed aggregates conform to the requirements given above.

5.3 In the case where different types of aggregates are mixed in use, the types of aggregates mixed and the mixing ratio shall be indicated.

5.4 In the case where gravel, sand, crushed stones and crushed sand include some portions of those judged type B in the alkali-silica reactivity test, the whole aggregate mixture shall be treated as aggregates whose innocuousness is not yet established.

6. Test Methods for Aggregates

6.1 The methods for testing aggregates shall be in accordance with the following Standards.

JIS A 1102
JIS A 1103
JIS A 1104
JIS A 1109
JIS A 1110
JIS A 1121
JIS A 1122
JIS A 1126
JIS A 1134
JIS A 1135
JIS A 1137(5)

Note (5) The test shall be carried out using the sample through with the washing treatment in accordance with JIS A 1103.

6.2 The method for testing salt content in the fine aggregates shall be in accordance with the specifications of 4.5 of JIS A 5002. However, the quantity of the sample of the ordinary aggregates shall be 1000 g.

6.3 The method for testing the particles to float in the liquid 1.95 in specific gravity in the aggregates shall be in accordance with Annex 2.

6.4 The method for testing the sand through the compressive strength of mortar shall be in accordance with Annex 3.

6.5 The method for testing the rate of particles floating in the lightweight coarse aggregates shall be in accordance with Annex 4.

6.6 The alkali-silica reactivity test method shall be in accordance with Annex 7 or Annex 8.

Annex 2. Method of Testing Particles Contained in Aggregates and Floating in Liquid of Specific Gravity 1.95

1. Scope

This Annex specifies the testing method for approximately gauging the particles of specific gravity 1.95 or under contained in the aggregates.

2. Test Appliances

2.1 In the Case of Fine Aggregates The appliances for testing the fine aggregates shall be as given in the following:

(1) The balance shall be 1000 g or over in weighing capacity and capable of weighing to the nearest 0.1 g.

(2) The sieve shall be 0.6 mm in sieve opening.

(3) Two or more small screening nets, which are made of wire gauze 0.6 mm or under in mesh, shall be prepared.

(4) Three 1000-ml glass beakers shall be prepared.

2.2 In the Case of Coarse Aggregates The appliances for testing the coarse aggregates shall be as given in the following:

(1) The balance shall 5000 g or over in weighing capacity and capable of weighing to the nearest 0.5 g.

(2) The vessel for the test solution and the wire gauze basket for the aggregates shall not be corroded by the solution, and the capacity of the vessel shall be so arranged that, when the sample is immersed in it, the surface of the solution remains at least 5 cm above the upper surface of the sample.

(3) Two or more small screening nets, which are made of wire gauze 2.5 mm or under in mesh, shall be prepared.

(4) A spoon for stirring of an appropriate size shall serve.

3. Test Solution

The solution to be used for test shall be a zinc chloride solution ($ZnCl_2$) 1.95 ± 0.02 in specific gravity at 21 to 27°C.

Informative Reference: Because the zinc chloride solution of this concentration stimulates the skin and causes a burn, care shall be exerted in handling it.
In case the skin has contacted it, washing with plenty of water can disinfect the skin sufficiently.

4. Sample

4.1 In the Case of Testing Fine Aggregates Representative fine aggregates shall be sampled by the quartering method or with the sample separator. They are to remain on a 0.6-mm sieve and their quantity shall be 100 to 200 g according to the particle sizes of the sand. The sample shall be dried at 105 to 110℃ to constant mass, and then screened with the 0.6 mm sieve, and those remaining on the sieve shall be weighed to the nearest 0.1 g.

4.2 In the Case of Testing Coarse Aggregates Representative coarse aggregates shall be sampled by the quartering method or other suitable methods, and their quantity shall be 2500 g. The sample shall be dried at 105 to 110℃ to constant mass, and then weighed to the nearest 0.5 g.

5. Test Methods

5.1 In the Case of Testing Fine Aggregates The method of testing the fine aggregates shall be as given in the following:

(1) Pour 600 ml of the testing solution into a 1000-ml glass beaker, and add the sample to the solution while mixing by stirring the solution violently.

(2) When the entire sample begins to float, stop stirring, and allow the sample to stand for about 30 s unitl a clear boundary is formed between the floating lightweight particles and the fine aggregates.

(3) Pour the solution into the screening net with care to transfer only the floating particles together with the solution and to prevent the settled sand from running over the edge of the beaker.

In the case of the sample which includes a large amount of lightweight particles, add the solution to the sample excessively and carry out the operations of (2) and (3).

In this test, the sample shall not be kept in contact with the zinc chloride solution for 2.5 min or over.

(4) Wash the particles remaining on the screening net thoroughly with clean water to eliminate the zinc chloride, then dry at 105 to 110℃ to constant mass, and weigh to the nearest 0.1 g. Inspect the dried particles with the nakes eye for any sand particles remaining to remove them.

5.2 In the Case of Testing Coarse Aggregates The method of testing the coarse aggregates shall be as given in the following:

(1) Put the sample in the metallic basket, immerse them in the vessel containing the testing solution, and stir the sample and the solution violently for 1 min with a large mixing spoon.

(2) Within 1 minute after stopping stirring, scoop out the floating particles with the screening net.

(3) Wash the particles which have been scooped out with clean water thoroughly to eliminate the zinc chloride, then dry at 105 to 110℃ to constant mass, and weigh to the nearest 0.5 g.

6. Calculation of Results

The approximate percentage value of the lightweight particles shall be calculated from the following formula:

$$\text{Percentage (\%) of lightweight particles} = \frac{\text{Mass of particles remaining on screening net}}{\text{Mass of dried sample}^{(1)}} \times 100^{(2)}$$

Notes (1) In the case of the fine aggregates, this value is the mass of the sample which has remained on the 0.6 mm sieve.

(2) In this test method, particles 0.6 mm or under cannot be separated thoroughly.

Annex 3. Method of Testing Sand by Compressive Strength of Mortar

1. Scope

1.1 This Annex specifies the method of testing the sand for which the color of testing solution in the organic impurity test has turned darker than the standard color.

1.2 Comparison shall be conducted between the compressive strength of the mortar prepared by using the sand to be tested and that of the mortar prepared by using the same kind of sand which has been washed with a 3 % solution of sodium hydroxide.

2. Test Appliances

2.1 The balance shall be 2000 g or over in weighing capacity and capable of weighing to the nearest 0.5 g.

2.2 The mixer to serve shall be an electric mixer having a mixing drum 4.7 *l* or over in nominal capacity, and fitted with a paddle which makes a circular motion, rotates on its own axis and at the same time revolves in the opposite direction around the drum. The number of rotations of the paddle shall be, in the case of low speed, 140 ± 5 rpm for self-rotation and approximately 62 rpm for nominal revolution, and in the case of high speed, 285 ± 10 rpm for self-rotation and approximately 125 rpm for nominal revolution.

2.3 The formwork shall be a metallic cylinder 5 cm in inside diameter and 10 cm in height.

2.4 The tamping rod shall be a round steel rod 9 mm in diameter the tip end of which shall be pointed bluntly.

3. Materials to Be Used in Testing

3.1 The cement shall generally be that used in the factory.

3.2 The water shall generally be that used in the factory.

4. Sample

4.1 Representative sand shall be sampled for the test, and reduced to approximately 25 kg by the quartering method or with a sample separator, and one-third of this shall be washed with a 3 % solution of sodium hydroxide(1).

Note (1) The guaranteed grade specified in JIS K 8576 shall be used.

4.2 In washing the sand with the sodium hydroxide solution, the sodium hydroxide solution shall be added to such an extent that the sand contained in the vessel is hidden and, after stirred thoroughly, shall be left to stand for about 1 h.

The sand which has been washed with the sodium hydroxide solution shall be washed with clean water thoroughly until alkalinity due to residual sodium hydroxide becomes undetectable. In washing the sand, a cloth of a fine texture and the like shall be used in order to prevent microparticles of sand from being lost with the water.

4.3 The sand shall be used under the water-saturated surface-dry condition. To effect the water-saturated surface-dry condition of sand, take procedures in accordance with 3.3 of JIS A 1109.

5. Test Methods

5.1 Determination of Proportion of Mortar The proportion of the mortar to be used in the tests shall be determined as given in the following, using the sample of the sand which is not washed with the sodium hydroxide solution.

Set the mixing drum and paddle to the mixer, pour 400 g of water into the mixing drum 800 g of the cement and mix for 40 s at a low speed. In the meantime, feed the water-saturated surface-dry conditioned test sand gradually. Next, stop for 20 s, and meanwhile, scrape off the mortar adhering to the mixing drum and the paddle with a spoon. Determine the mass of the sand so that the flow of the mortar attains 190 ± 5 when it has been mixed further for 2 min at a high speed(2).

Note (2) This mass shall also be used for the washed sand.

Further, in the case of the ordinary river sand, it is about 2000 to 2500 g.

5.2 Measurements of Flow and Air Content of Mortar The flow test of the mortar shall be in accordance with 9.7 of JIS R 5201.

The air content shall be calculated in accordance with 5. of JIS A 1116(3) after obtaining the unit volume mass of mortar in accordance with 7.3 of JIS A 6201.

Furthermore, measurements of flow and air content shall be carried out for each kind of sand, and the mortar used in these measurements shall not be used in molding the specimens.

Note (3) The measurement of the air content gives an index for judging whether or not the sand to be used in the test is contaminated with detergents, oils and fats, humic acid, etc.

5.3 Molding of Specimen

5.3.1 The mixing of the mortar shall be in accordance with 5.1. Two batches shall be mixed for each sand, and four specimens shall be made from each batch.

5.3.2 The mortar shall be packed in the formwork separated into two layers. Each layer shall be tamped 25 times with a tamping rod. After the tamping, hollows due to the tamping shall be leveled off by tapping the formwork lightly.

5.3.3 Capping shall be made 4 h after the packing of mortar in the formwork, and 24 h later the formwork shall be detached to allow the mortar to cure until the time of test.

The capping and curing shall be in accordance with 4.4 and 7. of JIS A 1132.

5.4 Compressive Strength Test The compressive strength test shall be made in accordance with JIS A 1108.

The number of specimens to be subjected to the test shall be four for each material age. The material ages shall be 7 days and 28 days for the ordinary portland cement, moderate heat portland cement and mixed cement, and 1 day and 3 days for the high-early-strength portland cement.

6. Calculation of Results

From the compressive strength of the mortar using the test sand and that of the mortar using the test sand washed with the 3 % solution of sodium hydroxide, the compressive strength ratio at each material age shall be calculated from the following formula, and the figure of one place of decimal shall be rounded off to an integer in accordance with JIS Z 8401.

$$\text{Compressive strength ratio (\%)} = \frac{\text{Compressive strength of mortar using the test sand}}{\text{Compressive strength of mortar using the test sand washed with the sodium hydroxide solution}} \times 100$$

Annex 4. Method of Testing Floating Particle Rate of Lightweight Coarse Aggregates

1. Scope

This Annex specifies the method of testing the floating particle rate of the lightweight coarse aggregates for structure.

2. Test Appliances

2.1 The balance shall be 2000 g or over in capacity, and capable of weighing to the nearest 2 g.

2.2 The vessel in which the coarse aggregates are to be immersed shall be watertight, and 24 cm or over in inside diameter and 22 cm or over in inside height.

2.3 The drying appliance used for the coarse aggregates shall be an electric thermostatic drier([1]).

Note ([1]) This should preferably be provided with an air stirrer and a ventilator.

2.4 The sieve to serve shall be a 5-mm sieve.

3. Sample

The coarse aggregates under air-dry condition shall be screened with a 5-mm sieve, and from the aggregates remaining on the sieve, approximately 2 l shall be taken by the quartering method or with a sample separator to serve as the sample.

4. Test Method

4.1 Dry the sample at 105 to 110℃ until it attains the constant mass.

4.2 After the dried aggregates have been left to cool to room temperature, weigh their mass (M_r) to the nearest 2 g.

4.3 Transfer the sample of which the mass has been measured into a vessel and pour water into it while stirring so that the aggregates contact water adequately and air bubbles adhering to the aggregates are removed.

4.4 Ten min after the water has been poured in, scoop out the particles floating on the water with a metal gauze and the like.

4.5 Dry again the scooped-out particles according to the method of 4.1, allow them to cool to room temperature, and then weigh the mass (M) to the nearest 2 g.

5. Calculation of Results

5.1 The floating particle rate shall be calculated to 0.1 % according to the following formula:

$$\text{Floating particle rate (\%)} = \frac{M}{M_r} \times 100$$

where, M : dried mass of the scooped-out particles (g)

M_r : mass of the dried aggregates before pouring water (g).

5.2 The test shall be carried out two times, and the results shall be expressed by the mean value.

Annex 5. Method of Testing Chlorine Ion Concentration in Water Contained in Fresh Concrete

1. Scope

This Annex specifies the analyzing method for chlorine ion concentration in water contained in concrete to obtain the chloride content in fresh concrete.

2. Sample Filtrate

2.1 A sample filtrate of an amount necessary for the analysis shall be taken from the representative sample of the fresh concrete of which the chloride content is to be determined.

2.2 The representative sample of the concrete shall be taken in accordance with JIS A 1115.

2.3 The filtrate shall be taken from the fresh concrete or from the mortar wet-screened from it by suction filtration or centrifugal separation, or else shall be the bleeding water itself oozing out from the upper surface of the concrete or the mortar.

3. Analyzing Method

The analysis of the chlorine ion in the sample filtrate shall be made in accordance with the mercury thiocyanate (II) absorption photometric method or the silver nitrate titration method prescribed in 32. Chloride Ion (Cl^-) of JIS K 0101, or in accordance with the potentiometric titration method using chlorine ion-selective electrodes on the basis of JIS K 0113.

Remark: Because there may appear some disturbing ions depending on the analyzing methods, their effects shall be taken into consideration. In the case where the silver nitrate titration method is employed, the potassium chromate may be used as an indicator.

4. Results

The results of analysis shall be obtained down to three places of decimals in mass percentage.

The test shall be performed two times on the same sample, and the mean value of the two tests rounded off to the second decimal place shall be the test result.

Annex 6. Method for Restraining Alkali Reactivity of Aggregates through Selection of Cement and Others

1. Scope

This Annex specifies the method of restraining the alkali reactivity of aggregates in the case where gravel, sand, crushed stone and crushed sand of class B in Annex 1 are to be used as the aggregates for the ready-mixed concrete.

2. Classification

The measures for restraining the alkali reactivity of aggregates shall be classified into (1) to (3) as shown below.

(1) The restraining measures using portland cement (low alkali type)

(2) The restraining measures using mixed cement which has the restraining effect on the alkali reactivity of aggregates

(3) The restraining measures by delimiting the total alkali content in the concrete

3. Restraining Measures Using Portland Cement (Low Alkali Type)

The cement to serve shall be one of the following five types conforming to Annex to JIS R 5210.

(1) Ordinary portland cement (low alkali type)

(2) High-early-strength portland cement (low alkali type)

(3) Ultra-high-early-strength portland cement (low alkali type)

(4) Moderate heat portland cement (low alkali type)

(5) Sulfate-resistant portland cement (low alkali type)

4. Restraining Measures Using Mixed Cement with Effects Restraining Alkali Reactivity of Aggregates

The cement to serve shall be blast-furnace slag cement type B or C conforming to JIS R 5211, or fly ash cement type B or C conforming to JIS R 5213.

Remark: The amount (mass ratio, %) of blast-furnace slag in portland blast-furnace slag cement type B shall be 40 % or over for the alkali amount of base cement within 0.8 %, and 50 % or over for other blast-furnace cements of type B.

The amount of fly ash (mass ratio, %) in type B fly ash cement shall be 15 % or over for the alkali amount of base cement of basement within 0.8 %, and 20 % for other fly ask cements of type B.

5. Restraining Measures by Delimiting Total Alkali Content in Concrete

5.1 Cement The cement to serve shall conform to JIS R 5210 and have a known alkali content([1]).

Note ([1]) The alkali content in cement shall be expressed by R_2O (%), as:

$$R_2O(\%) = Na_2O(\%) + 0.658K_2O(\%)$$

5.2 Total Alkali Content The total alkali content in the concrete shall be 3.0 kg/m³ or under([2]) as calculated from the formula (1). However, in the case where only the admixture which does not greatly increase Na^+ and K^+ in the concrete (the admixture specified in JIS A 6204) is used, the total alkali content in the concrete shall be 2.5 kg/m³ as the limit as calculated from the formula (2) to obtain the alkali due only to the concrete.

$$R_t = \frac{R_2O}{100} \times C + 0.9 \times Cl^- + R_m \quad \cdots\cdots (1)$$

$$R_t = \frac{R_2O}{100} \times C \quad \cdots\cdots (2)$$

where,
R_t : total alkali content (kg/m³)
R_2O : alkali content in the cement (%)
C : unit cement content (kg/m³)
Cl^- : chlorine ion obtained by the measurement of chloride in the concrete (kg/m³)
R_m : alkali content in the admixture in the concrete (kg/m³).

NOte ([2]) When the purchaser performs fluidizing of the concrete at the point of discharge, the total alkali content shall be not more than the value to be obtained by subtracting alkali content mixed in the admixture from 3.0 kg/m³.

6. Report

When the restraining measures have been duly taken in accordance with this Annex, the method employed shall be entered using the symbols of Annex 6 Table in the Report Sheet on Composite Proportion of Ready-mixed Concrete of Table 8 in the main text of this Standard by means of the symbols denoting the type of cement to serve or the kind of restraining method through delimiting the total alkali content in concrete as specified in Annex 6 Table.

Annex 6 Table. Symbols Denoting Restraining Method

Restraining method	Symbol
3. (1) Use of ordinary portland cement (low alkali type)	NL
3. (2) Use of high-early-strength portland cement (low alkali type)	HL
3. (3) Use of ultra-high-early-strength portland cement (low alkali type)	UHL
3. (4) Use of moderate heat portland cement (low alkali type)	ML
3. (5) Use of sulfate resisting portland cement (low alkali type)	SRL
4. Use of mixed cement (blast-furnace slag cement Class B)	BB
4. Use of mixed cement (blast-furnace slag cement Class C)	BC
4. Use of mixed concrete (fly ash cement type B)	FB
4. Use of mixed concrete (fly ash cement type C)	FC
5. Delimiting total alkali content in concrete	AL (kg/m^3)(3) Formula ( )

Note (3) In ( ) after "AL", enter the calculated total alkali content rounded off to the first decimal place.

In ( ) after "Formula", enter formula (1) or formula (2) of Annex 6 whichever has been used.

Annex 7. Test Method for Potential Alkali-silica Reactivity of Aggregates (Chemical Method)

1. Scope

This Annex specifies the test method for chemically and relatively quickly estimating potential alkali-silica reactivity of aggregates by measuring the decrease in alkali concentration (Rc) and the amount of dissolved silica (Sc) in the test solution derived either from the aggregates before mixing or from the fresh concrete.

2. Definitions

For the purposes of this Annex, the following definitions apply:

(1) Alkali-silica Reaction (ASR) A phenomenon in which the substance produced by the reaction between the potentially reactive silica contained in the aggregates and the alkali in the concrete expands by absorbing water and causes a crack in the concrete.

(2) Decrease in Alkali Concentration (Rc) The amount of alkali consumed in the reaction with the aggregates.

(3) Amount of Dissolved Silica (Sc) The amount of silica eluted out by the reaction of the aggregates and the alkali.

(4) Fresh Concrete Concrete in the state not yet solidified.

3. Sample

The sample shall be the unused aggregates and those from fresh concrete, and generally about 40 kg each of representative samples shall be taken from coarse and fine aggregates.

Remark: Because some aggregates may not come up to the standards for this method, it is sometimes necessary to investigate the aggregates mineralogically beforehand.

4. Test Apparatus, Appliances and Reagents

4.1 Apparatus and Appliances for Sample Preparation The apparatus and appliances for sample preparation shall be as follows:

(1) The crushing apparatus shall be a jaw crusher which can crush coarse aggregates to about 5 mm or under in grain size.

(2) The fine crusher shall be a crusher or an appropriate apparatus which can crush aggregates 5 mm or under in size into the state of 300 μm or under in grain size.

(3) The sieves shall be the 300 μm and 150 μm sieves specified in JIS Z 8801.

(4) The drier shall be one which can be controlled at 105°C and continuously used for a long period of time.

4.2 Test Apparatus and Appliances The test apparatus and appliances shall be as follows.

(1) The chemical balances shall be about 150 g in weighing capacity with accuracy to the nearest 10 mg, and about 80 g in weighing capacity with accuracy to the nearest 0.1 mg.

(2) The reaction vessel shall be 50 to 60 ml in capacity, manufactured from stainless steel or other appropriate corrosion resisting materials, and fitted with an airtight lid, and further in the event of a blank test, there shall be no silica elusion and the decrease in alkali concentration shall be under 10 mmol/ l .

(3) The constant-temperature water tank shall be capable of maintaining the temperature for over 24 h at 80 ± 1.0℃ under the condition that the reaction vessel is entirely immersed and kept immobile.

(4) Water bath plate (pan)

(5) Sand bath plate (pan)

(6) The photoelectric spectrophotometer or the photometric photometer shall be capable of measuring with sufficient accuracy the transmitted light in the vicinity of 410 nm in measuring wavelength.

(7) The atomic absorption photometer shall be fitted with a high temperature burner and capable of measurements using acetylene-nitrogen-dioxide gas.

(8) The electric furnace shall be capable of maintaining the temperature at the maximum temperature of 1100℃ for a long period of time.

(9) The following analytical appliances shall be used:

(a) Whole pipette (5 ml, 10 ml, 20 ml and 25 ml)

(b) Büchner funnel (about 80 mm in inside diameter)

(c) Burette (25 ml)

(d) Volumetric flasks (100 ml and 1 l)

(e) Erlenmeyer flask (100 ml)

(f) Beakers (100 ml and 200 ml)

(g) Watch glass

(h) Polyethylene vessel with ground-in stopper (30 to 50 ml)

(i) Polyethylene bottles (100 ml and 1 l)

(j) Teflon cylinder or polyethylene cylinder (10 ml)

(k) Platinum plate (75 ml or 100 ml)

(l) Platinum crucible (30 ml)

(m) Desiccator

(n) Suction filter

5. Water and Reagents

5.1 Water The water to serve shall be distilled water or the water of purity equal or superior to it.

5.2 Reagents The reagents to serve shall be those of the guaranteed grade specified in the pertinent JIS or those of quality equal or superior to them.

(1) 1 N sodium hydroxide standard solution Shall be of 1.000 ± 0.010 N, and standardized to ± 0.001 N.

(2) 0.05 N hydrochloric acid standard solution Shall be of 0.05 N and standardized to ± 0.001 N.

(3) Perchloric acid (60 % or 70 %)

(4) Hydrochloric acid (1+1)

(5) Hydrogen fluoride (about 47 %)

(6) Sulfuric acid (1+1)

(7) Sulfuric acid (1+10)

(8) Phenolphthalein indicator (1 % ethanol solution) Dissolve 1 g of phenolphthalein in 100 ml of ethanol (1+1) and keep in a dropping bottle.

(9) Ammonium molybdate solution (10 w/v %) Dissolve 10 g of ammonium molybdate [$(NH_4)_6Mo_7O_{24} \cdot 4H_2O$] in water to make 100 ml. Filter the solution through a filter paper (Class 5 C specified in JIS P 3801) if the solution is not transparent. Keep this solution in a polyethylene bottle. When white precipitate appears, prepare the solution newly.

(10) Oxalic acid solution (10 w/v %) Dissolve 10 g of oxalic acid dihydrate in water to make 100 ml. Keep this solution in a polyethylene bottle.

(11) Silica standard stock solution ($SiO_2$10 mmol/ l) Put silicon dioxide (99.9 % or over in purity) in a porcelain crucible and, after about 1 h of igniting at 1000°C, let it cool in a desiccator. Weigh out 0.601 g of the cooled silicon dioxide into a platinum crucible (30 ml), add 3.0 g of sodium carbonate (anhydride) and mix thoroughly. After heating gradually, put the crucible into an electric furnace heated at 1000°C and fuse silicon dioxide. After cooling, put the crucible into a beaker (200 ml) containing 100 ml of warm water to dissolve the melt thoroughly. Take out the platinum crucible from the beaker after washing well. Transfer the solution to a 1 l volumetric flask and after adding water up to the nominal volume, keep it in a polyethylene bottle. Prepare this standard solution for each time of plotting the working curve.

6. Preparation of Sample

The sample shall be prepared as follows:

6.1 Reduction of Sample Mix well and reduce the aggregates and prepare about 10 kg of representative sample of the aggregates.

6.2 Coarse Crushing Crush the representative aggregates to about 5 mm or under with a crusher. Mix well and reduce the crushed aggregates, and prepare about 1 kg of representative sample.

6.3 Preparation of Representative Sample The representative sample shall be prepared as follows:

(1) Separate the particles 300 to 150 μm in size from the representative sample by sieving, discarding fine powder 150 μm or under.

(2) Crush the portions of coarse particles 300 μm or over in size in small amounts at a time with care to minimize the ratio of the fine powder portions 150 μm.

(3) Separate the 300 to 150 μm particle groups from the crushed representative sample by sieving, discarding the fine powder 150 μm or under in size. Repeat the operations of (1) and (2) for the coarse particle portion 300 μm or over in size and collect the particle groups 300 to 150 μm.

(4) After the coarse particle portion 300 μm or over has been removed, mix the particle groups 300 to 150 μm in size, and wash in running water on a 150 μm sieve in small amounts at a time. Rinse the sample rid of the fine powder by washing with about 1 *l* of water.

(5) Transfer the rinsed sample to an adequate vessel such as a stainless steel vat or the like, remove the excess water, and dry in a drier controlled at 105 ± 5°C for 20 ± 4 h.

(6) After the sample has been cooled, again remove the fine powder portion through a 150-μm sieve, mix the particle groups 300 to 150 μm in size thoroughly and use it as the test sample.

7. Test Method

7.1 Procedure of Reaction between Alkali and Aggregate Sample Add 1 N sodium hydroxide standard solution to the sample, let them react in a constant-temperature water bath controlled at 80°C for 24 h, filter the solution by suction and obtain the sample stock solution. The procedure for this operation shall be as follows:

(1) Weigh out 3 aliquots of 25.00 ± 0.05 g each from the sample, put them each in three separate reaction vessels, add 25 ml of 1 N sodium hydroxide standard solution using a whole pipette and cover immediately.

Moreover, simultaneously operate one reaction vessel for the blank test.

(2) Rotate the reaction vessel three times on the working table horizontally and slowly in alternate directions, thereby separating the bubbles adhering to the sample.

(3) Tightly close the cover of the reaction vessel, immediately and completely immerse the vessel in the constant-temperature water tank kept at 80 ± 1°C, and leave it to stand for 24 h ± 15 min.

(4) When the defined period of time has elapsed, take out the reaction vessel from the constant-temperature water tank, and cool it with running water for 15 ± 2 min.

(5) Turn the vessel upside down two times with the cover closed tightly, allow it to stand for 5 min, open the cover, put a filter paper (Class 5 B, 55 mm in diameter specified in JIS P 3801) on the Büchner funnel and filter the suppernatant slowly by suction. Then transfer the residue in the vessel into the Büchner funnel using a stainless steel spoon or the like, and press slightly the residue to make it level and continue sucking for 4 min. Receive the filtrate in a polyethylene vessel fitted with ground-in stopper 30 to 50 ml in capacity. The duration of the sucking filtration in this operation shall always be the same.

(6) Stopper tightly the polyethylene vessel containing the filtrate, mix it and then make it the sample stock solution.

Informative Reference: The error will be minimized by performing the filtration on the reaction vessels one by one.

7.2 Method of Determining Decrease in Alkali Concentration

7.2.1 Procedure Take an aliquot of the sample stock solution and add water to obtain a diluted sample solution. Take a part of this solution and titrate with 0.05 N hydrochloric acid standard solution using phenolphthalein indicator. The procedure shall be as follows:

(1) Take 5 ml of the sample stock solution of 7.1 (6) with a whole pipette, transfer it immediately in a 100-ml volumetric flask, add water to bring it up to constant volume, mix well, take 20 ml of this diluted sample solution with a whole pipette and transfer it to an Erlenmeyer flask (100 ml).

(2) Add 2 or 3 drops of phenolphthalein indicator (1 % ethanol solution), titrate little by little with 0.05 N chloric acid standard solution, and take it as the end point when, by the last one drop, the faint red solution turns colorless.

(3) Then, take 20 ml of the diluted sample solution again, titrate it carefully referring to the result of the first titration and take the result obtained here as the formal measured value.

7.2.2 Calculation The decrease in alkali concentration shall be calculated from the follwoing formula:

$$Rc = \frac{20 \times 0.05 \times F}{V_1}(V_3 - V_2) \times 1\,000$$

where, Rc : decrease in alkali concentration (mmol/ l)

V_1 : aliquot from diluted sample solution in 7.2.1 (1) (ml)

V_2 : volume of 0.05 N hydrochloric acid solution required for titration of the diluted sample solution (ml)

V_3 : volume of 0.05 N hydrochloric acid solution required for titration of the diluted sample solution in the blank test (ml)

F : factor of 0.05 N hydrochloric acid solution.

7.3 Methods of Determining Dissolved Amount of Silica Measurement of the dissolved amount of silica shall be made by one of the following methods:

(1) Gravimetric method

(2) Atomic absorption photometric method

(3) Absorption photometric method

7.3.1 Gravimetric Method

(1) Procedure Take an aliquot of the stock solution, add hydrochloric acid, evaporate to dryness, and treat it with perchloric acid. Heat the precipitate violently and then treat it with hydrogen fluoride. The procedure shall be as follows:

(a) Take 5 ml of the stock solution of 7.1 (6) with a whole pipette and transfer it to a platinum plate (75 ml) or a beaker (100 ml).

(b) Add 5 ml of hydrochloric acid (1+1), mix and then evaporate it to dryness on the water bath in a draft chamber.

(c) After evaporating to dryness, add 8 ml of perchloric acid (60 % or 70 %), heat on a sand bath, evaporate taking care not to let the content scatter about and, when thick white fume of perchloric acid begins to rise, cover with a watch glass and continue heating for 10 min with the bottom of the vessel a little sunk in the sand.

(d) Take down the platinum plate or beaker from the sand bath, cool, take off the watch glass after washing with water, add 5 ml of hydrochloric acid (1+1) and about 20 ml of warm water, stir it with a glass rod and, after crushing lumps of jelly thoroughly, filter with filter paper (Class 5B, 110 mm in diameter specified in JIS P 3801) and wash ten times with warm water.

(e) Put the precipitate in a platinum crucible (30 ml), drip a few drops of sulfuric acid (1+10) on the filter paper, dry, heat slowly without producing flame to carbonize and then incinerate it. Then heat it violently in an electric furnace controlled at 1000 ± 50°C for one hour, cool in a desiccator, and weigh the mass.

Moisten the inside of the platinum crucible with a small amount of water, add 2 or 3 drops of sulfuric acid (1+1) and 10 ml of hydrofluoric acid (about 47 %), and heat gently on the sand bath in a draft chamber to effect a hydrofluoric acid treatment and further heat to perform a white fume treatment of sulfuric acid. Then, raise the temperature slowly, heat violently at 1000 ± 50°C for 5 min, cool in a desiccator, and weigh the mass.

(2) Calculation The dissolved amount of silica shall be calculated from the following formula:

$$Sc = 3\,330 \times W$$

where, Sc : dissolved silicon dioxide (mmol/ l)

W : mass of silicon dioxide in 5 ml of the sample stock solution calibrated by blank test (g).

7.3.2 Atomic Absorption Photometric Method The atomic absorption photometric method is a quantitative analytical method to obtain the silica content by atomizing the diluted sample solution in the high temperature acetylene-nitrogen dioxide flame and measuring the absorbance at a wavelength of 251.6 nm. The preparation, procedure and calculation shall be as follows:

(1) Preparation of Standard Solution

(a) Take accurately 0 ml, 10 ml, 20 ml, 30 ml and 40 ml from the silica standard stock solution (SiO_2 10 mmol/ l) of 5.2 (11) and put each of them in a 100-ml volumetric flask, add water up to the marked line (0 mmol/ l, 1.0 mmol/ l, 2.0 mmol/ l, 3.0 mmol/ l and 4.0 mmol/ l as SiO_2), shake well and transfer to a polyethylene vessel.

(b) When the silica standard solution (Si 1000 ppm) on the market is used, take accurately 0 ml, 1.0 ml, 2.0 ml, 4.0 ml, 6.0 ml. 8.0 ml and 10.0 ml from this standard solution and put each of them in a 100-ml volumetric flask, add water up to the marked line (0 mg/ l, 10 mg/ l, 20 mg/ l, 40 mg/ l, 60 mg/ l, 80 mg/ l and 100 mg/ l as Si), shake well and transfer to a polyethylene vessel.

(2) Plotting of Working Curve

(a) Light the hollow cathode lamp for silicon of atomic absorption photometer, and set the lamp to the optimum conditions in order to stabilize the brightness. After igniting the burner using acetylene and air, change over to the high temperature flame of acetylene-nitrogen dioxide.

(b) Set the conditions optimum for acetylene-nitrogen dioxide flow ratio, the burner head position, etc. by spraying the most concentrated silica standard solution.

(c) Then measure the absorbance of each standard solution, and plot a curve relative to the silica concentration, and use it as the working curve.

(3) Procedure Measure the absorbance of the diluted sample solution prepared in accordance with 7.2.1 (1) under the same condition as in plotting the working curve. When the absorbance exceeds that of the most concentrated silica standard solution, first adjust the concentration of the diluted sample solution adequately and exactly (dilution ratio n) before resuming the measurement.

(4) Calculation The dissolved amount of silica shall be calculated from the formula (1) when the silica standard stock solution (SiO_2 10 mmol/l) is used, and from the formula (2) when the market silica standard solution (Si 1000 ppm) is used.

$$Sc = 20 \times n \times C \quad \cdots\cdots (1)$$

$$Sc = 20 \times n \times A \times \frac{1}{28.09} \quad \cdots\cdots (2)$$

where,
- Sc : dissolved amount of silica (mmol/l)
- n : dilution ratio
- C : silica content obtained from the working curve (SiO_2 mmol/l)
- A : silica content obtained from the working curve (Si mg/l).

7.3.3 Absorption Photometric Method After the reaction between silica in the diluted sample solution and the ammonium molybdate has occurred, add oxalic acid and measure the absorbance with the wavelength in the vicinity of 410 nm.

(1) Plotting of Working Curve

(a) Take accurately 0 ml, 1.0 ml, 2.0 ml, 3.0 ml and 4.0 ml from the silica standard stock solution (SiO_2 10 mmol/l), put each of them in 100-ml volumetric flask, and add water to make about 50 ml.

(b) Add 2 ml of ammonium molybdate solution (10 %) and 1 ml of hydrochloric acid (1+1) and shake. After leaving still for 15 min, add exactly 1.5 ml of oxalic acid solution (10 %), and add water up to the marked line and agitate (0 mmol/l, 0.1 mmol/l, 0.2 mmol/l, 0.3 mmol/l and 0.4 mmol/l as SiO_2).

(c) When a silica standard solution (Si 1000 ppm) on the market is to be used, take exactly 10 ml of the silica standard solution and put in a 100-ml volumetric flask, add water up to the marked line and agitate. From this solution, take exactly 0 ml, 2.0 ml, 4.0 ml, 6.0 ml and 10.0 ml and put each of them in a 100-ml volumetric flask separately, and add water to make about 50 ml.

(d) Then, treat the solutions in the same manner as in (b) (0.0 mg/l, 2.0 mg/l, 4.0 mg/l, 6.0 mg/l and 10.0 mg/l as Si).

(e) Leave still each standard solution for 5 min ± 10 sec, measure the absorbance with the wavelength in the vicinity of 410 nm using water as the contrast solution, and plot a curve relative to the silica concentration to take as the working curve.

(2) Procedure

(a) Take 10 ml (V) of the diluted sample solution prepared in accordance with 7.2.1 (1) with a whole pipette and transfer it into a 100-ml volumetric flask.

(b) After adding water to make about 50 ml, treat the solution in the same manner as in (1) (b).

(c) After leaving still for 5 min ± 10 sec, measure the absorbance in the same condition as in plotting the working curve. When the absorbance falls outside the range from 0.1 to 0.6, repeat the measurement after adequately adjusting the concentration of the sample solution.

(3) Calculation The dissolved amount of silica shall be calculated from formula (3) when the silica standard stock solution (SiO_2 10 mmol/ l) is used, and from formula (4) when the market silica standard solution (Si 1000 ppm) is used.

$$Sc = 20 \times n \times C \quad \cdots\cdots (3)$$

$$Sc = 20 \times n \times A \times \frac{1}{28.09} \quad \cdots\cdots (4)$$

where, Sc : dissolved amount of silica (mmol/ l)

n : dilution ratio

C : silica content obtained from the working curve (SiO_2 mmol/ l)

A : silica content obtained from the working curve (Si mg/ l).

8. Method of Summarizing Test Results

8.1 Entry in Date Sheets Each measured value shall be expressed in mmol/ l and entered in data sheet after rounded off to an integer. The form of data sheet shall be as shown in Annex 7 Table.

8.2 Precision Tolerances Individual values of three measurements on the decrease in alkali concentration and the dissolved amount of silica shall not differ from respective mean values by more than 10 %. However, in the case where both values of decrease are not more than 100 mmol/ l , the difference shall be within 10 mmol/ l .

If the test results exceed these ranges, a retest shall be performed.

9. Determination of Potential Alkali Silica Reactivity of Aggregates

The potential alkali-silica reactivity of aggregates shall be judged deleterious when the dissolved amount of silica (Sc) is more than the decrease in alkali concentration (Rc) in the case where the dissolved amount of silica (Sc) is 10 mmol/ l or over and the decrease in alkali concentration (Rc) is under 700 mmol/ l , and shall be judged innocuous in the cases where the dissolved amount of silica (Sc) does not exceed the decrease in alkali concentration (Rc).

Annex 7 Table. Data Sheet for Results of Alkali-silica Reactivity Test

1. Date of test: Factor of 1 N-NaOH

2. Person in charge Department Name Factor of 0.05 N-HCl

Name of aggregates	Number of tests	Mass of sample (g)	Reaction time (hr)	Decrease in alkali concentration (Rc) (mmol/l)				Dissolved amount of silica (Sc) (mmol/l)										Evaluation of injuriousness
								Photometric method				Gravimetric method			Atomic absorption method			
				V_1 (ml)	V_2 (ml)	*Rc*	Mean	*V* (ml)	*C* (mmol/l) or *A* (mg/l)	*Sc*	Mean	*W* (g)	*Sc*	Mean	*C* (mmol/l) or *A* (mg/l)	*Sc*	Mean	
	1																	
	2																	
	3																	
	1																	
	2																	
	3																	
	1																	
	2																	
	3																	

Annex 8. Test Method for Potential Alkali-silica Reactivity of Aggregates (Mortar Bar Method)

1. Scope

This Annex specifies the test method for determining the potential alkali-silica reactivity of aggregates by measuring the length variation of mortar bars.

2. Sample

The sample shall be unused aggregates and aggregates in fresh concrete and, as a rule, about 40 kg of representative samples shall be taken each from the coarse and fine aggregates(1).

Note (1) When the test is to be made immediately succeeding the chemical method, the same sample may be used as a specimen.

3. Test Apparatus

3.1 Balance The balance to serve for screening the aggregates shall be of an accuracy more than 0.1 % of the mass of aggregates. The balance for weighing materials for preparation of mortar shall be of 2 kg of weighing capacity with accuracy of weighing to the nearest 0.1 g.

3.2 Formwork The formwork shall be of the triple type 40 x 40 x 160 mm in dimension specified in JIS R 5201, and fitted with a hole on either side to be used for embedding and fixing plug gauges for measuring the length variation.

3.3 Measuring Apparatus for Length Variation Measurement of length variation shall be made in accordance with the dial gauge method prescribed in JIS A 1129. The dial gauge of the minimum scale (accuracy) of 0.001 mm prescribed in JIS B 7509 shall be used. The gauge plugs shall be of a metal which will not rust while testing.

3.4 Apparatus for Preparing Mortar The apparatus to be used for mixing, forming and compacting mortar shall be a mixing machine, a formwork for forming mortar specimens, and a tamping rod, specified in 9.1 (1) and 9.1 (2) of JIS R 5201, respectively.

3.5 Sieve As the sieves for adjusting the grain sizes of sand, those of 4.75 mm, 2.36 mm, 1.18 mm, 600 μm, 300 μm, and 150 μm in nominal sizes, specified in JIS Z 8801, shall be used.

3.6 Storage Containers The storage containers for storing the specimens shall be so constructed as to be closed tightly with an airtight cover and to be free from loss of humidity.

3.7 Refiner The refiners which produce fine aggregates from coarse aggregates shall be a rod mill, a jaw crusher, a disk-type refiner, a roll-type refiner, etc.

4. Temperature and Humidity

4.1 Molding Room and Measuring Room The mortar molding room and the measuring room shall be kept at temperature 20 ± 3°C.

4.2 Storage Container The temperature and relative humidity of the inside of storage container shall be kept at 40 ± 2°C and 95 % or over, respectively.

5. Materials

5.1 Preparation of Aggregates and Adjustment of Particle Size When the aggregates to be used are coarse aggregates, wash beforehand and pulverize with a crusher or the like to obtain fine aggregates. Adjust the fine aggregates under air-dry condition to the particle size grading shown in Annex 8 Table.

Annex 8 Table. Particle Size Distribution of Fine Aggregates

Nominal dimension of sieve		Mass
Passing	Retained on	Percentage (%)
4.75 mm	2.36 mm	10
2.36 mm	1.18 mm	25
1.18 mm	600 μm	25
600 μm	300 μm	25
300 μm	150 μm	15

5.2 Cement The ordinary portland cement in which the alkali amount is 0.65 ± 0.05 % and the ratio of Na_2O (%) to K_2O (%) is in the range of 1 : 2 ± 0.5 specified in JIS R 5210 shall be used, and its content of Na_2O and K_2O shall be determined beforehand in accordance with JIS R 5202.

5.3 Sodium Hydroxide The reagent of special grade specified in JIS K 8576 shall be used as sodium hydroxide solution.

Further, 1 N sodium hydroxide solution available on the marked may be used instead.

5.4 Water Water conforming to article 4 of the Water Supply Regulation Law shall be used for mixing.

6. Preparation of Specimens (Mortar Bars)

6.1 Number of Specimens The number of specimens used for one test shall, as a rule, be three.

Further, three specimens shall be prepared from one batch.

6.2 Mixing Proportion of Mortar The mixing proportion of mortar shall be 1 cement, 0.5 water, and 2.25 sand in mass ratio. The amount of cement, sand and water for one mixing batch shall, as a standard, be as follows:

Water + NaOH solution: 300 ml
Cement : 600 g
Sand (Surface dried) : 1350 g

The amount of NaOH solution shall be determined by calculation so as to make the alkali amount in the cement 1.2 ± 0.05 %, as expressed by R_2O.

6.3 Measuring of Materials The materials to be measured by mass shall be weighed to obtain four significant figures. In the case of sand not surface-dry, the water content (water absorption) in the air-dry condition shall be determined for the present until later corrections at the time of measuring the water in order to keep the water-cement rate unchanged.

6.4 Mixing Method The mixing of mortar shall, as a rule, be as prescribed below:

The mixer prescribed in 9.1 (1) of JIS R 5201 shall be used. Fix the mixing vessel and paddle to the mixing position and pour the specified quantity of cement and sand into the vessel. Then start the mixer and mix for 30 s while rotating the paddle. Then, stop the mixer and put the specified amount of water. After restarting and running for 30 s, stop the mixer for 20 s. During the suspension, scrape off the mortar adhering to the mixing vessel and paddle with a spoon. In addition, mix the mortar at the bottom of the mixing vessel 2 or 3 times in a spooning-up motion. With the suspension over, start again the mixer and mix for 120 s.

6.5 Molding Immediately pour the mortar in the formwork in two layers up to one half of the height of formwork and tamp the mortar with a tamping rod about 15 times over the whole surface of each layer with the tip of the rod sinking about 5 mm into the mortar each time. In this case, care shall be taken so that the mortar is distributed sufficiently around the gauge plug. Then, pour the mortar up to the upper edge of the formwork, tamp it with the tamping rod in the same manner as before and heap the residual mortar about 5 mm in height above the edge. After the placement process, put the formwork in a wet box and cover with a wet cloth or the like so as to keep the mortar surface untouched and to minimize the drying of the mortar. About 5 h after the placing process, shave off the flush to make the upper surface smooth, taking care not to injure the specimen.

7. Initial Curing

For 24 ± 2 h after the placement, put the formwork containing the mortar in the wet box and cover it with a wet cloth or the like to keep the mortar surface untouched and to minimize the drying of the mortar.

8. Detachment from Formwork

After completion of the initial curing, extract the mortar from the formwork. At the time, clearly mark the mortar with the specimen number and symbols indicating top or bottom, or direction of the specimen when tested, taking care not to lessen the moisture content. The period from the placement to the detachment shall be 24 ± 2 h.

9. Method of Measuring Base Length

Immediately after marking the number on the specimen detached from the formwork, the base length shall be measured with care not to dry the specimen.

10. Storage and Measurement

The specimens shall be stored in a sealed container kept at 40 ± 2°C and at not lower than 95 % RH. As a means of keeping the relative humidity at not lower than 95 %, it should be preferable to cover the surface of the specimen with blotting paper containing water to an extent not to flow out. In this case the sealed container may be replaced by a vinyl bag.

When not covering the surface of the specimen with blotting paper, put temperature-controlled water to the bottom face of the container and erect the specimens one by one upright not to contact the water.

When the specimen has reached the specified material age, take it out of the storage room or the storage box together with the container and, after keeping at 20 ± 3°C for at least 16 h, open the container and make measurement for that age. During the measurement, keep the specimen from drying up.

After the measurement, immediately restore the specimen to the conditions of 40 ± 2°C and 95 % RH or over.

All the specimens which are to go into the same container subsequent to the initial measurement of their lengths after the lapse of 24 ± 2 h shall be prepared on the same day and put in the same container at the same time so that they can all be subjected to measurement simultaneously.

After the measurement, the specimens shall be put again in the container with their positions of top or bottom reversed from those during the previous period.

11. Measuring Method

11.1 Measurement of Change of Length The measurement shall be made in accordance with the dial gauge method of JIS A 1129. The length measuring frame shall be kept in the same conditions (perpendicular or at fixed degrees to the perpendicular) as in the measurement of the perpendicularity and temperature. Contact the contact point of the measuring frame with one of the two plugs of the standard scale, make the tip of the dial gauge move in concert with the travel of reference rod, push out the spindle slowly and contact it with the other plug of the standard scale, and read the dial gauge to the nearest $\frac{1}{1000}$ mm. Draw the spindle in, repeat the above operations and, from the readings when the values have stabilized, obtain the mean value to take it as sXi.

Carry out the above operations on specimens and obtain Xi.

The specimens shall always be placed with the same end up and with the same face in front. The relative positions of the gauge and the specimen shall always be kept the same.

The measuring instruments and standard scale shall be kept at the temperature determined for the respective tests for 3 h till the start of the measurement.

11.2 Observation of Appearance Along with the measuring of the change of length, observation shall be made of the change of warping and popout and the like of the specimen, and fissure, leached products such as the gel of water glass and soil on the surface.

12. Calculation of Expansion Coefficient

The difference between the initial length and the length at each material age shall be divided by the effective gauge length, and calculated to the nearest 0.001 %, and the result shall be recorded as the expansion coefficient of the specimen during this period.

The expansion coefficient shall be calculated from the following formula:

$$\text{Expansion coefficient (\%)} = \frac{(Xi - sXi) - (Xini - sXini)}{L} \times 100$$

where,

Xi : reading of dial gauge on the specimen at age i

sXi : reading of standard scale dial gauge on the specimen at age i

$Xini$: reading of dial gauge at the time of detachment of the specimen from formwork

$sXini$: reading of standard scale dial gauge with which measurement has been made at the same time

L : effective gauge length(2) (distance between inside end surfaces of the gauge plug).

(The units for Xi, sXi, $Xini$, $sXini$, and L shall be the same.)

Note (2) Take heed of the fact that the effective gauge lengths may differ according to the individual gauge plugs.

13. Material Ages for Measurements

The material ages at which measurements are to be made shall be indicated below:

At the time of detachment, 2 weeks, 4 weeks, 8 weeks, 3 months and 6 months.

14. Evaluation

When the mean expansion coefficient of three specimens after six months turns out under 0.100 %, it shall be judged innocuous, and when 0.100 % or over not innocuous.

Remark: Expansion of 0.050 % or over after 3 months may be judged other than innocuous. However, when the result is under 0.050 % after 3 months, judgment shall be deferred until after the test has been continued for additional 6 months.

15. Precision

When the absolute difference between the mean expansion coefficient of all the specimens molded from the same batch and those of individual specimens is within 0.010 %, the precision may be considered satisfactory. However, in the case where the mean expansion coefficient exceeds 0.050 %, the precision may be deemed satisfactory provided that the relative difference between the expansion coefficient of the individual specimens and the mean expansion coefficient does not exceed ± 20 % of the mean value. When all the three specimens show expansion of 0.100 % or over, judgment shall be "not innocuous" regardless of the precision.

Remark: When the condition of precision does not conform to any of the above conditions, the judgment may be made from the average value of the two specimens to the exclusion of the one which shows the smallest expansion.

16. Report

In the report, the following information shall be stated:

(1) Source and type of aggregates

(2) Alkali content in cement [potassium oxide (K_2O), sodium oxide (Na_2O) and total alkali content]

(3) Expansion coefficients for individual measuring ages of specimens and their mean values

(4) Other important facts observed on specimens during and after the test and the like.

Annex 9. Water to Serve for Mixing Ready-mixed Concrete

1. Scope

This Annex specifies water to serve for mixing the ready-mixed concrete (hereafter referred to as "water").

2. Classification

The water shall be classified into water from public water supply, water other than water from public water supply and recycled water.

3. Definitions

For the purpose of this Annex, the following definitions apply.

(1) Water Other Than Water from Public Water Supply   Water taken as river water, lake water, well water, undeground water and the like which are not particularly subjected to the treatment as water from public water supply or industrial water, except for the recycled water.

(2) Recycled Water   Generic term for sludge water and supernatant water obtained by treating the wastewater used for washing the concrete adhering to the transportation unit, mixer, hopper and the like of the plant and the returned concrete (hereafter referred to as "wastewater of washing concrete"), as distinct from other forms of wastewater produced by washing in the plant of ready-mixed concrete.

(3) Sludge Water   Suspension water which remains after coarse and fine aggregates are separated and recovered from concrete-washing wastewater.

(4) Supernatant Water   Water which is obtained from the sludge water by removing the sludge solid content by precipitation or other means.

(5) Sludge   Substance produced from the sludge water through concentration and loss of fluidity.

(6) Sludge Solid Content   Substance obtained by drying the sludge at 105 to 110°C.

(7) Sludge Solid Content Ratio   The ratio in percentage of the mass of sludge solid content to the unit mass of cement in the concrete proportion.

4. Water from Public Water Supply

The water from public water supply may be used without particular tests.

The quality of water from public water supply complying with Article 4 (quality of water) of the water supply regulation law is given in Annex 9. Informative Reference Table.

Annex 9 Informative Reference Table Quality of Water from Public Water Supply

Test item	Tolerances
Chromaticity	Degree 5 or under
Turbidity	Degree 2 or under
Hydrogen-ion concentration (pH)	5.8 to 8.6
Residue on evaporation	500 ppm or under
Chlorine ion content	200 ppm or under
Consumption of potassium permanganate	10 ppm or under

5. Water Other Than That From Public Water Supply

Water other than that from public water supply shall be tested in terms of quality in accordance with the test method of 8.1 and the results shall comply with the criteria given in Annex 9 Table 1. When the above water safisfies the quality of the water of public water supply prescribed in Article 4 (quality of water) of the water supply regulation law, the requirements for the above water shall be in accordance with those for public water supply, as appropriate.

Annex 9 Table 1. Quality of Water Other Than That from Water Supply

Item	Quality
Quantity of suspended matter	2 g/ *l* or under
Quantity of soluble residue on evaporation	1 g/ *l* or under
Chlorine ion content	200 ppm or under
Difference in solidification time of cement	30 min or under at start, 60 min or under at end
Ratio of compressive strengths of mortar	90 % or over at material age of 7 days and material age of 28 days

6. Recycled Water

6.1 Quality The quality of recycled water shall comply with the criteria specified in Annex 9 Table 2 when it is tested in accordance with the test method of 8.2. Its raw water, however, shall comply with the specification of 4 or 5.

Annex 9 Table 2. Quality of Recycled Water

Item	Quality
Chlorine ion content	200 ppm or under
Difference in solidification time of cement	30 min or under at start, 60 min or under at end
Ratio of compressive strengths of mortar	90 % or over at material age of 7 days and material age of 28 days

6.2 Limit of Sludge Solid Content Ratio When the sludge water is to be used, its sludge solid content ratio shall not exceed 3 %.

Informative Reference: In the proportion of ready-mixed concrete, the sludge solid content of the sludge water shall not be included in the mass of water.

7. Case Where Waters Are Mixed for Use

When the mixed water is to be used, each component water shall comply with the requirements of 4., 5. or 6., respectively.

8. Test Method for Water

8.1 Water Other Than That from Public Water Supply

8.1.1 Test items The test items shall be as follows.

(1) Suspended matter content

(2) Content of residue on evaporation

(3) Chlorine ion content

(4) Difference in solidification times

(5) Ratio of compressive strengths of mortar

8.1.2 Test Appliances Test appliance used for (1) and (2) of 8.1.1 shall be as follows.

(1) The container for the sample shall be a hard glass bottle with ground-in stopper or a polyethylene bottle with a cover. A bottle thoroughly cleaned shall be used.

(2) The appliances used for analysis shall be two volumetric flasks (200 ml and 100 ml, one each), a filter made of glass (Buchner-funnel type 3 G 2), a porcelain evaporating dish (10 to 20 cm in diameter), a watch glass (10 to 20 cm in diameter), a beaker (500 ml), filter paper (Class 6 or glass-fiber reinforced filter paper specified in JIS P 3801), a desiccator (one which can accommodate a filter made of glass and a porcelain evaporating dish), a precision chemical balance and an electric constant-temperature drier.

8.1.3 Sample The sample shall be as follows.

(1) Fill the sample bottle with the water for test, tightly seal the bottle with a clean stopper leaving no air above the sample surface, and carry out the test within 7 days after the sampling.

(2) The amount of sample taken for one test shall be approximately 4 l.

(3) When well water is to be sampled, the water after some quantity of water has been pumped up shall be sampled as the test water. In sampling from a river, a lake, a lagoon or a reservoir, samples shall be taken several times a day and equal amounts of the samples shall be mixed to obtain a representative sample.

8.1.4 Test for Content of Suspended Matters The test for the content of suspended matters shall be as follows.

(1) Procedure

(a) Lay a fitler paper on the bottom of a glass filter and dry it at a temperature of 105 to 110℃. Cool to room temperature in a desiccator, and weigh the mass (W_1) of the glass filter and filter paper to the nearest 0.01 g.

(b) Measure 200 ml of test water with a volumetric flask, filtrate the whole water, dry the residue together with the filter at a temperature of 105 to 110℃, cool to room temperature in a desiccator, and weigh the mass (W_2) of the glass filter, residue on the filter paper and the filter paper to the nearest 0.01 g. The filtrate shall be used in 8.1.5.

(2) Calculation Calculate the content (Sd) of suspended matters from the following equation and round off the results to the first decimal place in accordance with JIS Z 8401.

$$S_d = (W_2 - W_1) \times 5$$

where, S_d : content of suspended matters (g/l)

W_1 : mass of glass filter and filter paper (g)

W_2 : mass of glass filter, residue on the filter paper and filter paper (g).

8.1.5 Test for Content of Soluble Evaporation Residue The test for the content of the soluble evaporation residue shall be as follows.

(1) Procedure

(a) Dry a well-cleaned porcelain evaporating dish at 105 to 110°C, cool to room temperature in a desiccator, and then weigh its mass (W_3) to the nearest 0.01 g.

(b) Take 100 ml of the filtrate removed of the suspended matters in 8.1.4 (1) (b) to a volumetric flask and transfer it to the porcelain evaporating dish.

(c) Cover the evaporating dish with a watch glass leaving a small space, evaporate to dryness by heating on a water bath, and dry it at a temperature of 105 to 110℃. After cooling the dried evaporation residue to room temperature, weigh its mass (W_4) to the nearest 0.01 g.

(2) Calculation Calculate the content of the soluble evaporation residue (S_s) from the following equation and round off the result to the first decimal place in accordance with JIS Z 8401.

$$S_s = (W_4 - W_3) \times 10$$

where, S_s : content of soluble evaporation residue (g/l)

W_3 : dried mass of evaporating dish (g)

W_4 : total mass of residue evaporated to dryness and evaporating dish (g).

8.1.6 Test for Chlorine Ion Content The test for chlorine ion content shall be performed in accordance with the test method specified in Annex 5.

8.1.7 Test for Difference in Cement Solidification Time The test for difference in cement soldification time shall be as follows.

(1) Test Method The test shall be performed using the test water and the reference water[1] in accordance with 7. of JIS R 5201. However, the cement-water ratio of mortar using the reference water and that using water other than the water from public water supply shall be identical.

Note [1] The reference water means distilled water, water purified by ion-exchange resin or water from public water supply.

(2) Calculation Express the start and end times in minute, and calculate the difference in the start time and the difference in the end time.

$$Ti = | Tio - Tis |$$

$$Tf = | Tfo - Tfs |$$

where, Ti : difference in start time (minute)

Tio : start time when reference water is used (minute)

Tis : start time when water other than from public water supply is used (minute)

Tf : difference in end time (minute)

Tfo : end time when reference water is used (minute)

Tfs : end time when water other than from public water supply is used (minute).

8.1.8 Test for Compressive Strength Ratio of Mortar The test for compressive strength ratio shall be performed either by the method (method A) in accordance with 9. of JIS R 5201 or the method (method B) using a columnar specimen 5 cm in diameter and 10 cm in height. The procedure according to the method B will be described below. Note that the calculation in the case of the method A shall be as shown in (5).

(1) Test Apparatus and Appliances

(a) The balance shall be 2000 g or over in weighing capacity and be capable of weighing to the nearest 0.5 g.

(b) The mixer shall be as follows: an electric mixer with the mixing drum of a nominal capacity of 4.7 *l* or over and having a paddle which makes a circular motion rotating on its own axis and at the same time revolving in the opposite direction. The number of revolutions of the paddle shall be 140 ± 5 rpm for rotation and approximately 62 rpm for revolution in the case of a low speed, and 285 ± 10 rpm for rotation and approximately 125 rpm for revolution in the case of high speed.

(c) The formwork shall be a metal cylinder 5 cm in inside diameter and 10 cm in height.

(d) The tamping bar shall be a steel bar 9 mm in diameter with an obtusely pointed end.

(2) Test Conditions The temperature in test room from the time of molding to the time of immersion shall be 10 to 25°C. However, the temperature change from the start of molding to the completion of molding shall be within 4°C.

(3) Materials Used in Test

(a) The cement shall, as a rule, be the ordinary portland cement used in the plant.

(b) The sand to serve shall be the sand usually used in the plant and subsequently changed into a water-saturated surface-dry condition. To effect a water-saturated surface-dry condition of sand, 3.3 of JIS A 1109 shall be conformed to.

(4) Procedure

(a) Set the mixing drum and paddles to the mixer, pour 400 g of test water in the mixing drum and 800 g of cement, and then mix for 40 s at the low speed. Meanwhile, put slowly the sand in the water-saturated surface-dry condition. The amount of sand to be put shall ensure the predetermined flow of mortar(2) of 190 ± 5. Then, stop for 20 s, and in the meanwhile scrape off the mortar adhering to the mixing drum and paddles with a spoon. Thereafter, mix for 2 min at the high speed to prepare the mortar. Also in the case where the reference water is used in place of the test water, mix in the same manner as above and prepare two batches of mortar.

Note (2) The flow test of mortar shall be performed in accordance with 9.7 of JIS R 5201.

Informative Reference: The amount of the sand to be put in the mortar shall be in the range from 2000 to 2500 g in the case of the river sand.

(b) Fill the formwork with this mortar in two layers and tamp each layer 25 times with a tamping bar. After tamping with the tamping bar, slightly tap the formwork so as to level off the holes produced by tamping. In this way, prepare four specimens from each batch of mortar.

(c) Four hours after the mortar is poured into the formwork, the mortar is subjected to a capping treatment. Remove the formwork 24 h later and cure the speciment till the day of test.

The capping and curing shall be performed in accordance with 4.4 and 7. of JIS A 1132.

(d) Seven days and 28 days after the preparation of the specimens, perform a compressive strength test on four specimens of each material age.

The compressive strength test shall be performed in accordance with JIS A 1108.

(5) Calculation Calculate the ratio (R) of compressive strengths of the mortar from the following equation.

$$R = \frac{\sigma_{cr}}{\sigma_{co}} \times 100$$

where, R : ratio of compressive strength of mortar (%)

σ_{co} : compressive strength of mortar prepared using reference water at material age of 7 days or 28 days (kgf/cm^2) {N/cm^2}

σ_{cr} : compressive strength of mortar prepared using water other than from public water supply at material age of 7 days or 28 days (kgf/cm^2) {N/cm^2}.

8.1.9 Report The report of test results on the water other than from public water supply shall include the following items.

(1) Division of river water, lake water, well water or ground water

(2) Suspended matter content

(3) Content of soluble evaporation residue

(4) Chlorine ion content

(5) Difference in solidification time of cement

(a) Start and end times in the case of the reference water

(b) Start and end times in the case of the water other than from public water supply

(c) Differences between the start times and the end times in the cases of (a) and (b)

(6) Ratio of compressive strength of mortar

(a) Test method (method A or B referred to in 8.1.8)

(b) Compressive strength in the case of the reference water (at material ages of 7 days and 28 days)

(c) Compressive strength in the case of the water other than from public water supply (at material ages of 7 days and 28 days)

(d) Ratio of compressive strength of the mortar prepared using the reference water to that of the mortar prepared using the water other than from public water supply

8.2 Recycled Water

8.2.1 Test Items The test items shall be as follows.

(1) Chlorine ion content

(2) Difference in solidification time of cement

(3) Ratio of compressive strength of mortar

8.2.2 Samples The samples shall be as follows.

(1) The representative sample of the sludge water shall be taken from a sludge water storage tank in the ready-mixed concrete plant, and shall be tested without delay.

(2) The supernatant water shall be put in a test bottle at a supernatant water storage tank in the ready-mixed concrete plant, and the test bottle shall be tightly sealed with a clean stopper leaving no space of air above the water. The test shall be conducted within 7 days after sampling.

8.2.3 Test for Chlorine Ion Content The test for chlorine ion content shall be in accordance with the test method specified in Annex 5.

8.2.4 Test for Difference in Solidification Time of Cement The test for the difference in solidification time of cement shall be performed as follows.

(1) Test Method The test shall be performed in accordance with the test method of 8.1.7. However, the sludge water to serve shall be that of which the concentration is 4.5 %([3]) as determined by the test method of 8.2.6. The supernatant water shall be used as it is.

Further, the cement water ratio in the case of the reference water shall be the same as that in the case of the recycled water.

Note (3) The solid content in this sludge water shall not be included in the amount of the water.

(2) Calculation Calculate the difference in start time and the difference in end time, each expressed in minute, from the following formula.

$$Ti' = | Tio - Tis' |$$
$$Tf' = | Tfo - Tfs' |$$

where, Ti' : difference in start time (minute)

Tio : start time in the case of reference water (minute)

Tis' : start time in the case of recycled water (minute)

Tf' : difference in end time (minute)

Tfo : end time in the case of reference water (minute)

Tfs' : end time in the case of recycled water (minute).

8.2.5 Test for Ratio of Compressive Strength of Mortar The test for the ratio of the compressive strengths of mortar shall be as follows.

(1) Test Method The test shall be performed in accordance with the test method of 8.1.8. However, in the case of method A, the water to serve shall be 338 g of the water from public water supply as reference water, 354 g(4) of sludge water of the concentration of 4.5 % as determined by the test method of 8.2.6, and 338 g of the supernatant water.

In the case of method B, 400 g of the reference water, 419 g of sludge water of the concentration of 4.5 % as determined by the test method of 8.2.6 and 400 g of the supernatant water.

Note (4) The mass of sludge in this case containes the sludge solid content.

(2) Calculation Calculate the ratio (R') of the compressive strength of mortar from the following equation.

$$R' = \frac{\sigma_{cr}'}{\sigma_{co}} \times 100$$

where, R' : ratio of compressive strength of mortar

σ_{co} : compressive strength at material ages of 7 days and 28 days of mortar prepared using reference water (kgf/cm^2) {N/cm^2}

σ_{cr}' : compressive strength at material ages of 7 days and 28 days of mortar prepared using recycled water (kgf/cm^2) {N/cm^2}.

8.2.6 Test for Concentration of Sludge Water The test for the concentration of the sludge water shall be as follows.

(1) Test Appliances

(a) The balance shall be 1000 g or over in weighing capacity and be capable of weighing to the nearest 0.1 g.

(b) The vat for drying shall be sufficiently large to accommodate approximately 500 ml of the sludge water.

(c) A 500-ml volumetric flask

(d) A 500-ml beaker

(2) Sample Take approximately 5 l of the representative sludge water, and use this as the sample.

(3) Procedure

(a) Take approximately 500 ml of sample in the drying vat while stirring the sample well, and weigh its mass (W) to the nearest 0.1 g.

(b) Put the vat in a drier and dry at 105 to 110°C to constant mass. After allowing to cool to room temperature, weigh the mass (S) to the nearest 0.1 g.

(4) Calculation Calculate the concentration (Cs) of the sludge water from the following equation, and round off the obtained value to the first decimal place in accordance with JIS Z 8401.

$$Cs = \frac{S}{W} \times 100 - 0.2$$

where, Cs : concentration of sludge water (%)

W : mass of sludge water (g)

S : mass of sludge after dried (g).

Informative Reference: According the report of the Recycled Water Committee of Japan Concrete Engineering Association, the country-wide mean value of the content of soluble components in the supernatant water is 0.2 %. Accordingly, subtract this value from the calculated result, and the value obtained will be approximately the same as that obtained by the filtration method.

8.2.7 Report In the test result report of the recycled water the following items shall be entered.

(1) Sludge water or supernatant water

(2) Chlorine ion content

(3) Difference in solidification time of cement

(a) Start and end times in the case of reference water

(b) Start and end times in the case of recycled water

(c) Start and end times in the cases of both (a) and (b)

(4) Ratio of compressive strength of mortar

(a) Test method (method A or B specified in 8.1.8)

(b) Compressive strength in the case of the reference water (at material ages of 7 and 28 days)

(c) Compressive strength in the case of the recycled water (at material ages of 7 and 28 days)

(d) Ratio of compressive strength of the mortar using the recycled water to that of the mortar using the reference water

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Applicable Standards:

JIS A 1101-Method of Test for Slump of Concrete

JIS A 1102-Method of Test for Sieve Analysis of Aggregates

JIS A 1103-Method of Test for Amount of Material Passing Standard Sieve 74 μm in Aggregates

JIS A 1104-Method of Test for Unit Weight of Aggregate and Solid Content in Aggregate

JIS A 1105-Method of Test for Organic Impurities in Fine Aggregate

JIS A 1106-Method of Test for Flexural Strength of Concrete

JIS A 1108-Method of Test for Compressive Strength of Concrete

JIS A 1109-Method of Test for Specific Gravity and Absorption of Fine Aggregate

JIS A 1110-Method of Test for Specific Gravity and Absorption of Coarse Aggregates

JIS A 1115-Method of Sampling Fresh Concrete

JIS A 1116-Method of Test for Unit Weight and Air Content (Gravimetric) of Fresh Concrete

JIS A 1118-Method of Test for Air Content of Fresh Concrete by the Volumetric Method

JIS A 1119-Method of Test for Variability of Constituents in Freshly Mixed Concrete

JIS A 1121-Method of Test for Abrasion of Coarse Aggregates by Use of the Los Angeles Machine

JIS A 1122-Method of Test for Soundness of Aggregates by Use of Sodium Sulfate

JIS A 1126-Method of Test for Soft Particles in Coarse Aggregates by Use of Scratch Tester

JIS A 1128-Method of Test for Air Content of Fresh Concrete by Pressure Method

JIS A 1129-Methods of Test for Length Change of Mortar and Concrete

JIS A 1132-Method of Making and Curing Concrete Specimens

JIS A 1134-Methods of Test for Bulk Specific Gravity and Absorption of Light Weight Fine Aggregates for Structural Concrete

JIS A 1135-Methods of Test for Bulk Specific Gravity and Absorption of Light Weight Coarse Aggregates for Structural Concrete

JIS A 1137-Method of Test for Clay Contained in Aggregates

JIS A 5002-Light Weight Aggregates for Structural Concrete

JIS A 5004-Manufactured Sand for Concrete

JIS A 5005-Crushed Stone for Concrete

JIS A 5011-Air-Cooled Iron-Blast-Furnace Slag Aggregate for Concrete

JIS A 5012-Granulated Blast Furnace Slag Fine Aggregate for Concrete

JIS A 6201-Fly Ash

JIS A 6202-Expansive Additive for Concrete

JIS A 6204-Chemical Admixtures for Concrete

JIS A 6205-Corrosion Inhibitor for Reinforcing Steel in Concrete

JIS B 7509-Dial Gauges Reading in 0.001 mm

JIS K 0101-Testing Method for Industrial Water

JIS K 0113-General Rules for Methods of Potentiometric, Amperometric, Coulometric, and Karl-Fischer Titrations

JIS K 8576-Sodium Hydroxide

JIS P 3801-Filter Paper (for Chemical Analysis)

JIS R 5201-Physical Testing Methods of Cement

JIS R 5202-Method for Chemical Analysis of Portland Cement

JIS R 5210-Portland Cement

JIS R 5211-Portland Blast-furnace Slag Cement

JIS R 5212-Portland Pozzolan Cement

JIS R 5213-Portland Fly-ash Cement

JIS Z 8401-Rules for Rounding off of Numerical Values

JIS Z 8801-Test Sieves

Reference Standards:

JIS B 7413-Etched-Stem Mercury-in-Glass Thermometers (Partial Immersion Type)

JIS K 0050-General Rules for Chemical Analysis

JIS K 0115-General Rules for Absorptiometric Analysis

JIS K 0121-General Rules for Atomic Absorption Spectrochemical Analysis

JIS K 8001-General Rules of Testing Methods for Reagents

JIS K 8005-Standard Substances for Volumetric Analysis

JIS R 3503-Glass Apparatus for Chemical Analysis

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