

# SISTEMA CONTROL MIX EXPRESS

## EXPEDIENTE TÉCNICO

***CME-ETC-001***

***Rev. 35***



2026

## **SISTEMA CONTROL MIX EXPRESS**

### **EXPEDIENTE TÉCNICO**

#### **1. DESCRIPCIÓN GENERAL**

- A.** El Sistema Control Mix Express (CME) está constituido por un círculo de calidad de 6 etapas para garantizar: 1) el muestreo, 2) moldeo, 3) transporte a laboratorio, 4) curado, 5) ensayo en compresión y 6) remisión de resultados de ensayos en cumplimiento de las normas estándar aplicables. El Sistema CME cuenta con certificación ISO 9001:2015.
- B.** Las normas estándar en su última versión bajo las cuales se ha configurado el Sistema Control Mix Express son:
- ASTM C31/C31M-25a "Standard Practice for Making and Curing Concrete Test Specimens in the Field".
  - ASTM C39/C39M-24 "Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens".
  - ASTM C172/C172M-17 "Standard Practice for Sampling Freshly Mixed Concrete".
  - ASTM C470/C470M-23 "Standard Specification for Molds for Forming Concrete Test Cylinders Vertically".
  - ASTM C511-21 "Standard Specification for Mixing Rooms, Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cements and Concretes".
  - ASTM C1231/1231M-23 "Standard Practice for Use of Unbonded Caps in Determination of Compressive Strength of Hardened Concrete Cylinders"
  - ASTM C1077-25 "Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation"
- C.** Las normas peruanas NTP están basadas en las normas ASTM detalladas, sin embargo, se ha decidido emplear la fuente original dado que corresponden a las versiones revisadas y actualizadas regularmente, y nuestra Norma E 060-2009 define su empleo en vez de las Normas NTP para el caso particular del muestreo y ensayo de concreto. (Acápites 5.6.3.1 y 5.6.3.2)

#### **2. DETALLE TÉCNICOS DEL SISTEMA CONTROL MIX EXPRESS**

##### **21 ETAPA 1: MUESTREO DEL CONCRETO FRESCO EN OBRA**

- A.** El muestreo del concreto en obra en conformidad con el Sistema Control Mix Express es ejecutado por personal designado por el cliente, quien recibirá la capacitación, evaluación y certificación a cargo de técnicos especialistas de Control Mix Express (CME).

En el Anexo I se adjuntan los documentos que habilitan al suscrito, Ing. Enrique Pasquel, como instructor para la capacitación en las Normas ASTM incluidas en el Código ACI-318 y los Técnicos Richard Lino y Fortunato Villanueva, como los responsables de las capacitaciones prácticas del personal de obra.

- B. La capacitación a distancia, que imparte CME está basada en los requisitos de la norma ASTM C1077-25, así como la norma peruana de edificaciones NTE E060 Concreto Armado. CME toma como referencia el Programa de Certificación para Técnicos de Control de Concreto Grado I del American Concrete Institute - ACI, en los aspectos de muestreo, moldeo de testigos en campo, determinación del asentamiento (slump) y medición de temperatura del concreto fresco, conforme a las Normas ASTM aplicables. El diploma emitido por CME, tiene una vigencia de 5 años.
- C. Al personal que aprueba la evaluación teórica y práctica que considera el Programa de capacitación a distancia, se le asigna un código de certificación, siendo el único personal reconocido por el Sistema CME como certificado y habilitado para el muestreo y moldeo de los testigos en obra.
- D. El cliente dispone de un periodo de 1 semana para el cumplimiento de la evaluación del personal de muestreo, debiendo aprobar la capacitación a distancia en el plazo indicado, bajo la supervisión del personal de CME. Cumplido el plazo no se aceptará ningún testigo que no haya sido muestreado y moldeado por el personal certificado, en cumplimiento de la Norma ASTM C31. En el Anexo I se adjunta un ejemplo del diploma.

## **22 ETAPA2: MOLDEO DE TESTIGOS DE CONCRETO**

- A. En obra, luego de ser efectuado el muestreo del concreto fresco en conformidad con ASTM C172, por parte del personal certificado del cliente, este mismo personal procede al moldeo de los testigos cilíndricos y registra inmediatamente los datos del concreto muestreado en la plataforma digital CME.
- B. El Sistema CME considera el suministro y empleo de módulos para testigos constituidos por una caja de madera con numeración única, de diseño original de CME, para la protección y traslado de testigos, 6 moldes cilíndricos plásticos de 4" de diámetro x 8" de altura, varilla compactadora, martillo de goma y regla enrasadora previstos por la norma ASTM C31.
- C. Los moldes plásticos han sido fabricados por CME con matriz propia, cumpliendo los requisitos y tolerancias de la Norma ASTM C470, y constan adicionalmente de una tapa también de plástico de ajuste hermético, para garantizar el mantenimiento de la humedad del testigo luego de moldeado y enrasado.
- D. Efectuado el moldeo de los testigos en condición estándar controlada, el personal certificado coloca cuidadosamente los moldes con tapa dentro de la caja de madera con numeración única, que tiene la doble función de proteger los testigos de golpes o maltratos durante las 48 horas previas a su traslado al laboratorio y proveer aislamiento térmico para asegurar que los testigos se mantengan dentro del rango de temperatura de 16°C a 27°C, o curado inicial a ser garantizado en el periodo indicado, en cumplimiento de ASTM C31 para que no se afecte la resistencia a 28 días.
- E. El personal responsable del moldeo de los testigos tiene a su cargo la generación de la orden de servicio digital en la plataforma CME con todos los detalles relativos al N° de la caja o módulo de testigos, tipo de concreto, procedencia, fechas de ensayo, etc. que deberán figurar en el informe de ensayo correspondiente y que adjuntará a cada módulo de testigos, incluyéndose en el Anexo II el formato correspondiente

### **23 ETAPA3: TRANSPORTE DE MÓDULOS CON TESTIGOS AL LABORATORIO**

- A. El transporte al laboratorio es efectuado por personal técnico de CME en unidades móviles con anaqueles especialmente acondicionados para el traslado de los módulos de madera con los testigos, a fin de garantizar que no sufran golpes ni daños.
- B. En conformidad con ASTM C31, el transporte se efectúa no antes de 8 horas de producido el fraguado final del concreto, ni después de 48 horas de haberse moldeado los testigos, no debiendo durar el traslado más de 4 horas.

### **24 ETAPA4: CURADO EN CONDICIONES CONTROLADAS**

- A. Los testigos son trasladados al Laboratorio de CME en Lurín, donde se ingresa y registra cada módulo con su orden de servicio correspondiente en la base de datos del software original patentado que forma parte del Sistema CME.
- B. El software registra también la ubicación matricial única que tendrán los testigos en los anaqueles de las cámaras de curado, emitiendo etiquetas con códigos de barras para su identificación.
- C. Los testigos se desmoldan y de inmediato se le colocan sus etiquetas de identificación, ubicándose en grupos de 3 en cajas plásticas de diseño especial con numeración única, para su almacenaje ordenado en los anaqueles de los cuartos de curado.
- D. Se cuenta con cajas numeradas de color rojo donde se depositan los testigos a ensayarse a edad temprana (normalmente a 7 días o la edad que requiera el cliente) y también con cajas de color azul para almacenar los testigos a probarse a 28 días o mayor edad si lo requiere el cliente, de tal forma de eliminar cualquier posibilidad de confusión en almacenaje e identificación de los testigos.
- E. En un periodo máximo de 30 minutos luego de ser desmoldados, etiquetados y colocados en sus cajas plásticas, los testigos se trasladan a su ubicación programada en las cámaras de curado.
- F. Las cámaras de curado cumplen con los requisitos de la Norma ASTM C511 y cuentan con un sistema de recirculación y control de temperatura para garantizar el mantenimiento de la humedad superficial permanente y la temperatura en el rango de 21°C a 25°C previsto en ASTM C31.

### **25 ETAPA5: ENSAYO EN COMPRESIÓN DE LOS TESTIGOS**

- A. El software del Sistema CME emite diariamente un reporte de los testigos programados para ser ensayados en la fecha, con su ubicación matricial en las cámaras de curado, a fin de que sean trasladados al laboratorio de ensayos.
- B. Los testigos se trasladan en sus cajas de curado al laboratorio de ensayos para mantener su condición de humedad hasta el momento de ser probados.

- C. El ensayo se realiza empleando prensas británicas Marca JV Tech, N.º de serie 0501503, serie 14/001438, serie 481313, serie 16/001476 y la serie 0431138 digitales, totalmente automatizadas, controladas por el software del Sistema CME y con certificados de calibración vigentes emitidos por el Instituto Nacional de Calidad INACAL (Perú), así mismo, se hace uso del pie de rey de marca LITZ N° de Código: ESM-003 y con certificado de calibración emitido por METRINDUST para medición de diámetros; se adjunta una copia de los documentos mencionados en el Anexo III del Expediente técnico.
- D. Como elemento de distribución de carga en el ensayo de compresión se emplean cabezales de acero y pads de neopreno en conformidad con la Norma ASTM C1231.
- E. Luego de colocado el testigo en su posición de ensayo en la prensa, se procede a escanear el código de barras para su reconocimiento por el software, y la comprobación de que procede el ensayo programado, con lo que el técnico autoriza a través de la computadora el inicio de la prueba que se efectúa automáticamente sin intervención de ningún personal, con la velocidad de carga programada previamente dentro del rango de 0.20 MPa/s a 0.30 MPa/s establecido en ASTM C39.
- F. Conseguida la rotura del testigo y registrada la carga máxima el técnico registra el tipo de falla según Método de Ensayo Normalizado para Resistencia a la Compresión de Especímenes Cilíndricos de Concreto ASTM C39 y autoriza que el software grabe la información, con lo que se calcula el esfuerzo máximo sobre la base del diámetro del testigo ingresado previamente al sistema y el área correspondiente de la sección.

## 26 **ETAPA 6: EMISIÓN Y ENVÍO DEL INFORME DE ENSAYO**

- A. Cada vez que se completa la rotura de un grupo de 3 testigos de 4" x 8", (cuyo promedio es considerado por ACI 318 como representativo de la resistencia en compresión de la muestra), el software procede a generar y emitir en formato pdf, el informe de ensayo correspondiente acorde con el acápite 10 de ASTM C39, avalado con la firma de Ingeniero Civil Colegiado Especialista, responsable Técnico, tal como lo consideran los dispositivos legales vigentes.
- B. El informe de ensayo generado y emitido como se menciona anteriormente es almacenado en una base de datos de uso y acceso exclusivo del cliente, a quién el software le envía de inmediato un correo electrónico a las casillas que haya declarado previamente, con el aviso de la disponibilidad del informe de ensayos y un enlace para que proceda a descargarlo en formato pdf e imprimirlo a voluntad.
- C. En el Anexo IV se incluye un formato del informe de ensayo según el método de ensayo normalizado para resistencia a la compresión de especímenes cilíndricos de concreto ASTM C39.
- D. Por razones de seguridad informática y resguardo, toda la información registrada y generada por el software es almacenada simultáneamente en un servidor residente en la oficina de CME en Lurín y un segundo servidor dedicado alojado en un servicio por internet contratado en Alemania.
- E. Se adjunta como documento gráfico en el Anexo V el link de descarga del video ilustrativo de los procesos del Sistema CME, y en el website <https://www.controlmixexpress.com> se puede acceder a un demo de los servicios mencionados.

**3. SISTEMA DE GESTIÓN ISO 9001:2015**

- A. El Sistema CME cuenta con certificación vigente ISO 9001:2015 N° PE14/175309, "Sistema Control Mix Express para el Control de Calidad del Concreto de obras en Lima", emitida por SGS United Kingdom Ltd Systems & Services Certification con fecha 04/02/14, que abarca los rubros previamente detallados. (Ver Anexo IX)

**4. ACREDITACIÓN INACAL - NTP-ISO/IEC 17025:2017 Requisitos Generales para la Competencia de los Laboratorios de Ensayo y Calibración**

- A. Control Mix Express, cuenta con acreditación emitida por la Dirección de Acreditación del Instituto de la Calidad INACAL, Registro N° LE-168, en marco de la Ley N° 30224.
- B. El alcance de la acreditación en el "ENSAYO DE RESISTENCIA A COMPRESIÓN DE TESTIGOS CILÍNDRICOS DE CONCRETO, según norma ASTM C39/C39M-24 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimen. (Ver Anexo X)

**5. SERVICIOS COMPLEMENTARIOS DE CONTROL MIX EXPRESS S.A.C.**

- A. CME pone a disposición gratuita para uso exclusivo de sus clientes el Módulo Informático Control Data que evalúa según ACI-318 la estadística generada.
- B. Como servicios complementarios Control Mix Express SAC realiza extracción, recorte y ensayos de núcleos de concreto con brocas diamantinas de 2", 3" y 4" de diámetro en conformidad con la norma ASTM C42 y servicio de Ensayo de vigas a Flexión en conformidad con la Norma ASTM C78.
- C. Se cuenta con 2 perforadoras diamantinas marca Hilti Modelo DD-150 U y una sierra circular con disco diamantado de 20" para acondicionar los testigos dentro de los parámetros de geometría, planitud y verticalidad establecidos por ASTM C42 y ASTM C39.
- D. También provee de servicio de monitoreo de ubicación de acero de refuerzo con equipo Proceq Profometer PM-600.
- E. Se proporciona adicionalmente el servicio de determinación de Número de Rebote Comparativo en estructuras de concreto (esclerometría) con equipo Forney acorde con la norma ASTM C805.

**6. RESPONSABLES TÉCNICOS**

- A. El responsable técnico del Sistema Control Mix Express y Gerente General es el Ing. Enrique Pasquel Carbajal con Registro del Colegio de Ingenieros del Perú N° 19480.
- B. En el Anexo VI se adjunta el Resumen de Hoja de vida del responsable Técnico que avala la experiencia mínima de 5 años en el ensayo de materiales de construcción requerida por ASTM C1077 para dirigir empresas de control de calidad de concreto.

- C. En el Anexo VII se incluyen copias de las normas ASTM mencionadas previamente.
- D. En el Anexo VIII se puede apreciar un detalle de los clientes atendidos por nuestra empresa.

Lima, 13 de Febrero del 2026



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**Enrique Pasquel Carbajal**  
Ingeniero Civil  
Registro CIP 19480

**Responsable Técnico Gerente General**  
**Control Mix Express S.A.C.**

**ANEXO I**  
**Documento Instructor ASTM**  
**Documento de Técnicos de Capacitación CME de**  
**Campo**  
**y**  
**Ejemplo de Diploma de Capacitación**

## Technical & Professional Training



**Enrique Néstor Pasquel Carbajal**

Instructor certificado del curso

**Significado y Trascendencia de las Normas ASTM para Cemento  
y Concreto en el código ACI-318**

*Scott W. Munday*  
Director, Education Services

*James A. Gomez*  
President



## **CERTIFICADO DE REVALIDACIÓN DE TÉCNICO ACI GRADO I PARA ENSAYOS DE CONCRETO EN OBRA**

OTORGADO A:

**RICHARD LINO NUÑEZ**

POR HABER APROBADO SATISFACTORIAMENTE LA EVALUACIÓN DE RE-VALIDACIÓN DE HABILIDAD EN CONOCIMIENTOS TEÓRICOS Y PRÁCTICOS EN CONCORDANCIA CON LOS LINEAMIENTOS DEL “PROGRAMA DE CERTIFICACIÓN PARA TÉCNICOS GRADO I PARA ENSAYOS DE CONCRETO EN OBRA DEL AMERICAN CONCRETE INSTITUTE” CERTIFICADA INICIALMENTE CON ID 01164309 EXPEDIDA POR ACI EL 03/04/2009 Y VIGENCIA DE 5 AÑOS.

SE EXTIENDE EL PRESENTE CERTIFICADO CON EL TERCER PERIODO DE VALIDEZ DEL 03/04/2024 AL 03/04/2029.



Enrique Pasquel Carbajal  
Ingeniero Civil  
Registro CIP 19480

**ING. ENRIQUE PASQUEL CARBAJAL**

**REGISTRO CIP: 19480**

**INSTRUCTOR CERTIFICADO ASTM PARA LATINOAMERICA**

**FELLOW AMERICAN CONCRETE INSTITUTE**

**HONORARY MEMBER AMERICAN CONCRETE INSTITUTE**

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**CERTIFICADO DE CAPACITACIÓN COMO TÉCNICO EN  
MUESTREO Y ELABORACIÓN DE PROBETAS EN OBRA**

OTORGADO A:

FORTUNATO VILLANUEVA HOYLE

POR HABER APROBADO SATISFACTORIAMENTE LA CAPACITACIÓN Y EVALUACIÓN DE CONOCIMIENTOS TEÓRICOS Y PRÁCTICOS PARA EL MUESTREO Y ELABORACIÓN DE PROBETAS EN OBRA EN CONFORMIDAD CON LAS NORMAS ASTM C 39 Y ASTM C 172, CON UNA DURACIÓN DE 24 HORAS DESARROLLADA EL 03/04/2019, CON EL TERCER PERIODO DE VALIDEZ DEL 03/04/2024 AL 03/04/2029.

  
Enrique Pasquel Carbajal  
Ingeniero Civil  
Registro CIP 19480

ING. ENRIQUE PASQUEL CARBAJAL REGISTRO

CIP: 19480

INSTRUCTOR CERTIFICADO ASTM PARA LATINOAMERICA

FELLOW AMERICAN CONCRETE INSTITUTE

HONORARY MEMBER AMERICAN CONCRETE INSTITUTE

## DIPLOMA DE CAPACITACIÓN

Control Mix Express S.A.C. otorga a:

**Carlos Enrique Huaman Pareja**

Identificado con DNI 48977165, por haber aprobado el "Programa de Capacitación Teórico-Práctico para Muestreo y Moldeo de Testigos de Concreto en Obra", en conformidad con las normas ASTM C 172 y ASTM C 31, por lo que está acreditado para la ejecución de estas labores dentro del Sistema Control Mix con el **Código N° CME-1194** con fecha de vigencia al 20/08/2026



Instructor: Ing. CIP Enrique Pasquel Carbajal

20/08/2021

Fecha

## ANEXO II

### Formato de Orden de Servicio

# ORDEN DESERVICIO DIGITAL



CLIENTE

CONSTRUCTORA SAINT CRUZ

Nº módulo

666

Obra

Edificio Picaflor

Sector (opcional)

No tienes sectores asignados

Nº guía camión

888-001638.

Resistencia

280

Estructura

Placa PLB1-13 y 14 Piso 07

Código probetero

CME - 088

Fecha de moldeo

15/05/20



Hora de moldeo

10:30

(formato 24 horas)

Tamaño probetas

4" x 8"

Edad grupo 1

7

Edad grupo 2 (opcional)

28

Observaciones (opcional)

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Servicio prioritario

Si deseas servicio prioritario, comunícate con el área comercial

Ingresar orden

## ANEXO III

- Certificados de Calibración de Prensas
- Certificado de Calibración del Vernier



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de Calidad  
Metrología

# Certificado de Calibración

## LFP - 067 - 2026

Laboratorio de Fuerza, Torque y Presión

Página 1 de 4

Expediente	<b>1057828</b>
Solicitante	<b>CONTROL MIX EXPRESS S.A.C.</b>
Dirección	<b>Habilitación Industrial El Lúcumo, Calle 4, Lurín 15823</b>
Instrumento de Medición	<b>MAQUINA DE ENSAYO UNIAXIAL</b>
Intervalo de Indicaciones	<b>0 kN a 400 kN / 2000 kN</b>
Resolución	<b>0,1 kN / 1 kN</b>
Marca	<b>VJ TECH</b>
Modelo	<b>VJT6000-2A</b>
Número de Serie	<b>0501503</b>
Procedencia	<b>NO INDICA</b>
Clase de Exactitud	<b>NO INDICA</b>
Fecha de Calibración	<b>2026-02-04</b>

Este certificado de calibración documenta la trazabilidad a los patrones nacionales, que realizan las unidades de medida de acuerdo con el Sistema Internacional de Unidades (SI)

La Dirección de Metrología custodia, conserva y mantiene los patrones nacionales de las unidades de medida, calibra patrones secundarios, realiza mediciones y certificaciones metrológicas a solicitud de los interesados, promueve el desarrollo de la metrología en el país y contribuye a la difusión del Sistema Legal de Unidades de Medida del Perú. (SLUMP).

La Dirección de Metrología es miembro del Sistema Interamericano de Metrología (SIM) y participa activamente en las Intercomparaciones que éste realiza en la región.

Con el fin de asegurar la calidad de sus mediciones el usuario está obligado a recalibrar sus instrumentos a intervalos apropiados.

Este certificado de calibración sólo puede ser difundido completamente y sin modificaciones. Los extractos o modificaciones requieren la autorización de la Dirección de Metrología del INACAL.  
Certificados sin firma digital y sello carecen de validez.



Responsable del área

Responsable del laboratorio



Firmado digitalmente por:  
QUISPE CUSIPUMA Billy Berino FAU  
20600283015 soft  
Motivo: Firma de documento - INACAL  
Fecha: 11/02/2026 12:30:51-0500



Firmado digitalmente por:  
SANCHEZ AVILES Ricardo Alfonso FAU  
20600283015 soft  
Motivo: Firma de documento - INACAL  
Fecha: 11/02/2026 11:15:41-0500

Dirección de Metrología

Dirección de Metrología



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de Calidad

Metrología

**Laboratorio de Fuerza, Torque y Presión**

# Certificado de Calibración

## LFP – 067 – 2026

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### Método de Calibración

Método de comparación tomando como referencia la Norma ISO 7500-1 "Metallic materials-Verification of static uniaxial testing machines"

### Lugar de Calibración

LABORATORIO DE ENSAYO  
Habilitación Industrial El Lúcumo, Calle 4, Lurín 15823

### Condiciones Ambientales

	Inicial	Final
Temperatura	28,1°C	28,8°C

### Patrones de referencia

Trazabilidad metrológica	Patrón de medición	Documento de calibración
Patrón de referencia del Centro Nacional de Metrología de México (CENAM)	Transductor de Fuerza LFP 02 017_1 Clase 0,5	CNM-CC-720-402/2025 DE :2025-12-03
Patrón de referencia del Centro Nacional de Metrología de México (CENAM)	Transductor de Fuerza LFP 02 017 Clase 0,5	CNM-CC-720-369/2025 DE: 2025-11-05

### Observaciones

Con fines de identificación se ha colocado una etiqueta autoadhesiva de color verde INACAL-DM.  
La máquina de ensayo fue calibrada hasta el alcance de 1 000 kN.



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Laboratorio de Fuerza, Torque y Presión

# Certificado de Calibración

## LFP – 067 – 2026

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### Resultados de Medición

Dirección de Carga :		Compresión						
Indicación de Fuerza de la Máquina de Ensayo		Indicación en el transductor de fuerza patrón					Promedio	Error de medición
(%)	(kN)	1ª Serie Ascenso	2ª Serie Ascenso	3ª Serie Ascenso	3ª Serie Descenso	4ª Serie - Accesorios Ascenso		
5	100,0	100,2	99,3	99,1	-----	-----	99,5	0,5
10	200,0	199,5	198,9	199,7	-----	-----	199,4	0,6
15	300,0	297,6	297,6	298,5	-----	-----	297,9	2,1
20	400,0	396,6	396,2	397,3	-----	-----	396,7	3,3
25	500	496	496	497	-----	-----	496	4
30	600	596	596	597	-----	-----	596	4
35	700	696	697	697	-----	-----	696	4
40	800	796	797	796	-----	-----	796	4
45	900	897	897	898	-----	-----	897	3
50	1 000	997	997	997	-----	-----	997	3

### Errores Encontrados del Sistema de Medición de Fuerza

Valor Nominal		Errores de medición relativos encontrados en %					Incertidumbre del error de medición U (%) k=2
(%)	(kN)	Indicación q	Repetibilidad b	Reversibilidad v	Resolución Relativa a	Error con Accesorios	
5	100,0	0,47	1,13	-----	0,50	-----	0,81
10	200,0	0,33	0,39	-----	0,25	-----	0,35
15	300,0	0,71	0,30	-----	0,17	-----	0,28
20	400,0	0,83	0,26	-----	0,13	-----	0,23
25	500	0,80	0,22	-----	0,20	-----	0,24
30	600	0,66	0,15	-----	0,17	-----	0,21
35	700	0,51	0,20	-----	0,14	-----	0,21
40	800	0,46	0,09	-----	0,13	-----	0,17
45	900	0,32	0,13	-----	0,11	-----	0,17
50	1 000	0,29	0,05	-----	0,10	-----	0,15
Error relativo de cero $f_0$		0,09					

Clase de la escala de la máquina	Valor máximo permitido % Según la Norma ISO 7500 - 1				
	Indicación q	Repetibilidad b	Reversibilidad v	Resolución Relativa a	Cero $f_0$
0,5	± 0,5	0,5	± 0,75	0,25	± 0,05
1	± 1,0	1,0	± 1,5	0,5	± 0,1
2	± 2,0	2,0	± 3,0	1,0	± 0,2
3	± 3,0	3,0	± 4,5	1,5	± 0,3

kN = kilonewton

La estimación de la incertidumbre fue realizada según el anexo C de la ISO 7500-1.



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Metrología

**Laboratorio de Fuerza, Torque y Presión**

# Certificado de Calibración

## LFP – 067 – 2026

Página 4 de 4

### **Incertidumbre**

La incertidumbre reportada en el presente certificado es la incertidumbre expandida de medición que resulta de multiplicar la incertidumbre estándar combinada por el factor de cobertura  $k=2$ . La incertidumbre fue determinada según la "Guía para la Expresión de la Incertidumbre en la Medición", segunda edición, julio del 2001 (Traducción al castellano efectuada por Indecopi, con autorización de ISO, de la GUM, "Guide to the Expression of Uncertainty in Measurement", corrected and reprinted in 1995, equivalente a la publicación del BIPM JCGM:100 2008, GUM 1995 with minor corrections "Evaluation of Measurement Data - Guide to the Expression of Uncertainty in Measurement").

La incertidumbre expandida de medición fue calculada a partir de los componentes de incertidumbre de los factores de influencia en la calibración. La incertidumbre indicada no incluye una estimación de variaciones a largo plazo.

### **Recalibración**

Los resultados son válidos en el momento de la calibración. Al solicitante le corresponde disponer en su momento la ejecución de una recalibración, la cual está en función del uso, conservación y mantenimiento del instrumento de medición o a reglamentaciones vigentes.

### **Fecha de Emisión del Documento**

Se considera como fecha de emisión del documento la fecha que figura en la firma digital del responsable de área.

### **Dirección de Metrología**

El Servicio Nacional de Metrología (actualmente la Dirección de Metrología del INACAL), fue creado mediante Ley N° 23560 el 6 enero de 1983 y fue encomendado al INDECOPI mediante Decreto Supremo DS-024-93 ITINCI.

El 11 de julio 2014 fue aprobada la Ley N° 30224 la cual crea el Sistema Nacional de Calidad, y tiene como objetivo promover y garantizar el cumplimiento de la Política Nacional de Calidad para el desarrollo y la competitividad de las actividades económicas y la protección del consumidor.

El Instituto Nacional de Calidad (INACAL) es un organismo público técnico especializado adscrito al Ministerio de Producción, es el cuerpo rector y autoridad técnica máxima en la normativa del Sistema Nacional de la Calidad y el responsable de la operación del sistema bajo las disposiciones de la ley, y tiene en el ámbito de sus competencias: Metrología, Normalización y Acreditación.

La Dirección de Metrología del INACAL cuenta con diversos Laboratorios Metrológicos debidamente acondicionados, instrumentos de medición de alta exactitud y personal calificado. Cuenta con un Sistema de Gestión de la Calidad que cumple con las siguientes Normas internacionales vigentes ISO/IEC 17025; ISO 17034; ISO/IEC 17043; ISO 27001 e ISO 37001; con lo cual se constituye en una entidad capaz de brindar un servicio integral, confiable y eficaz de aseguramiento metrológico para la industria, la ciencia y el comercio brindando trazabilidad metrológicamente válida al Sistema Internacional de Unidades SI y al Sistema Legal de Unidades de Medida del Perú (SLUMP).

La Dirección de Metrología del INACAL cuenta con la cooperación técnica de organismos metrológicos internacionales de alto prestigio tales como: el Physikalisch-Technische Bundesanstalt (PTB) de Alemania; el Centro Nacional de Metrología (CENAM) de México; el National Institute of Standards and Technology (NIST) de USA; el Centro Español de Metrología (CEM) de España; el Instituto Nacional de Tecnología Industrial (INTI) de Argentina; el Instituto Nacional de Metrología (INMETRO) de Brasil; entre otros.

### **Sistema Interamericano de Metrología - SIM**

El Sistema Interamericano de Metrología (SIM) es una organización regional auspiciado por la Organización de Estados Americanos (OEA), cuya finalidad es promover y fomentar el desarrollo de la metrología en los países americanos. La Dirección de Metrología del INACAL es miembro del SIM a través de la subregión ANDIMET (Bolivia, Colombia, Ecuador, Perú y Venezuela) y participa activamente en las Intercomparaciones realizadas por el SIM.

----- FIN DEL DOCUMENTO -----



**INACAL**  
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Metrología

# Certificado de Calibración

## LFP - 064 - 2026

Laboratorio de Fuerza, Torque y Presión

Página 1 de 4

Expediente	<b>1057826</b>
Solicitante	<b>CONTROL MIX EXPRESS S.A.C.</b>
Dirección	<b>Habilitación Industrial El Lúcumo, Calle 4, Lurín 15823</b>
Instrumento de Medición	<b>MAQUINA DE ENSAYO UNIAXIAL</b>
Intervalo de Indicaciones	<b>0 kN a 400 kN / 2000 kN</b>
Resolución	<b>0,1 kN / 1 kN</b>
Marca	<b>VJ TECH</b>
Modelo	<b>NO INDICA</b>
Número de Serie	<b>431138</b>
Procedencia	<b>NO INDICA</b>
Clase de Exactitud	<b>NO INDICA</b>
Fecha de Calibración	<b>2026-01-30</b>

Este certificado de calibración documenta la trazabilidad a los patrones nacionales, que realizan las unidades de medida de acuerdo con el Sistema Internacional de Unidades (SI)

La Dirección de Metrología custodia, conserva y mantiene los patrones nacionales de las unidades de medida, calibra patrones secundarios, realiza mediciones y certificaciones metrológicas a solicitud de los interesados, promueve el desarrollo de la metrología en el país y contribuye a la difusión del Sistema Legal de Unidades de Medida del Perú. (SLUMP).

La Dirección de Metrología es miembro del Sistema Interamericano de Metrología (SIM) y participa activamente en las Intercomparaciones que éste realiza en la región.

Con el fin de asegurar la calidad de sus mediciones el usuario está obligado a recalibrar sus instrumentos a intervalos apropiados.

Este certificado de calibración sólo puede ser difundido completamente y sin modificaciones. Los extractos o modificaciones requieren la autorización de la Dirección de Metrología del INACAL. Certificados sin firma digital y sello carecen de validez.



Responsable del área

Responsable del laboratorio



Firmado digitalmente por:  
QUISPE CUSIPUMA Billy Berino FAU  
20600283015 soft  
Motivo: Firma de documento - INACAL  
Fecha: 11/02/2026 12:30:40-0500



Firmado digitalmente por:  
SANCHEZ AVILES Ricardo Alfonso FAU  
20600283015 soft  
Motivo: Firma de documento - INACAL  
Fecha: 11/02/2026 11:15:41-0500

Dirección de Metrología

Dirección de Metrología



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Metrología

**Laboratorio de Fuerza, Torque y Presión**

# Certificado de Calibración

## LFP – 064 – 2026

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### Método de Calibración

Método de comparación tomando como referencia la Norma ISO 7500-1 "Metallic materials-Verification of static uniaxial testing machines"

### Lugar de Calibración

LABORATORIO DE ENSAYO  
Habilitación Industrial El Lúcumo, Calle 4, Lurín 15823

### Condiciones Ambientales

	Inicial	Final
Temperatura	26,4°C	27,1°C

### Patrones de referencia

Trazabilidad metrológica	Patrón de medición	Documento de calibración
Patrón de referencia del Centro Nacional de Metrología de México (CENAM)	Transductor de Fuerza LFP 02 017_1 Clase 0,5	CNM-CC-720-402/2025 DE :2025-12-03
Patrón de referencia del Centro Nacional de Metrología de México (CENAM)	Transductor de Fuerza LFP 02 017 Clase 0,5	CNM-CC-720-369/2025 DE: 2025-11-05

### Observaciones

Con fines de identificación se ha colocado una etiqueta autoadhesiva de color verde INACAL-DM.  
La máquina de ensayo fue calibrada hasta el alcance de 1 000 kN.



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# Certificado de Calibración

## LFP – 064 – 2026

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### Resultados de Medición

Dirección de Carga :		Compresión						
Indicación de Fuerza de la Máquina de Ensayo		Indicación en el transductor de fuerza patrón					Promedio	Error de medición
		1ª Serie Ascenso	2ª Serie Ascenso	3ª Serie Ascenso Descenso		4ª Serie - Accesorios Ascenso		
(%)	(kN)	(kN)	(kN)	(kN)	(kN)	(kN)	(kN)	(kN)
5	100,0	98,9	98,9	99,0	-----	-----	99,0	1,0
10	200,0	197,8	198,0	198,1	-----	-----	198,0	2,0
15	300,0	296,4	296,6	296,6	-----	-----	296,5	3,5
20	400,0	395,7	395,6	395,6	-----	-----	395,6	4,4
25	500	492	492	492	-----	-----	492	8
30	600	590	590	591	-----	-----	590	10
35	700	689	689	689	-----	-----	689	11
40	800	787	788	787	-----	-----	787	13
45	900	886	886	886	-----	-----	886	14
50	1 000	984	985	985	-----	-----	985	15

### Errores Encontrados del Sistema de Medición de Fuerza

Valor Nominal		Errores de medición relativos encontrados en %					Incertidumbre del error de medición U (%) k=2
		Indicación	Repetibilidad	Reversibilidad	Resolución Relativa	Error con Accesorios	
(%)	(kN)	q	b	v	a		
5	100,0	1,06	0,05	-----	0,50	-----	0,43
10	200,0	1,02	0,14	-----	0,25	-----	0,25
15	300,0	1,18	0,05	-----	0,17	-----	0,19
20	400,0	1,11	0,03	-----	0,13	-----	0,15
25	500	1,68	0,11	-----	0,20	-----	0,20
30	600	1,66	0,10	-----	0,17	-----	0,17
35	700	1,58	0,05	-----	0,14	-----	0,15
40	800	1,61	0,11	-----	0,13	-----	0,15
45	900	1,57	0,07	-----	0,11	-----	0,15
50	1 000	1,55	0,08	-----	0,10	-----	0,15
Error relativo de cero $f_0$		0,03					

Clase de la escala de la máquina	Valor máximo permitido % Según la Norma ISO 7500 - 1				
	Indicación	Repetibilidad	Reversibilidad	Resolución Relativa	Cero $f_0$
	q	b	v	a	
0,5	± 0,5	0,5	± 0,75	0,25	± 0,05
1	± 1,0	1,0	± 1,5	0,5	± 0,1
2	± 2,0	2,0	± 3,0	1,0	± 0,2
3	± 3,0	3,0	± 4,5	1,5	± 0,3

kN = kilonewton

La estimación de la incertidumbre fue realizada según el anexo C de la ISO 7500-1.



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# Certificado de Calibración

## LFP – 064 – 2026

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### **Incertidumbre**

La incertidumbre reportada en el presente certificado es la incertidumbre expandida de medición que resulta de multiplicar la incertidumbre estándar combinada por el factor de cobertura  $k=2$ . La incertidumbre fue determinada según la "Guía para la Expresión de la Incertidumbre en la Medición", segunda edición, julio del 2001 (Traducción al castellano efectuada por Indecopi, con autorización de ISO, de la GUM, "Guide to the Expression of Uncertainty in Measurement", corrected and reprinted in 1995, equivalente a la publicación del BIPM JCGM:100 2008, GUM 1995 with minor corrections "Evaluation of Measurement Data - Guide to the Expression of Uncertainty in Measurement").

La incertidumbre expandida de medición fue calculada a partir de los componentes de incertidumbre de los factores de influencia en la calibración. La incertidumbre indicada no incluye una estimación de variaciones a largo plazo.

### **Recalibración**

Los resultados son válidos en el momento de la calibración. Al solicitante le corresponde disponer en su momento la ejecución de una recalibración, la cual está en función del uso, conservación y mantenimiento del instrumento de medición o a reglamentaciones vigentes.

### **Fecha de Emisión del Documento**

Se considera como fecha de emisión del documento la fecha que figura en la firma digital del responsable de área.

### **Dirección de Metrología**

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El Instituto Nacional de Calidad (INACAL) es un organismo público técnico especializado adscrito al Ministerio de Producción, es el cuerpo rector y autoridad técnica máxima en la normativa del Sistema Nacional de la Calidad y el responsable de la operación del sistema bajo las disposiciones de la ley, y tiene en el ámbito de sus competencias: Metrología, Normalización y Acreditación.

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La Dirección de Metrología del INACAL cuenta con la cooperación técnica de organismos metrológicos internacionales de alto prestigio tales como: el Physikalisch-Technische Bundesanstalt (PTB) de Alemania; el Centro Nacional de Metrología (CENAM) de México; el National Institute of Standards and Technology (NIST) de USA; el Centro Español de Metrología (CEM) de España; el Instituto Nacional de Tecnología Industrial (INTI) de Argentina; el Instituto Nacional de Metrología (INMETRO) de Brasil; entre otros.

### **Sistema Interamericano de Metrología - SIM**

El Sistema Interamericano de Metrología (SIM) es una organización regional auspiciado por la Organización de Estados Americanos (OEA), cuya finalidad es promover y fomentar el desarrollo de la metrología en los países americanos. La Dirección de Metrología del INACAL es miembro del SIM a través de la subregión ANDIMET (Bolivia, Colombia, Ecuador, Perú y Venezuela) y participa activamente en las Intercomparaciones realizadas por el SIM.

----- FIN DEL DOCUMENTO -----



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Metrología

# Certificado de Calibración

## LFP - 065 - 2026

Laboratorio de Fuerza, Torque y Presión

Página 1 de 4

Expediente	<b>1057824</b>
Solicitante	<b>CONTROL MIX EXPRESS S.A.C.</b>
Dirección	<b>Habilitación Industrial El Lúcumo, Calle 4, Lurín 15823</b>
Instrumento de Medición	<b>MAQUINA DE ENSAYO UNIAXIAL</b>
Intervalo de Indicaciones	<b>0 kN a 400 kN / 2000 kN</b>
Resolución	<b>0,1 kN / 1 kN</b>
Marca	<b>VJ TECH</b>
Modelo	<b>VJT 51-2011</b>
Número de Serie	<b>14/001438</b>
Procedencia	<b>NO INDICA</b>
Clase de Exactitud	<b>NO INDICA</b>
Fecha de Calibración	<b>2026-01-30</b>

Este certificado de calibración documenta la trazabilidad a los patrones nacionales, que realizan las unidades de medida de acuerdo con el Sistema Internacional de Unidades (SI)

La Dirección de Metrología custodia, conserva y mantiene los patrones nacionales de las unidades de medida, calibra patrones secundarios, realiza mediciones y certificaciones metrológicas a solicitud de los interesados, promueve el desarrollo de la metrología en el país y contribuye a la difusión del Sistema Legal de Unidades de Medida del Perú. (SLUMP).

La Dirección de Metrología es miembro del Sistema Interamericano de Metrología (SIM) y participa activamente en las Intercomparaciones que éste realiza en la región.

Con el fin de asegurar la calidad de sus mediciones el usuario está obligado a recalibrar sus instrumentos a intervalos apropiados.

Este certificado de calibración sólo puede ser difundido completamente y sin modificaciones. Los extractos o modificaciones requieren la autorización de la Dirección de Metrología del INACAL.  
Certificados sin firma digital y sello carecen de validez.

Responsable del área

Responsable del laboratorio



Firmado digitalmente por:  
QUISPE CUSIPUMA Billy Berino FAU  
20600283015 soft  
Motivo: Firma de documento - INACAL  
Fecha: 11/02/2026 12:30:45-0500



Firmado digitalmente por:  
SANCHEZ AVILES Ricardo Alfonso FAU  
20600283015 soft  
Motivo: Firma de documento - INACAL  
Fecha: 11/02/2026 11:15:41-0500

Dirección de Metrología

Dirección de Metrología



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Metrología

**Laboratorio de Fuerza, Torque y Presión**

# Certificado de Calibración

## LFP – 065 – 2026

Página 2 de 4

### Método de Calibración

Método de comparación tomando como referencia la Norma ISO 7500-1 "Metallic materials-Verification of static uniaxial testing machines"

### Lugar de Calibración

LABORATORIO DE ENSAYO  
Habilitación Industrial El Lúcumo, Calle 4, Lurín 15823

### Condiciones Ambientales

	Inicial	Final
Temperatura	25,0°C	27,1°C

### Patrones de referencia

Trazabilidad metrológica	Patrón de medición	Documento de calibración
Patrón de referencia del Centro Nacional de Metrología de México (CENAM)	Transductor de Fuerza LFP 02 017_1 Clase 0,5	CNM-CC-720-402/2025 DE :2025-12-03
Patrón de referencia del Centro Nacional de Metrología de México (CENAM)	Transductor de Fuerza LFP 02 017 Clase 0,5	CNM-CC-720-369/2025 DE: 2025-11-05

### Observaciones

Con fines de identificación se ha colocado una etiqueta autoadhesiva de color verde INACAL-DM.  
La máquina de ensayo fue calibrada hasta el alcance de 1 000 kN.



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Metrología

Laboratorio de Fuerza, Torque y Presión

# Certificado de Calibración

## LFP – 065 – 2026

Página 3 de 4

### Resultados de Medición

Dirección de Carga :		Compresión						
Indicación de Fuerza de la Máquina de Ensayo		Indicación en el transductor de fuerza patrón					Promedio	Error de medición
(%)	(kN)	1ª Serie Ascenso	2ª Serie Ascenso	3ª Serie Ascenso	3ª Serie Descenso	4ª Serie - Accesorios Ascenso		
5	100,0	99,3	99,3	99,0	-----	-----	99,2	0,8
10	200,0	197,8	198,6	197,5	-----	-----	198,0	2,0
15	300,0	295,7	296,8	295,5	-----	-----	296,0	4,0
20	400,0	394,2	395,7	393,7	-----	-----	394,5	5,5
25	500	494	495	493	-----	-----	494	6
30	600	593	594	592	-----	-----	593	7
35	700	691	692	690	-----	-----	691	9
40	800	790	791	788	-----	-----	789	11
45	900	889	890	886	-----	-----	888	12
50	1 000	987	989	985	-----	-----	987	13

### Errores Encontrados del Sistema de Medición de Fuerza

Valor Nominal		Errores de medición relativos encontrados en %					Incertidumbre del error de medición U (%) k=2
(%)	(kN)	Indicación q	Repetibilidad b	Reversibilidad v	Resolución Relativa a	Error con Accesorios	
5	100,0	0,82	0,33	-----	0,50	-----	0,48
10	200,0	1,02	0,55	-----	0,25	-----	0,42
15	300,0	1,36	0,42	-----	0,17	-----	0,33
20	400,0	1,39	0,50	-----	0,13	-----	0,35
25	500	1,19	0,36	-----	0,20	-----	0,30
30	600	1,23	0,42	-----	0,17	-----	0,31
35	700	1,31	0,41	-----	0,14	-----	0,30
40	800	1,33	0,42	-----	0,13	-----	0,30
45	900	1,34	0,46	-----	0,11	-----	0,32
50	1 000	1,34	0,44	-----	0,10	-----	0,30
Error relativo de cero $f_0$		0,10					

Clase de la escala de la máquina	Valor máximo permitido % Según la Norma ISO 7500 - 1				
	Indicación q	Repetibilidad b	Reversibilidad v	Resolución Relativa a	Cero $f_0$
0,5	± 0,5	0,5	± 0,75	0,25	± 0,05
1	± 1,0	1,0	± 1,5	0,5	± 0,1
2	± 2,0	2,0	± 3,0	1,0	± 0,2
3	± 3,0	3,0	± 4,5	1,5	± 0,3

kN = kilonewton

La estimación de la incertidumbre fue realizada según el anexo C de la ISO 7500-1.



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Metrología

**Laboratorio de Fuerza, Torque y Presión**

# Certificado de Calibración

## LFP – 065 – 2026

Página 4 de 4

### **Incertidumbre**

La incertidumbre reportada en el presente certificado es la incertidumbre expandida de medición que resulta de multiplicar la incertidumbre estándar combinada por el factor de cobertura  $k=2$ . La incertidumbre fue determinada según la "Guía para la Expresión de la Incertidumbre en la Medición", segunda edición, julio del 2001 (Traducción al castellano efectuada por Indecopi, con autorización de ISO, de la GUM, "Guide to the Expression of Uncertainty in Measurement", corrected and reprinted in 1995, equivalente a la publicación del BIPM JCGM:100 2008, GUM 1995 with minor corrections "Evaluation of Measurement Data - Guide to the Expression of Uncertainty in Measurement").

La incertidumbre expandida de medición fue calculada a partir de los componentes de incertidumbre de los factores de influencia en la calibración. La incertidumbre indicada no incluye una estimación de variaciones a largo plazo.

### **Recalibración**

Los resultados son válidos en el momento de la calibración. Al solicitante le corresponde disponer en su momento la ejecución de una recalibración, la cual está en función del uso, conservación y mantenimiento del instrumento de medición o a reglamentaciones vigentes.

### **Fecha de Emisión del Documento**

Se considera como fecha de emisión del documento la fecha que figura en la firma digital del responsable de área.

### **Dirección de Metrología**

El Servicio Nacional de Metrología (actualmente la Dirección de Metrología del INACAL), fue creado mediante Ley N° 23560 el 6 enero de 1983 y fue encomendado al INDECOPI mediante Decreto Supremo DS-024-93 ITINCI.

El 11 de julio 2014 fue aprobada la Ley N° 30224 la cual crea el Sistema Nacional de Calidad, y tiene como objetivo promover y garantizar el cumplimiento de la Política Nacional de Calidad para el desarrollo y la competitividad de las actividades económicas y la protección del consumidor.

El Instituto Nacional de Calidad (INACAL) es un organismo público técnico especializado adscrito al Ministerio de Producción, es el cuerpo rector y autoridad técnica máxima en la normativa del Sistema Nacional de la Calidad y el responsable de la operación del sistema bajo las disposiciones de la ley, y tiene en el ámbito de sus competencias: Metrología, Normalización y Acreditación.

La Dirección de Metrología del INACAL cuenta con diversos Laboratorios Metrológicos debidamente acondicionados, instrumentos de medición de alta exactitud y personal calificado. Cuenta con un Sistema de Gestión de la Calidad que cumple con las siguientes Normas internacionales vigentes ISO/IEC 17025; ISO 17034; ISO/IEC 17043; ISO 27001 e ISO 37001; con lo cual se constituye en una entidad capaz de brindar un servicio integral, confiable y eficaz de aseguramiento metrológico para la industria, la ciencia y el comercio brindando trazabilidad metrológicamente válida al Sistema Internacional de Unidades SI y al Sistema Legal de Unidades de Medida del Perú (SLUMP).

La Dirección de Metrología del INACAL cuenta con la cooperación técnica de organismos metrológicos internacionales de alto prestigio tales como: el Physikalisch-Technische Bundesanstalt (PTB) de Alemania; el Centro Nacional de Metrología (CENAM) de México; el National Institute of Standards and Technology (NIST) de USA; el Centro Español de Metrología (CEM) de España; el Instituto Nacional de Tecnología Industrial (INTI) de Argentina; el Instituto Nacional de Metrología (INMETRO) de Brasil; entre otros.

### **Sistema Interamericano de Metrología - SIM**

El Sistema Interamericano de Metrología (SIM) es una organización regional auspiciado por la Organización de Estados Americanos (OEA), cuya finalidad es promover y fomentar el desarrollo de la metrología en los países americanos. La Dirección de Metrología del INACAL es miembro del SIM a través de la subregión ANDIMET (Bolivia, Colombia, Ecuador, Perú y Venezuela) y participa activamente en las Intercomparaciones realizadas por el SIM.

----- FIN DEL DOCUMENTO -----



**INACAL**  
Instituto Nacional  
de Calidad  
Metrología

# Certificado de Calibración

## LFP - 313 - 2025

Laboratorio de Fuerza, Torque y Presión

Página 1 de 4

Expediente	<b>1055611</b>
Solicitante	<b>CONTROL MIX EXPRESS S.A.C.</b>
Dirección	<b>Habilitación Industrial El Lúcumo, Calle 4, Lurín 15823</b>
Instrumento de Medición	<b>MAQUINA DE ENSAYO UNIAXIAL</b>
Intervalo de Indicaciones	<b>0 kN a 2 000 kN ( * )</b>
Resolución	<b>0,1 kN (0 kN a 400 kN) / 1 kN (400 kN a 2 000 kN)</b>
Marca	<b>VJ TECH</b>
Modelo	<b>VJT 51-2011</b>
Número de Serie	<b>16/001476</b>
Procedencia	<b>NO INDICA</b>
Clase de Exactitud	<b>NO INDICA</b>
Fecha de Calibración	<b>2025-10-03</b>

Este certificado de calibración documenta la trazabilidad a los patrones nacionales, que realizan las unidades de medida de acuerdo con el Sistema Internacional de Unidades (SI)

La Dirección de Metrología custodia, conserva y mantiene los patrones nacionales de las unidades de medida, calibra patrones secundarios, realiza mediciones y certificaciones metrológicas a solicitud de los interesados, promueve el desarrollo de la metrología en el país y contribuye a la difusión del Sistema Legal de Unidades de Medida del Perú. (SLUMP).

La Dirección de Metrología es miembro del Sistema Interamericano de Metrología (SIM) y participa activamente en las Intercomparaciones que éste realiza en la región.

Con el fin de asegurar la calidad de sus mediciones el usuario está obligado a recalibrar sus instrumentos a intervalos apropiados.

Este certificado de calibración sólo puede ser difundido completamente y sin modificaciones. Los extractos o modificaciones requieren la autorización de la Dirección de Metrología del INACAL.  
Certificados sin firma digital y sello carecen de validez.

Responsable del área

Responsable del laboratorio



Firmado digitalmente por  
DE LA CRUZ GARCIA  
Leonardo FAU 20600283015  
soft  
Fecha: 2025-10-07 18:00:56



Firmado digitalmente por  
SANCHEZ AVILES Ricardo  
Alfonso FAU 20600283015 soft  
Fecha: 2025-10-07 17:14:53

Dirección de Metrología

Dirección de Metrología



**INACAL**  
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de Calidad

Metrología

**Laboratorio de Fuerza, Torque y Presión**

# Certificado de Calibración

## LFP – 313 – 2025

Página 2 de 4

### Método de Calibración

Método de comparación tomando como referencia la Norma ISO 7500-1 "Metallic materials-Verification of static uniaxial testing machines"

### Lugar de Calibración

Laboratorio de Ensayos  
Habilitación Industrial El Lúcumo, Calle 4, Lurín 15823

### Condiciones Ambientales

	Inicial	Final
Temperatura	19,8°C	20,3°C

### Patrones de referencia

Trazabilidad metrológica	Patrón de medición	Documento de calibración
Patrón de referencia del Centro Nacional de Metrología de México (CENAM)	Transductor de Fuerza LFP 02 038 Clase 0,5	CNM-CC-720-378/2023 DE :2023-11-03
Patrón de referencia del Centro Nacional de Metrología de México (CENAM)	Transductor de Fuerza LFP 02 038 Clase 0,5	CNM-CC-720-392/2023 DE: 2023-11-03

### Observaciones

Con fines de identificación se ha colocado una etiqueta autoadhesiva de color verde INACAL-DM.  
(\* ) A solicitud del usuario, se calibró el instrumento en el intervalo de indicaciones de 100 kN a 1 000 kN .



**INACAL**  
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Metrología

Laboratorio de Fuerza, Torque y Presión

# Certificado de Calibración

## LFP – 313 – 2025

Página 3 de 4

### Resultados de Medición

Dirección de Carga :		Compresión						
Indicación de Fuerza de la Máquina de Ensayo		Indicación en el transductor de fuerza patrón					Promedio	Error de medición
		1 <sup>ra</sup> Serie Ascenso	2 <sup>da</sup> Serie Ascenso	3 <sup>ra</sup> Serie Ascenso Descenso		4 <sup>ta</sup> Serie - Accesorios Ascenso		
(%)	(kN)	(kN)	(kN)	(kN)	(kN)	(kN)	(kN)	(kN)
5	100,00	98,38	98,33	98,36	-----	-----	98,36	1,64
10	200,00	198,26	195,87	198,08	-----	-----	197,40	2,60
15	300,00	297,62	296,79	296,79	-----	-----	297,07	2,93
20	400,00	398,88	396,45	396,45	-----	-----	397,26	2,74
25	500,0	499,2	497,8	497,8	-----	-----	498,2	1,8
30	600,0	599,1	597,3	597,3	-----	-----	597,9	2,1
35	700,0	697,8	696,4	696,4	-----	-----	696,9	3,1
40	800,0	797,9	795,6	795,6	-----	-----	796,4	3,6
45	900,0	896,8	896,0	896,0	-----	-----	896,3	3,7
50	1 000,0	995,6	995,2	995,2	-----	-----	995,3	4,7

### Errores Encontrados del Sistema de Medición de Fuerza

Valor Nominal		Errores de medición relativos encontrados en %					Incertidumbre del error de medición U (%) k=2
		Indicación	Repetibilidad	Reversibilidad	Resolución Relativa	Error con Accesorios	
(%)	(kN)	q	b	v	a		
5	100,00	1,67	0,05	-----	0,10	-----	0,42
10	200,00	1,32	1,23	-----	0,05	-----	0,87
15	300,00	0,99	0,28	-----	0,33	-----	0,46
20	400,00	0,69	0,61	-----	0,25	-----	0,56
25	500,00	0,35	0,28	-----	0,20	-----	0,41
30	600,00	0,35	0,30	-----	0,17	-----	0,40
35	700,00	0,45	0,20	-----	0,14	-----	0,37
40	800,00	0,45	0,28	-----	0,13	-----	0,39
45	900,00	0,42	0,10	-----	0,11	-----	0,34
50	1 000,00	0,47	0,04	-----	0,10	-----	0,33
Error relativo de cero $f_0$		0,26					

Clase de la escala de la máquina	Valor máximo permitido % Según la Norma ISO 7500 - 1				
	Indicación	Repetibilidad	Reversibilidad	Resolución Relativa	Cero $f_0$
	q	b	v	a	
0,5	± 0,5	0,5	± 0,75	0,25	± 0,05
1	± 1,0	1,0	± 1,5	0,5	± 0,1
2	± 2,0	2,0	± 3,0	1,0	± 0,2
3	± 3,0	3,0	± 4,5	1,5	± 0,3

kN = kilonewton

La estimación de la incertidumbre fue realizada según el anexo C de la ISO 7500-1.



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Metrología

**Laboratorio de Fuerza, Torque y Presión**

# Certificado de Calibración

## LFP – 313 – 2025

Página 4 de 4

### **Incertidumbre**

La incertidumbre reportada en el presente certificado es la incertidumbre expandida de medición que resulta de multiplicar la incertidumbre estándar combinada por el factor de cobertura  $k=2$ . La incertidumbre fue determinada según la "Guía para la Expresión de la Incertidumbre en la Medición", segunda edición, julio del 2001 (Traducción al castellano efectuada por Indecopi, con autorización de ISO, de la GUM, "Guide to the Expression of Uncertainty in Measurement", corrected and reprinted in 1995, equivalente a la publicación del BIPM JCGM:100 2008, GUM 1995 with minor corrections "Evaluation of Measurement Data - Guide to the Expression of Uncertainty in Measurement").

La incertidumbre expandida de medición fue calculada a partir de los componentes de incertidumbre de los factores de influencia en la calibración. La incertidumbre indicada no incluye una estimación de variaciones a largo plazo.

### **Recalibración**

Los resultados son válidos en el momento de la calibración. Al solicitante le corresponde disponer en su momento la ejecución de una recalibración, la cual está en función del uso, conservación y mantenimiento del instrumento de medición o a reglamentaciones vigentes.

### **Fecha de Emisión del Documento**

Se considera como fecha de emisión del documento la fecha que figura en la firma digital del responsable de área.

### **Dirección de Metrología**

El Servicio Nacional de Metrología (actualmente la Dirección de Metrología del INACAL), fue creado mediante Ley N° 23560 el 6 enero de 1983 y fue encomendado al INDECOPI mediante Decreto Supremo DS-024-93 ITINCI.

El 11 de julio 2014 fue aprobada la Ley N° 30224 la cual crea el Sistema Nacional de Calidad, y tiene como objetivo promover y garantizar el cumplimiento de la Política Nacional de Calidad para el desarrollo y la competitividad de las actividades económicas y la protección del consumidor.

El Instituto Nacional de Calidad (INACAL) es un organismo público técnico especializado adscrito al Ministerio de Producción, es el cuerpo rector y autoridad técnica máxima en la normativa del Sistema Nacional de la Calidad y el responsable de la operación del sistema bajo las disposiciones de la ley, y tiene en el ámbito de sus competencias: Metrología, Normalización y Acreditación.

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----- FIN DEL DOCUMENTO -----

**CERTIFICADO DE CALIBRACIÓN  
LF-A-098-2025**



Página 1 de 3

**Expediente** : 2025087  
**Solicitante** : CONTROL MIX EXPRESS S.A.C.  
**Dirección** : Mza. I1 Lote 9-10 Z.I. El Lucumo, Lurín, Lima  
**Instrumento de Medición** : Máquina de Ensayo Uniaxial  
**Marca** : VJ Tech  
**Modelo** : 6000-2A  
**Serie** : 481313  
**Identificación** : ESM-004  
**Capacidad Máxima** : 2 000 kN  
**Resolución** : 0,1 kN (0 kN - 399,9 kN)  
1 kN (400 kN - 2000 kN)  
**Procedencia** : No indica  
**Tipo de Indicación** : Digital  
**Fecha de Calibración** : 2025-10-24  
**Fecha de Emisión** : 2025-10-27

Este certificado de calibración es trazable a patrones internacionales y/o nacionales, los cuales realizan las unidades de acuerdo con el Sistema Internacional de Unidades (SI).

Con el fin de asegurar la calidad de sus mediciones el usuario está obligado a recalibrar sus instrumentos a intervalos apropiados.

CELDA E.I.R.L. recomienda interpretar correctamente el presente documento a fin de evitar resultados o acciones erróneas.

Este certificado de calibración no debe ser reproducido en forma parcial ni modificado sin la autorización de CELDA E.I.R.L.

El certificado de calibración sin firma y sello carece de validez.

Los resultados del certificado de calibración sólo son válidos para el objeto calibrado.

**Condiciones ambientales**

	Inicial	Final
Temperatura (°C)	22,1	22,1



**John Oros Fuerte**  
Laboratorio de Calibración

#### Método de Calibración

La calibración se realizó según la PC-032 ed. 01 "Procedimiento para la calibración de máquinas de ensayos uniaxiales" del INACAL.

#### Trazabilidad

Los resultados de la calibración tienen trazabilidad a los patrones de HBK (Alemania), en concordancia con el Sistema Internacional de Unidades de Medida (SI).

Código	Instrumento patrón	Certificado de Calibración
TF-C04	Transductor de Fuerza Clase 0,5 de 1000 kN	130442 D-K-12029-01-00 2024-12

#### Lugar de Calibración

Laboratorio de Ensayos  
Mza. 11 Lote 9-10 Z.I. El Lucumo, Lurín, Lima

#### Observaciones

La incertidumbre de medición reportada se denomina Incertidumbre Expandida (U), la que se obtiene a partir de la multiplicación de la Incertidumbre Estándar Combinada (u) por el Factor de Cobertura (k) igual a 2, de modo que la Probabilidad de Cobertura (p) corresponde a un Nivel de Confianza de aproximadamente 95 %.

A solicitud del cliente, la máquina de ensayo uniaxial se calibro en el intervalo de indicación de 100 kN a 1 000 kN.

Resultados de Medición

Dirección de carga: Compresión

Indicación del instrumento a calibrar		Indicación en el transductor de fuerza patrón				Error
		Serie 1	Serie 2	Serie 3	Promedio	
(%)	(kN)	(kN)	(kN)	(kN)	(kN)	(kN)
5	100,0	100,5	100,2	100,4	100,4	-0,4
10	200,0	200,8	200,4	200,2	200,5	-0,5
15	300,0	300,2	300,7	301,2	300,7	-0,7
20	400	401	401	402	401	-1
25	500	497	498	499	498	2
30	600	596	596	598	597	3
35	700	695	697	696	696	4
40	800	795	795	796	795	5
45	900	896	895	896	896	4
50	1 000	995	995	997	996	4

Indicación del instrumento a calibrar		Errores de medición relativos de				Incertidumbre U (k=2)
		Exactitud	Repetibilidad	Reversibilidad	Resolución Relativa	
(%)	(kN)	q	b	v	a	(%)
5	100,0	-0,37	0,22	---	0,10	0,17
10	200,0	-0,24	0,28	---	0,05	0,18
15	300,0	-0,24	0,34	---	0,03	0,21
20	400	-0,31	0,29	---	0,25	0,23
25	500	0,45	0,40	---	0,20	0,27
30	600	0,55	0,31	---	0,17	0,22
35	700	0,56	0,21	---	0,14	0,16
40	800	0,58	0,14	---	0,13	0,12
45	900	0,49	0,11	---	0,11	0,10
50	1 000	0,44	0,16	---	0,10	0,12
Error relativo de cero $f_0$		0,00				

Clase de la escala de la máquina	Valor máximo permitido %				
	Error relativo de				Resolución Relativa
	Exactitud	Repetibilidad	Reversibilidad	Cero $f_0$	
	q	b	v	$f_0$	a
0,5	± 0,5	0,5	± 0,75	± 0,05	0,25
1	± 1,0	1,0	± 1,5	± 0,1	0,5
2	± 2,0	2,0	± 3,0	± 0,2	1,0
3	± 3,0	3,0	± 4,5	± 0,3	1,5

FIN DEL DOCUMENTO

## CERTIFICADO DE CALIBRACIÓN

Cotización : 10136

SOLICITANTE : CONTROL MIX EXPRESS S.A.C

DIRECCIÓN : MZA. 11 LOTE. 9-10 Z.I. EL LUCUMO LIMA - LIMA - LURIN

INSTRUMENTO DE MEDICIÓN : PIE DE REY

Marca : LITZ  
Modelo : No indica  
N° de serie : No indica  
Alcance de indicación : 0 mm a 600 mm  
División de escala : 0.05 mm  
Tipo de indicación : Analógico  
Código de identificación : ESM-003  
Procedencia : No indica  
Ubicación : No indica

FECHA Y LUGAR DE CALIBRACIÓN

Fecha de calibración : 2025 - 03 - 22  
Fecha de emisión : 2025 - 03 - 22  
Lugar de calibración : Laboratorio de Longitud /  
**METRINDUST S.A.C. - SEDE LOS JAZMINES**

MÉTODO DE CALIBRACIÓN

La calibración se realizó por comparación directa, según el PC-012 "Procedimiento de Calibración de Pie de Rey". Quinta Edición - Agosto 2012. SNM-012-CP1.



N° DE CERTIFICADO

MT - 1109 - 2025

METRINDUST S.A.C. Departamento de Metrología realiza calibraciones y certificaciones en metrología según

procedimientos de calibración validados o normalizados.

Este certificado de calibración documenta la trazabilidad a los patrones nacionales o internacionales, que realizan las unidades de medida de acuerdo con el Sistema Internacional de Unidades (SI).

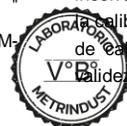
Con el fin de asegurar la calidad de sus mediciones se le recomienda al cliente recalibrar sus instrumentos y equipos a intervalos apropiados.

Los resultados son válidos solamente para el ítem sometido a calibración, no deben

ser utilizados como una certificación de conformidad con normas de producto o como certificado del sistema de calidad de la entidad que lo produce.

METRINDUST S.A.C. no se responsabiliza de los perjuicios que pueda ocasionar el uso inadecuado de este equipo, ni de una

incorrecta interpretación de los resultados de la calibración aquí declarados. El certificado de calibración sin firma y sello carece de validez.



*Dennis Palma*  
FIRMA DIGITAL

AUTORIZADO POR:

 [www.metrindust.com.pe](http://www.metrindust.com.pe)

 [Informes@metrindust.com.pe](mailto:Informes@metrindust.com.pe)

 Av. del Aire 579 - 581 Urbanización Santa Catalina, La Victoria

 (+51) 915 972 598  
(+51) 925 923 922



Certificado : MT - 1109 - 2025

CONDICIONES AMBIENTALES

MAGNITUD	INICIAL	FINAL
Temperatura	20,2 °C	20,3 °C
Humedad Relativa	47 %	48 %

TRAZABILIDAD

TRAZABILIDAD	PATRÓN DE TRABAJO	CERTIFICADO DE CALIBRACIÓN	CÓDIGO QR
Patrones de referencia de DM - INACAL	Bloque de Longitud 1 mm a 100 mm	LLA-C-076-2024	
Patrones de referencia de MITUTOYO CO.	Bloque de Longitud 125 mm a 500 mm	2407122	
Patrones de referencia de DM - INACAL	Varilla Cilíndrica Patrón de 10 mm	LLA - 623 - 2024	
Patrones de referencia de METRINDUST S.A.C	Micrómetro de Exteriores 0 mm a 25 mm	MT - 1920 - 2024	

RESULTADOS DE MEDICIÓN

ERROR DE REFERENCIA INICIAL (I) = 0 µm

ERROR DE INDICACIÓN DEL PIE DE REY PARA MEDICIONES DE EXTERIORES (E)		
VALOR PATRÓN ( mm )	PROMEDIO DE LA INDICACIÓN DEL PIE DE REY ( mm )	ERROR ( µm )
50,000	50,033	33
100,000	100,000	0
150,000	149,997	-3
200,000	199,984	-16
300,000	299,951	-49
500,001	499,985	-16
600,001	599,968	-33

VALOR PATRÓN ( mm )	ERROR DE CONTACTO DE LA SUPERFICIE PARCIAL ( E ) ( µm )
600,001	60

VALOR PATRÓN ( mm )	ERROR DE REPETIBILIDAD ( R ) ( µm )
300,000	50

PGC-16-r11/Setiembre 2024/Rev. 06

Página 2 de 4

Certificado : MT - 1109 - 2025

VALOR PATRÓN ( mm )	ERROR DE CAMBIO DE ESCALA DE EXTERIORES A INTERIORES ( $S_{E-I}$ ) ( $\mu\text{m}$ )
30,000	9961

VALOR PATRÓN ( mm )	ERROR DE CAMBIO DE ESCALA DE EXTERIORES A PROFUNDIDAD ( $S_{E-P}$ ) ( $\mu\text{m}$ )
30,000	ERROR - No aplica

VALOR PATRÓN ( mm )	ERROR DE CONTACTO LINEAL ( L ) ( $\mu\text{m}$ )
10,000	0

VALOR PATRÓN ( mm )	ERROR DE CONTACTO DE SUPERFICIE COMPLETA ( J ) ( $\mu\text{m}$ )
10,000	50

VALOR PATRÓN ( mm )	ERROR DEBIDO A LA DISTANCIA DE CRUCE DE LAS SUPERFICIES DE MEDICIÓN DE INTERIORES ( K ) ( $\mu\text{m}$ )
4,999	NO APLICA

INCERTIDUMBRE DE MEDICIÓN :  $( \quad^2 + \quad^2 * L^2 )^{1/2} \mu\text{m}$

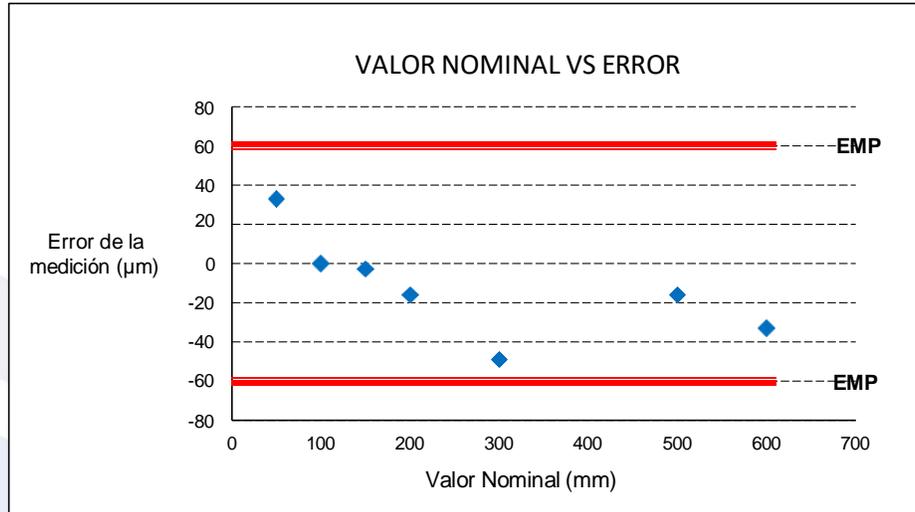
L : Indicación del pie de rey expresado en milímetros (mm)

Nota 1: Error de indicación del pie de rey para medición de interiores = Error de indicación de exteriores + Error de cambio de escala de exteriores e interiores ( $S_{E-I}$ )

Nota 2: Error de indicación del pie de rey para medición de profundidad = Error de indicación de exteriores + Error de cambio de escala de exteriores a profundidad ( $S_{E-P}$ ).

Nota 3: El instrumento tiene un error máximo permisible de  $\pm 60 \mu\text{m}$ , según norma JIS B 7507:2016.

Certificado : MT - 1109 - 2025



**OBSERVACIONES**

Con fines de identificación de la calibración se colocó una etiqueta autoadhesiva (CALIBRADO).

**INCERTIDUMBRE**

La incertidumbre expandida reportada es la incertidumbre combinada multiplicada por el factor de cobertura ( $k = 2$ ) de modo que la probabilidad de cobertura corresponde aproximadamente a un nivel de confianza del 95 %.

**\*\* FIN DEL DOCUMENTO \*\***

## ANEXO IV

Formato de Informe de ensayo según método de ensayo normalizado para resistencia a la compresión de especímenes cilíndricos de concreto ASTM C39.

CONTROL MIX EXPRESS S.A.C.

Calle 8, Mz I1 Lote 9 y 10 Parque Industrial El Lúcumo Lurín 15823  
Email: info@controlmixexpress.com / Website: https://www.controlmixexpress.com

INFORME DE ENSAYO N° CME-M2825-0112

Norma de Ensayo ASTM C39/C39M-24 Ensayo de Resistencia en Compresión de Testigos Cilíndricos de Concreto  
Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens

INFORMACIÓN SUMINISTRADA POR EL CLIENTE

SOLICITANTE	PEPE PEREZ	N° ORDEN	
CLIENTE	PRUEBA	FECHA/HORA MOLDEO	
OBRA		GUÍA CAMION	
OBRA DIR.		PROBETERO	
ESTRUCTURA		SECTOR	*****
		f'c (kg/cm <sup>2</sup> )	280

DATOS COMPLEMENTARIOS DE LA MUESTRA

FECHA/HORA RECEPCIÓN	2025/03/04 11:24	FECHA/HORA ENSAYO	2025/03/28 11:17	EDAD ENSAYO (HORAS)	669	FECHA DE EMISIÓN	
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RESULTADOS DE ENSAYO DE RESISTENCIA EN COMPRESIÓN  
DE TESTIGOS CILÍNDRICOS DE CONCRETO

Código Testigo	Edad Ensayo (días)	Diámetro Promedio (mm)	Área Sección (mm <sup>2</sup> )	Carga Máxima (kN)	Esfuerzo Compresión (MPa)	Esfuerzo Compresión (kg/cm <sup>2</sup> )	Tipo Falla (*)
T545-81026748-4	28	100.8	7996.0	237	29.6	302	2
T545-81026748-5	28	100.9	7996.0	232	29.0	296	1
T545-81026748-6	28	100.9	7996.0	238	29.8	303	1
			Promedio		29.5	300	

NOTAS :

- El muestreo, moldeo y custodia in-situ de los testigos hasta el recojo, ha sido efectuado bajo responsabilidad del cliente por su personal, que ha sido capacitado por CME según las normas ASTM C31/C31M-17 y ASTM C31/C31M-21.
- El curado de los testigos ha sido efectuado en cámaras acondicionadas con humedad y temperatura controladas en conformidad con la Norma ASTM C511-19, manteniendo las condiciones de curado estandarizadas establecidas por la Norma ASTM C31/C31M-21 hasta el momento de su ensayo.
- Los ensayos se realizaron en una prensa automatizada Marca Vj Tech Modelo VJT 51-2011 N° Serie 16/001476 de 2000 kN de capacidad con certificado de calibración trazable, aplicando una velocidad de carga de 2.20 kN/s en conformidad con la Norma ASTM C39/C39M-24.
- Como elementos de distribución de carga en los extremos de los testigos se usaron pads de neopreno en conformidad con la Norma ASTM C1231/C1231M-15.
- El curado inicial, curado final y edad de ensayo se han adaptado a los días laborables, horario de trabajo y requisitos establecidos por CME en el acuerdo contractual, con conocimiento y aceptación del cliente. La edad de ensayo nominal (días) es la indicada por el cliente en su orden de servicio.
- Los resultados presentados, son válidos únicamente para los testigos de concreto entregados por el cliente y no deben ser utilizados para certificación en conformidad con normativas de productos que la entidad produce. Se encuentra prohibida la reproducción del informe sin autorización de Control Mix Express SAC.
- El laboratorio no se hace responsable de la información suministrada por el cliente, con respecto a los ítems de ensayos, que pueda afectar a la validez de los resultados.
- Los resultados del informe de ensayo sólo son válidos para las muestras ensayadas, tal como fueron recibidas.

(\*) Los gráficos correspondientes a los tipos de falla establecidos por la Norma ASTM C39/C39M-24 pueden descargarse de nuestro website :  
[https://www.controlmixexpress.com/tipo\\_fallas](https://www.controlmixexpress.com/tipo_fallas)



Enrique Pasquel Carbajal  
Ingeniero Civil  
Registro CIP 19480

## ANEXO V

### Video Sistema Control Mix Express

Enlace : <https://www.youtube.com/watch?v=zjytv9iyKXc>

### Demo Sistema Control Mix Express

Enlace : [http://www.controlmixexpress.com/interno\\_demo/home.php](http://www.controlmixexpress.com/interno_demo/home.php)

# ANEXO VI

## Resumen Hoja de Vida del Responsable Técnico de Control Mix Express SAC

## **RESUMEN HOJA DE VIDA**

### **ING. ENRIQUE PASQUEL CARBAJAL**

#### **FORMACION PROFESIONAL.-**

- ◆ Ing. Civil, Pontificia Universidad Católica del Perú – PUCP- Promoción 1975
- ◆ Especialización en investigación experimental en concreto en la Universidad Tecnológica de Delft - Holanda.
- ◆ Cursos de especialización en tecnología de concreto y procesos constructivos especiales en USA, Colombia, Argentina, Brasil y Suiza.

#### **ACTIVIDADES ACADEMICAS.-**

- ◆ Ex Jefe Laboratorio de Ensayo de Materiales PUCP
- ◆ Ex Jefe Laboratorio Estructuras Antisísmicas PUCP
- ◆ Profesor en la especialidad de Tecnología del Concreto en la PUCP 1997 a la fecha
- ◆ Profesor en la especialidad de Tecnología del Concreto en la Universidad Peruana de Ciencias Aplicadas 2005 a 2011.
- ◆ Profesor en la Escuela de Posgrado PUCP, 2005 a 2015
- ◆ Profesor en la Escuela de Postgrado UPC, 2006 a 2011.
- ◆ Profesor en CENTRUM - PUCP en la Maestría de Gestión y Dirección de Empresas Constructoras e Inmobiliarias, 2012 -2013.
- ◆ Dictado de Cursos como Instructor certificado ASTM en Perú, Chile, Bolivia, República Dominicana, 2006 a la fecha.
- ◆ Mentor de alumnos universitarios distinguidos en Programa de Becas y Mentoring del BCP - 2021

#### **ACTIVIDADES PROFESIONALES.-**

Participación durante los últimos 35 años como Ingeniero especialista en Tecnología del Concreto o Consultor en los principales proyectos de Edificación, Aeropuertos, Muelles, Irrigaciones, Puentes, Carreteras etc. desarrollados en nuestro país dentro de los cuales se mencionan:

Reactor Nuclear Huarangal (Lima), Muelle Conchán (Lima), Aeropuerto de Juliaca (Puno), Carretera Pomata-Yunguyo (Puno), Rehabilitación Aeropuerto de Piura, Irrigación Ilpa (Puno), Ampliación embalse y Túnel Corani (Cochabamba-Bolivia), Bocatoma Proyecto de Irrigación Chavimochic (La Libertad), Túnel Proyecto Chavimochic (La Libertad), Proyecto Integral de Irrigación Majes (Arequipa), Tunel Jachacuesta Proyecto Pasto Grande (Moquegua), Proyecto de Irrigación Pampa Baja-Majes (Arequipa), Rehabilitación Carretera Panamericana Sur Tramo Puente Haway - Acceso Microondas (Arequipa), Represa Lagunillas (Puno), Rehabilitación Carretera Panamericana Norte Tramo Límite Regional-Empalme Ruta 1N (Lambayeque), Nuevo Aeropuerto de Cochabamba (Bolivia), Bocatoma Cabana-Mañazo (Juliaca – Puno), Puente Aguaytía (Aguaytía), Proyecto Vilavilani (Tacna), Proyecto Pasto Grande (Moquegua), Proyecto Carretera Transoceánica Tramo 3 (Madre de Dios), Proyecto Cerro Corona (Cajamarca), Proyecto Central Termoeléctrica Ilo (Moquegua), Rehabilitación Aeropuerto del Cusco (Cusco) JCamet, Proyecto Tren Eléctrico (Lima) Odebrecht, Proyecto Estación Central (Lima), GyM, Proyecto Edificio Capital (Lima), Proyecto Morococha (Junín), Proyecto Ampliación Cementos Lima (Lima), Proyecto Ampliación Cemento Andino (Junín), Proyecto Fuerabambas (Apurímac), Proyecto Melchorita (Pisco), Proyecto Muelle Sur (Callao), Proyecto de Vivienda Masiva La Pólvora (Lima), Proyecto Quitaracsa (Lambayeque), Proyecto Rehabilitación Aeropuerto Jorge Chávez – LAP (Callao), Proyecto Edificio Alto Caral (Lima), Proyecto Central Termoeléctrica Chilca (Lima), Proyecto Nueva Planta Tratamiento de Efluentes ALICORP (Lima). Proyecto Carretera Interoceánica Tramo 1 – Puerto Maldonado-

CONIRSA, Proyecto Hotel Decamerón Punta Sal – Tumbes, JJCAMET, Proyecto Hidroeléctrico Quitaraca- La Libertad, JJCAMET, Proyecto I.E. San José de Chiclayo, COSAPI, Proyecto Carretera Callejón de Huaylas-Chacas-San Luis, Odebrecht Perú, Proyecto Línea Amarilla, Lima , Constructora OAS Ltda., Proyecto Ciudad Verde, Paz Centenario, Proyecto Real Plaza Pucallpa, InRetail, Proyecto Real Plaza Chiclayo, InRetail, Proyecto Mina Inmaculada, Grupo Hochschild, Proyecto Clínica Delgado, Constructora San José, Proyecto Morococha, JJ Camet, Proyecto Ampliación Central Hidroeléctrica Machupicchu, Graña y Montero, Proyecto Almacenes Inkafarma, Sigral, Bóveda de Seguridad Prosegur Lima – Prosegur S.A., Proyecto Lima Tower, Inmobiliari, Nueva Fábrica Cementos Pacasmayo en Piura, Proyecto Real Plaza Cusco, Proyecto Real Plaza Chiclayo, Proyecto Olmos-Presa Limón – Odebrecht, Proyecto Mina Andaychagua- SVS-Volcan, Proyecto Carretera Red Vial 4 – OHL, Proyecto Mina Toquepala – JJCamet, Proyecto Unidad Minera Cerro Lindo – COSAPI, Aeropuerto Jorge Chávez, Consorcio Wayra, Hospital Regional Zacarías Correa – Huancavelica – Consorcio de Salud Zacarías, Minera Kollpa, Huancavelica – Consorcio Cowsa – Corporación Mayo, Puente Fortaleza, Red Vial 4 – Incot S.A.C., Proyecto Mina Toquepala – Consorcio JJC-Besalco, Pista de Calentamiento en La Videna – Cosapi S.A., Proyecto Minero Las Bambas – Cumbra Ingeniería, Modernización de Refinería de Talara – G y M S.A., Línea de Impulsión y Sistema de Abastecimiento Chilota – Chiloe, - Consorcio Obrainsa – Astaldi, Moquegua, Museo Nacional de Arqueología, Pachacamac - Consorcio Constructor MUNA, Revitalización Edificio 1-NAMRU6 Hospital Naval – Palpag Perú S.A.C., Templo Mormón Arequipa – Cosapi S.A., Condominio Mamua, San Bartolo – Lider S.A., Nuevo Hospital de Policía en Jesús María, Lima – JJC Contratistas Generales, Modernización de la Refinería de Talara, Piura – Técnicas Reunidas S.A., Ampliación Aeropuerto Jorge Chávez – Consorcio Wayra, Parque Eólico Punta Lomitas – Ica – JJC Contratistas Generales, Corredor Vial Lima-Canta-Huayay – China Road and Bridge Corporation – CRBC-Perú, Vía Exoresa Cuzco – Concretos Supermix S.A., Terminal Portuario Chancay – Consorcio Chancay-Supervisión, UNACEM, Investigación proyecto Cementos adicionales - Atocongo, Cementos Pacasamayo, Consultoría Planta Prefabricados – Piura, Cementos Yura, Consultoría Planta Prefabricados – Yura – Arequipa.

- ◆ Ex Gerente de Investigación & Desarrollo de Unión de Concreteras S.A. - UNICON
- ◆ Ex Director Ejecutivo del Centro de Investigación Tecnológica del Cemento y el Concreto – CITEDEC.
- ◆ Director Ejecutivo de Pasquel Consultores SAC – Especialistas en concreto.
- ◆ Gerente General de Control Mix Express SAC – Ensayos en Concreto

#### **ACTIVIDADES INSTITUCIONALES.-**

- ◆ Miembro del American Concrete Institute (ACI) – 1993 a la fecha
- ◆ Miembro del American Society for Testing and Materials (ASTM) – 1993 a la fecha
- ◆ Miembro del Consejo Directivo del Colegio de Ingenieros del Perú–Consejo Nacional –2004-2005
- ◆ Presidente del Capítulo Peruano del ACI (2001 – 2005)
- ◆ Miembro del Comité Técnico de la Norma NTE E.060 Concreto Armado.
- ◆ Miembro del Comité ACI 318 0L International Liasson
- ◆ Miembro del Comité ACI 318 0S Spanish Translation Task Group
- ◆ Miembro del Comité ACI 318 Structural Concrete Building Code
- ◆ Miembro del Comité ACI 237 Self Consolidating Concrete
- ◆ Miembro del Comité ACI 304 Measuring, Mixing, Transporting and Placing Concrete
- ◆ Miembro del Comité ACI 305 Hot Weather Concrete
- ◆ Miembro del Comité ASTM C 09 Concrete and Concrete Aggregates
- ◆ Líder del Grupo de Trabajo 01 de ASTM para traducción de normas en el Código ACI 318.
- ◆ Instructor Certificado ASTM para dictado de Cursos en Latinoamérica 2010 a la fecha
- ◆ Conferencista Nacional e Internacional en temas de su especialidad.

### **PUBLICACIONES.-**

- ◆ Autor del Libro “Tópicos de Tecnología del Concreto” y coautor de 5 libros sobre Tecnología del Concreto, Supervisión de Obras y Procesos Especiales. Ha publicado alrededor de 70 artículos y trabajos de investigación en revistas especializadas del Perú y el extranjero.

### **PREMIOS Y DISTINCIONES.-**

- ◆ Distinción Pontificia Universidad Católica del Perú – Departamento de Ingeniería “Destacada Labor Académica”- Periodo Académico 2001-1
- ◆ Premio “Exalumno Distinguido Asociación de Egresados y Graduados de la Pontificia Universidad Católica del Perú” - 2004
- ◆ Premio Universidad Peruana de Ciencias Aplicadas – UPC al mejor Profesor Periodo Académico 2006-1
- ◆ Distinción Fellow ACI International – “In Recognition of Outstanding Contributions to the American Concrete Institute and to Concrete Technology” - 2006
- ◆ Medalla Henry C. Turner – ACI International “For Notable Achievement in the Concrete Industry” - 2007
- ◆ Premio “Chapter Activities” ACI International – “ For Outstanding Leadership, Promotion and Growth of the ACI Peru Chapter” - 2007
- ◆ Medalla Miembro Distinguido–Colegio de Ingenieros del Perú Consejo Departamental de Lima – 2007
- ◆ Orden de la Ingeniería Peruana – Colegio de Ingenieros del Perú – Consejo Nacional - 2012
- ◆ Distinción "Honorary Member" ACI International – “For your extraordinary work for concrete in Peru and for bringing the Peruvian Chapter to the foremost place among overseas Chapters” - 2014

### **IDIOMAS.-**

- ◆ Inglés Avanzado
- ◆ Italiano Básico

Lima, 13 de Febrero 2026

# ANEXO VII

## Copias de Normas ASTM empleadas por el Sistema Control Mix Express (Acceso exclusivo para clientes a Plataforma CME)



Designation: C39/C39M – 24

# Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens<sup>1</sup>

This standard is issued under the fixed designation C39/C39M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

*This standard has been approved for use by agencies of the U.S. Department of Defense.*

## 1. Scope\*

1.1 This test method covers determination of compressive strength of cylindrical concrete specimens such as molded cylinders and drilled cores. It is limited to concrete having a density in excess of 800 kg/m<sup>3</sup> [50 lb/ft<sup>3</sup>].

1.2 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The inch-pound units are shown in brackets. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.* (Warning—Means should be provided to contain concrete fragments during sudden rupture of specimens. Tendency for sudden rupture increases with increasing concrete strength and it is more likely when the testing machine is relatively flexible. The safety precautions given in R0030 are recommended.)

1.4 The text of this standard references notes which provide explanatory material. These notes shall not be considered as requirements of the standard.

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee C09 on Concrete and Concrete Aggregates and is the direct responsibility of Subcommittee C09.61 on Testing for Strength.

Current edition approved June 1, 2024. Published June 2024. Originally approved in 1921. Last previous edition approved in 2023 as C39/C39M – 23. DOI: 10.1520/C0039\_C0039M-24.

## 2. Referenced Documents

2.1 *ASTM Standards:*<sup>2</sup>

C31/C31M Practice for Making and Curing Concrete Test Specimens in the Field

C42/C42M Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete

C125 Terminology Relating to Concrete and Concrete Aggregates

C192/C192M Practice for Making and Curing Concrete Test Specimens in the Laboratory

C617/C617M Practice for Capping Cylindrical Concrete Specimens

C670 Practice for Preparing Precision and Bias Statements for Test Methods for Construction Materials

C873/C873M Test Method for Compressive Strength of Concrete Cylinders Cast in Place in Cylindrical Molds

C943 Practice for Making Test Cylinders and Prisms for Determining Strength and Density of Preplaced-Aggregate Concrete in the Laboratory

C1077 Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation

C1176/C1176M Practice for Making Roller-Compacted Concrete in Cylinder Molds Using a Vibrating Table

C1231/C1231M Practice for Use of Unbonded Caps in Determination of Compressive Strength of Hardened Cylindrical Concrete Specimens

C1435/C1435M Practice for Molding Roller-Compacted Concrete in Cylinder Molds Using a Vibrating Hammer

C1604/C1604M Test Method for Obtaining and Testing Drilled Cores of Shotcrete

E4 Practices for Force Calibration and Verification of Testing Machines

E18 Test Methods for Rockwell Hardness of Metallic Materials

<sup>2</sup> For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at www.astm.org/contact. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

### 3. Terminology

3.1 *Definitions*—For definitions of terms used in this practice, refer to Terminology C125.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *bearing block, n*—steel piece to distribute the load from the testing machine to the specimen.

3.2.2 *lower bearing block, n*—steel piece placed under the specimen to distribute the load from the testing machine to the specimen.

3.2.2.1 *Discussion*—The lower bearing block provides a readily machinable surface for maintaining the specified bearing surface. The lower bearing block may also be used to adapt the testing machine to various specimen heights. The lower bearing block is also referred to as *bottom block*, *plain block*, and *false platen*.

3.2.3 *platen, n*—primary bearing surface of the testing machine.

3.2.3.1 *Discussion*—The platen is also referred to as the testing machine *table*.

3.2.4 *spacer, n*—steel piece used to elevate the lower bearing block to accommodate test specimens of various heights.

3.2.4.1 *Discussion*—Spacers are not required to have hardened bearing faces because spacers are not in direct contact with the specimen or the retainers of unbonded caps.

3.2.5 *upper bearing block, n*—steel assembly suspended above the specimen that is capable of tilting to bear uniformly on the top of the specimen.

3.2.5.1 *Discussion*—The upper bearing block is also referred to as the *spherically seated block* and the *suspended block*.

### 4. Summary of Test Method

4.1 This test method consists of applying a compressive axial load to molded cylinders or cores at a rate which is within a prescribed range until failure occurs. The compressive strength of the specimen is calculated by dividing the maximum load attained during the test by the cross-sectional area of the specimen.

### 5. Significance and Use

5.1 Care must be exercised in the interpretation of the significance of compressive strength determinations by this test method since strength is not a fundamental or intrinsic property of concrete made from given materials. Values obtained will depend on the size and shape of the specimen, batching, mixing procedures, the methods of sampling, molding, and fabrication and the age, temperature, and moisture conditions during curing.

5.2 This test method is used to determine compressive strength of cylindrical specimens prepared and cured in accordance with Practices C31/C31M, C192/C192M, C617/C617M,

5.3 The results of this test method are used as a basis for quality control of concrete proportioning, mixing, and placing operations; determination of compliance with specifications; control for evaluating effectiveness of admixtures; and similar uses.

5.4 The individual who tests concrete cylinders for acceptance testing shall meet the concrete laboratory technician requirements of Practice C1077, including an examination requiring performance demonstration that is evaluated by an independent examiner.

NOTE 1—Certification equivalent to the minimum guidelines for ACI Concrete Laboratory Technician, Level I or ACI Concrete Strength Testing Technician will satisfy this requirement.

### 6. Apparatus

6.1 *Testing Machine*—The testing machine shall be of a type having sufficient capacity and capable of providing the rates of loading prescribed in 8.5.

6.1.1 Verify the accuracy of the testing machine in accordance with Practices E4, except that the verified loading range shall be as required in 6.4. Verification is required:

6.1.1.1 Within 13 months of the last calibration,

6.1.1.2 On original installation or immediately after relocation,

6.1.1.3 Immediately after making repairs or adjustments that affect the operation of the force applying system or the values displayed on the load indicating system, except for zero adjustments that compensate for the mass of bearing blocks or specimen, or both, or

6.1.1.4 Whenever there is reason to suspect the accuracy of the indicated loads.

6.1.2 *Design*—The design of the machine must include the following features:

6.1.2.1 The machine must be power operated and must apply the load continuously rather than intermittently, and without shock. If it has only one loading rate (meeting the requirements of 8.5), it must be provided with a supplemental means for loading at a rate suitable for verification. This supplemental means of loading may be power or hand operated.

6.1.2.2 The space provided for test specimens shall be large enough to accommodate, in a readable position, an elastic calibration device which is of sufficient capacity to cover the potential loading range of the testing machine and which complies with the requirements of Practice E74.

NOTE 2—The types of elastic calibration devices most generally available and most commonly used for this purpose are the circular proving ring or load cell.

6.1.3 *Accuracy*—The accuracy of the testing machine shall be in accordance with the following provisions:

6.1.3.1 The percentage of error for the loads within the proposed range of use of the testing machine shall not exceed  $\pm 1.0\%$  of the indicated load.

6.1.3.2 The accuracy of the testing machine shall be verified by applying five test loads in four approximately equal increments in ascending order. The difference between any two successive test loads shall not exceed one third of the difference between the maximum and minimum test loads.

6.1.3.3 The test load as indicated by the testing machine and the applied load computed from the readings of the verification device shall be recorded at each test point. Calculate the error,  $E$ , and the percentage of error,  $E_p$ , for each point from these data as follows:

$$E = A - B \tag{1}$$

$$E_p = 100(A - B)/B$$

where:

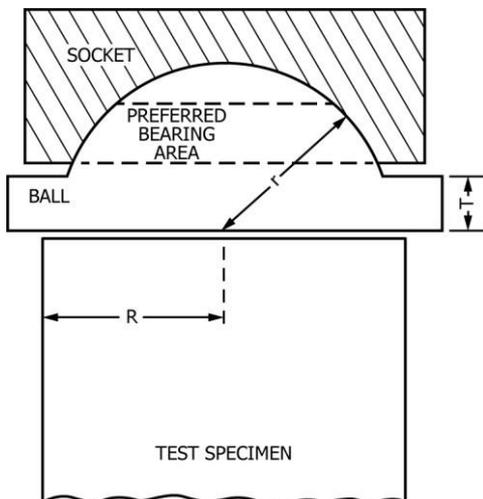
$A$  = load, kN [lbf] indicated by the machine being verified, and

$B$  = applied load, kN [lbf] as determined by the calibrating device.

6.1.3.4 The report on the verification of a testing machine shall state within what loading range it was found to conform to specification requirements rather than reporting a blanket acceptance or rejection. In no case shall the loading range be stated as including loads below the value which is 100 times the smallest change of load estimable on the load-indicating mechanism of the testing machine or loads within that portion of the range below 10 % of the maximum range capacity.

6.1.3.5 In no case shall the loading range be stated as including loads outside the range of loads applied during the verification test.

6.1.3.6 The indicated load of a testing machine shall not be corrected either by calculation or by the use of a calibration diagram to obtain values within the required permissible variation.



$$T \geq R - r$$

$r$  = radius of spherical portion of upper bearing block

$R$  = nominal radius of specimen

$T$  = thickness of upper bearing block extending beyond the sphere

FIG. 1 Schematic Sketch of Typical Upper Bearing Block

6.2 *Bearing Blocks*—The upper and lower bearing blocks shall conform to the following requirements:

6.2.1 Bearing blocks shall be steel with hardened bearing faces (Note 3).

6.2.2 Bearing faces shall have dimensions at least 3 % greater than the nominal diameter of the specimen.

6.2.3 Except for the inscribed concentric circles described in 6.2.4.7, the bearing faces shall not depart from a plane by more than 0.02 mm [0.001 in.] along any 150 mm [6 in.] length for bearing blocks with a diameter of 150 mm [6 in.] or larger, or by more than 0.02 mm [0.001 in.] in any direction of smaller bearing blocks. New bearing blocks shall be manufactured within one half of this tolerance.

NOTE 3—It is desirable that the bearing faces of bearing blocks have a Rockwell hardness at least 55 HRC as determined by Test Methods E18.

NOTE 4—Square bearing faces are permissible for the bearing blocks.

6.2.4 *Upper Bearing Block*—The upper bearing block shall conform to the following requirements:

6.2.4.1 The upper bearing block shall be spherically seated and the center of the sphere shall coincide with the center of the bearing face within  $\pm 5$  % of the radius of the sphere.

6.2.4.2 The ball and the socket shall be designed so that the steel in the contact area does not permanently deform when loaded to the capacity of the testing machine.

NOTE 5—The preferred contact area is in the form of a ring (described as *preferred bearing area*) as shown in Fig. 1.

6.2.4.3 Provision shall be made for holding the upper bearing block in the socket. The design shall be such that the bearing face can be rotated and tilted at least  $4^\circ$  in any direction.

6.2.4.4 If the upper bearing block is a two-piece design composed of a spherical portion and a bearing plate, a mechanical means shall be provided to ensure that the spherical portion is fixed and centered on the bearing plate.

6.2.4.5 The diameter of the sphere shall be at least 75 % of the nominal diameter of the specimen. If the diameter of the sphere is smaller than the diameter of the specimen, the portion of the bearing face extending beyond the sphere shall have a thickness not less than the difference between the radius of the sphere and radius of the specimen (see Fig. 1). The least dimension of the bearing face shall be at least as great as the diameter of the sphere.

6.2.4.6 The dimensions of the bearing face of the upper bearing block shall not exceed the following values:

Nominal Diameter of Specimen, mm [in.]	Maximum Diameter of Round Bearing Face, mm [in.]	Maximum Dimensions of Square Bearing Face, mm [in.]
50 [2]	105 [4]	105 by 105 [4 by 4]
75 [3]	130 [5]	130 by 130 [5 by 5]
100 [4]	165 [6.5]	165 by 165 [6.5 by 6.5]
150 [6]	255 [10]	255 by 255 [10 by 10]
200 [8]	280 [11]	280 by 280 [11 by 11]

6.2.4.7 If the diameter of the bearing face of the upper

bearing block exceeds the nominal diameter of the specimen by more than 13 mm [0.5 in.], concentric circles not more than 0.8 mm [0.03 in.] deep and not more than 1 mm [0.04 in.] wide shall be inscribed on the face of upper bearing block to facilitate proper centering.

6.2.4.8 At least every six months, or as specified by the manufacturer of the testing machine, clean and lubricate the curved surfaces of the socket and of the spherical portion of the upper bearing block. The lubricant shall be a petroleum-type oil such as conventional motor oil or as specified by the manufacturer of the testing machine.

NOTE 6—To ensure uniform seating, the upper bearing block is designed to tilt freely as it comes into contact with the top of the specimen. After contact, further rotation is undesirable. Friction between the socket and the spherical portion of the head provides restraint against further rotation during loading. Pressure-type greases can reduce the desired friction and permit undesired rotation of the spherical head and should not be used unless recommended by the manufacturer of the testing machine. Petroleum-type oil such as conventional motor oil has been shown to permit the necessary friction to develop.

6.2.5 *Lower Bearing Block*—The lower bearing block shall conform to the following requirements:

6.2.5.1 The lower bearing block shall be solid.

6.2.5.2 The top and bottom surfaces of the lower bearing block shall be parallel to each other.

6.2.5.3 The lower bearing block shall be at least 25 mm [1.0 in.] thick when new, and at least 22.5 mm [0.9 in.] thick after resurfacing.

6.2.5.4 The lower bearing block shall be fully supported by the platen of the testing machine or by any spacers used.

6.2.5.5 If the testing machine is designed that the platen itself is readily maintained in the specified surface condition, a lower bearing block is not required.

NOTE 7—The lower bearing block may be fastened to the platen of the testing machine.

NOTE 8—Inscribed concentric circles as described in 6.2.4.7 are optional on the lower bearing block.

6.3 *Spacers*—If spacers are used, the spacers shall be placed under the lower bearing block and shall conform to the following requirements:

6.3.1 Spacers shall be solid steel. One vertical opening located in the center of the spacer is permissible. The maximum diameter of the vertical opening is 19 mm [0.75 in.].

6.3.2 The top and bottom surfaces of the spacer shall be parallel to each other.

6.3.3 Spacers shall be fully supported by the platen of the test machine.

6.3.4 Spacers shall fully support the lower bearing block and any spacers above.

6.3.5 Spacers shall not be in direct contact with the specimen or the retainers of unbonded caps.

6.4 *Load Indication*—The testing machine shall be equipped with either a dial or digital load indicator.

6.4.1 The verified loading range shall not include loads less than 100 times the smallest change of load that can be read.

6.4.2 A means shall be provided that will record, or indicate until reset, the maximum load to an accuracy within 1.0 % of the load.

6.4.3 If the load is displayed on a dial, the graduated scale shall be readable to at least the nearest 0.1 % of the full scale load (Note 9). The dial shall be readable within 1.0 % of the indicated load at any given load level within the loading range. The dial pointer shall be of sufficient length to reach the graduation marks. The width of the end of the pointer shall not

exceed the clear distance between the smallest graduations. The scale shall be provided with a labeled graduation line load corresponding to zero load. Each dial shall be equipped with a zero adjustment located outside the dial case and accessible from the front of the machine while observing the zero mark and dial pointer.

NOTE 9—Readability is considered to be 0.5 mm [0.02 in.] along the arc described by the end of the pointer. If the spacing is between 1 mm and 2 mm [0.04 in. and 0.08 in.], one half of a scale interval is considered readable. If the spacing is between 2 mm and 3 mm [0.08 in. and 0.12 in.], one third of a scale interval is considered readable. If the spacing is 3 mm [0.12 in.] or more, one fourth of a scale interval is considered readable.

6.4.4 If the load is displayed in digital form, the numbers must be large enough to be read. The numerical increment shall not exceed 0.1 % of the full scale load of a given loading range. Provision shall be made for adjusting the display to indicate a value of zero when no load is applied to the specimen.

6.5 Documentation of the calibration and maintenance of the testing machine shall be in accordance with Practice C1077.

## 7. Specimens

7.1 Specimens shall not be tested if any individual diameter of a cylinder differs from any other diameter of the same cylinder by more than 2 %.

NOTE 10—This may occur when single use molds are damaged or deformed during shipment, when flexible single use molds are deformed during molding, or when a core drill deflects or shifts during drilling.

7.2 Prior to testing, neither end of test specimens shall depart from perpendicularity to the axis by more than 0.5° (approximately equivalent to 1 mm in 100 mm [0.12 in. in 12 in.]). The ends of compression test specimens that are not plane within 0.050 mm [0.002 in.] shall be sawed or ground to meet that tolerance, or capped in accordance with either Practice C617/C617M or, when permitted, Practice C1231/C1231M. The diameter used for calculating the cross-sectional area of the test specimen shall be determined to the nearest 0.25 mm [0.01 in.] by averaging two diameters measured at right angles to each other at about midheight of the specimen.

7.3 The number of individual cylinders measured for determination of average diameter is not prohibited from being reduced to one for each ten specimens or three specimens per day, whichever is greater, if all cylinders are known to have been made from a single lot of reusable or single-use molds which consistently produce specimens with average diameters within a range of 0.5 mm [0.02 in.]. When the average diameters do not fall within the range of 0.5 mm [0.02 in.] or when the cylinders are not made from a single lot of molds, each cylinder tested must be measured and the value used in calculation of the unit compressive strength of that specimen. When the diameters are measured at the reduced frequency, the cross-sectional areas of all cylinders tested on that day shall be computed from the average of the diameters of the three or more cylinders representing the group tested that day.

7.4 If the purchaser of the testing services or the specifier of the tests requests measurement of the specimen density, determine the specimen density before capping by either 7.4.1

(specimen dimension method) or 7.4.2 (submerged weighing method). For either method, use a balance or scale that is accurate to within 0.3 % of the mass being measured.

7.4.1 Remove any surface moisture with a towel and measure the mass of the specimen. Measure the length of the specimen to the nearest 1 mm [0.05 in.] at three locations spaced evenly around the circumference. Compute the average length and record to the nearest 1 mm [0.05 in.].

7.4.2 Remove any surface moisture with a towel and determine the mass of the specimen in air. Submerge the specimen in water at a temperature of  $23.0\text{ }^{\circ}\text{C} \pm 2.0\text{ }^{\circ}\text{C}$  [ $73.5\text{ }^{\circ}\text{F} \pm 3.5\text{ }^{\circ}\text{F}$ ] for  $15\text{ sec} \pm 5\text{ sec}$ . Then, determine the apparent mass of the specimen while submerged under water.

7.5 When density determination is not required and the length to diameter ratio is less than 1.8 or more than 2.2, measure the length of the specimen to the nearest 0.05 D.

## 8. Procedure

8.1 Compression tests of moist-cured specimens shall be made as soon as practicable after removal from moist storage.

8.2 Test specimens shall be kept moist by any convenient method during the period between removal from moist storage and testing. They shall be tested in the moist condition.

8.3 Tolerances for specimen ages are as follows:

Test Age <sup>a</sup>	Permissible Tolerance
24 h	$\pm 0.5\text{ h}$
3 days	$\pm 2\text{ h}$
7 days	$\pm 6\text{ h}$
28 days	$\pm 20\text{ h}$
90 days	$\pm 2\text{ days}$

<sup>a</sup>For test ages not listed, the test age tolerance is  $\pm 2.0\%$  of the specified age.

8.3.1 Unless otherwise specified by the specifier of tests, for this test method the test age shall start at the beginning of casting specimens.

8.4 *Placing the Specimen*—Place the lower bearing block, with the hardened face up, on the table or platen of the testing machine. Wipe clean the bearing faces of the upper and lower bearing blocks, spacers if used, and of the specimen. If using unbonded caps, wipe clean the bearing surfaces of the retainers and center the unbonded caps on the specimen. Place the specimen on the lower bearing block and align the axis of the specimen with the center of thrust of the upper bearing block.

NOTE 11—Although the lower bearing block may have inscribed concentric circles to assist with centering the specimen, final alignment is made with reference to the upper bearing block.

8.4.1 *Zero Verification and Block Seating*—Prior to testing the specimen, verify that the load indicator is set to zero. In cases where the indicator is not properly set to zero, adjust the indicator (NOTE 12). After placing the specimen in the machine but prior to applying the load on the specimen, tilt the movable portion of the spherically seated block gently by hand so that the bearing face appears to be parallel to the top of the test specimen.

NOTE 12—The technique used to verify and adjust load indicator to zero

will vary depending on the machine manufacturer. Consult your owner's manual or compression machine calibrator for the proper technique.

8.4.2 *Verification of Alignment When Using Unbonded Caps*—If using unbonded caps, verify the alignment of the specimen after application of load, but before reaching 10 % of the anticipated specimen strength. Check to see that the axis of the cylinder does not depart from vertical by more than  $0.5^{\circ}$  (NOTE 13) and that the ends of the cylinder are centered within the retaining rings. If the cylinder alignment does not meet these requirements, release the load, and carefully recenter the specimen. Reapply load and recheck specimen centering and alignment. A pause in load application to check cylinder alignment is permissible.

NOTE 13—An angle of  $0.5^{\circ}$  is equal to a slope of approximately 1 mm in 100 mm [ $\frac{1}{8}$  inches in 12 inches]

8.5 *Rate of Loading*—Apply the load continuously and without shock.

8.5.1 The load shall be applied at a rate of movement (platen to crosshead measurement) corresponding to a stress rate on the specimen of  $0.25\text{ MPa/s} \pm 0.05\text{ MPa/s}$  [ $35\text{ psi/s} \pm 7\text{ psi/s}$ ] (see NOTE 14). The designated rate of movement shall be maintained at least during the latter half of the anticipated loading phase.

NOTE 14—For a screw-driven or displacement-controlled testing machine, preliminary testing will be necessary to establish the required rate of movement to achieve the specified stress rate. The required rate of movement will depend on the size of the test specimen, the elastic modulus of the concrete, and the stiffness of the testing machine.

8.5.2 During application of the first half of the anticipated loading phase, a higher rate of loading shall be permitted. The higher loading rate shall be applied in a controlled manner so that the specimen is not subjected to shock loading.

8.5.3 Make no adjustment in the rate of movement (platen to crosshead) as the ultimate load is being approached and the stress rate decreases due to cracking in the specimen.

8.6 Apply the compressive load until the load indicator shows that the load is decreasing steadily and the specimen displays a well-defined fracture pattern (Types 1 to 4 in Fig. 2). For a testing machine equipped with a specimen break detector, automatic shut-off of the testing machine is prohibited until the load has dropped to a value that is less than 95 % of the peak load. When testing with unbonded caps, a corner fracture similar to a Type 5 or 6 pattern shown in Fig. 2 may occur before the ultimate capacity of the specimen has been attained. Continue compressing the specimen until the user is certain that the ultimate capacity has been attained. Record the maximum load carried by the specimen during the test, and note the type of fracture pattern according to Fig. 2. If the fracture pattern is not one of the typical patterns shown in Fig. 2, sketch and describe briefly the fracture pattern. If the measured strength is lower than expected, examine the fractured concrete and note the presence of large air voids, evidence of segregation, whether fractures pass predominantly around or through the coarse aggregate particles, and verify end preparations were in accordance with Practice C617/ C617M or Practice C1231/C1231M.

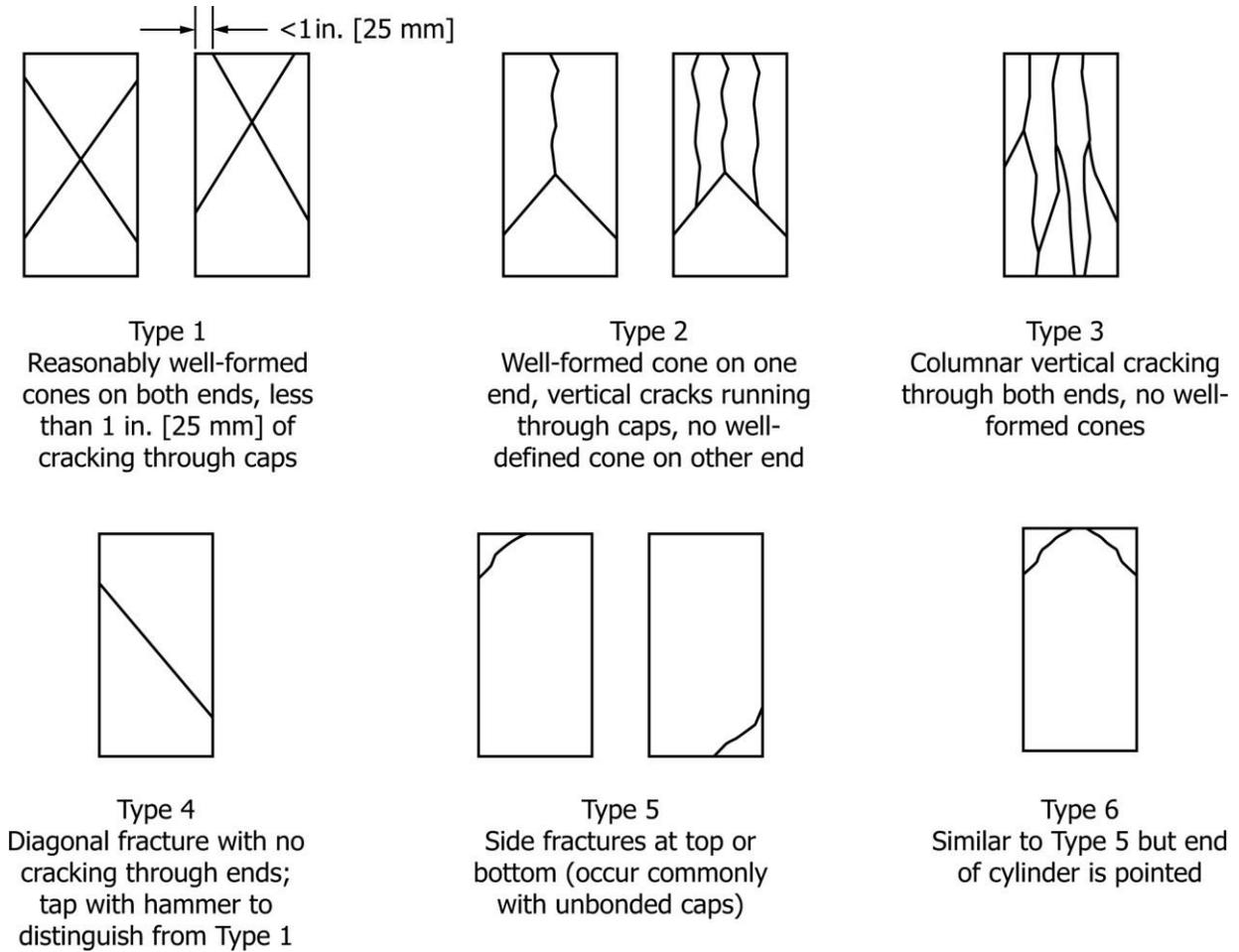


FIG. 2 Schematic of Typical Fracture Patterns

9. Calculation

9.1 Calculate the compressive strength of the specimen as follows:

SI units:

$$f_{cm} = \frac{4000 P_{max}}{\pi D^2} \tag{2}$$

Inch-pound units:

$$f = \frac{4 P_{max}}{\pi D^2} \tag{3}$$

where:

- $f_{cm}$  = compressive strength, MPa [psi],
- $P_{max}$  = maximum load, kN [lbf], and
- $D$  = average measured diameter, mm [in.].

Use at least five digits for the value of  $\pi$ , that is, use 3.1416

or a more precise value.

9.2 If the specimen length to diameter ratio is 1.75 or less,

NOTE 15—Correction factors depend on various conditions such as moisture condition, strength level, and elastic modulus. Average values are given in the table. These correction factors apply to low-density concrete weighing between 1600 kg/m<sup>3</sup> and 1920 kg/m<sup>3</sup> [100 lb/ft<sup>3</sup> and 120 lb/ft<sup>3</sup>] and to normal-density concrete. They are applicable to concrete dry or soaked at the time of loading and for nominal concrete strengths from 14

MPa to 42 MPa [2000 psi to 6000 psi]. For strengths higher than 42 MPa [6000 psi] correction factors may be larger than the values listed above<sup>3</sup>.

9.3 If required, calculate the specimen density to the nearest 10 kg/m<sup>3</sup> [1 lb/ft<sup>3</sup>] using the applicable method.

9.3.1 If specimen density is determined based on specimen

dimensions, calculate specimen density as follows:

SI units:

$$\rho_s = \frac{4 \times 10^9 \times W}{L \times D^2 \times \pi} \tag{4}$$

Inch-pound units:

corrected by multiplying the result by 1.354

$W$  = mass of specimen in air, kg [lb],  
 $L$  = average measured length, mm [in.], and  
 $D$  = average measured diameter, mm [in.].

9.3.2 If the specimen density is based on submerged weighing, calculate the specimen density as follows:

$$\rho_s = \frac{W \times \gamma_w}{W - W^s} \quad (6)$$

where:

$\rho_s$  = specimen density, kg/m<sup>3</sup> [lb/ft<sup>3</sup>],  
 $W$  = mass of specimen in air, kg [lb],  
 $W_s$  = apparent mass of submerged specimen, kg [lb], and  
 $\gamma_w$  = density of water at 23 °C [73.5 °F] = 997.5 kg/m<sup>3</sup> [62.27 lb/ft<sup>3</sup>].

## 10. Report

10.1 Report the following information:

10.1.1 Specimen identification,

10.1.2 Serial number of delivery ticket, if available,

10.1.3 Average measured diameter (and measured length, if outside the range of 1.8  $D$  to 2.2  $D$ ), in millimetres [inches],

10.1.4 Cross-sectional area, in square millimetres [square inches],

10.1.5 Maximum load, in kilonewtons [pounds-force],

10.1.6 Compressive strength rounded to the nearest 0.1 MPa [10 psi],

10.1.7 If the average of two or more companion cylinders tested at the same age is reported, calculate the average compressive strength using the unrounded individual compressive strength values. Report the average compressive-strength rounded to the nearest 0.1 MPa [10 psi].

10.1.8 Type of fracture (see Fig. 2),

10.1.9 Defects in either specimen or caps,

10.1.10 Age of specimen at time of testing. Report age in days for ages three days or greater, report age in hours if the age is less than three days,

NOTE 16—If software limitations prevent reporting the specimen age in hours, the age of the specimen in hours may be included in a note in the report.

10.1.11 If determined, the density to the nearest 10 kg/m<sup>3</sup> [1 lb/ft<sup>3</sup>].

## 11. Precision and Bias

### 11.1 Precision

11.1.1 *Single-Operator Precision*—The following table provides the single-operator precision of tests of 150 mm by 300 mm [6 in. by 12 in.] and 100 mm by 200 mm [4 in. by 8 in.] cylinders made from a well-mixed sample of concrete under laboratory conditions and under field conditions (see 11.1.2).

	Coefficient of Variation <sup>4</sup>	Acceptable Range of Individual Cylinder Strengths	
		2 cylinders	3 cylinders
150 mm by 300 mm [6 in. by 12 in.]			
Laboratory conditions	2.4 %	6.6 %	7.8 %
Field conditions	2.9 %	8.0 %	9.5 %
100 mm by 200 mm [4 in. by 8 in.]			
Laboratory conditions	3.2 %	9.0 %	10.6 %
Field conditions	3.0 %	8.4 %	9.9 %

11.1.2 The single-operator coefficient of variation repre-

sents the expected variation of measured strength of companion cylinders prepared from the same sample of concrete and tested by one laboratory at the same age. The values given for the single-operator coefficient of variation of 150 mm by 300 mm [6 in. by 12 in.] cylinders are applicable for compressive strengths between 15 MPa to 55 MPa [2000 psi to 8000 psi] for laboratory and field conditions. For 100 mm by 200 mm [4 in. by 8 in.] cylinders, the values are applicable for compressive strengths between 17 MPa to 32 MPa [2500 psi and 4700 psi] and 20 MPa to 75 MPa [3000 psi to 11 000 psi] for laboratory and field conditions, respectively.

NOTE 17—The single-operator coefficients of variation for 150 mm by 300 mm [6 in. by 12 in.] cylinders are derived from CCRL concrete proficiency sample data for laboratory conditions and a collection of 1265 test reports from 225 commercial testing agencies in 1978 for field conditions.<sup>5</sup> The single operator coefficient of variation of 100 mm by 200 mm [4 in. by 8 in.] cylinders are derived from CCRL concrete proficiency sample data for laboratory conditions and from a collection of 9400 test reports from 53 ready mixed companies that were compiled in 2022 for field conditions.<sup>6</sup>

11.1.3 *Multilaboratory Precision*—The multi-laboratory coefficient of variation for compressive strength test results of 150 mm by 300 mm [6 in. by 12 in.] cylinders has been found to be 5.0 %<sup>4</sup>; therefore, the results of properly conducted tests by two laboratories on specimens prepared from the same sample of concrete are not expected to differ by more than 14 %<sup>4</sup> of the average (see Note 18). A strength test result is the average of two cylinders tested at the same age.

NOTE 18—The multilaboratory precision does not include variations associated with different operators preparing test specimens from split or independent samples of concrete. These variations are expected to increase the multilaboratory coefficient of variation.

NOTE 19—The multilaboratory data were obtained from six separate organized strength testing round robin programs where 150 mm by 300 mm [6 in. by 12 in.] cylindrical specimens were prepared at a single

<sup>4</sup>These numbers represent respectively the (1s %) and (d2s %) limits as described in Practice C670.

<sup>5</sup>Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:C09-1006. Contact ASTM Customer Service at [www.astm.org/contact](http://www.astm.org/contact).

<sup>6</sup>Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:C09-2003. Contact ASTM Customer Service at [www.astm.org/contact](http://www.astm.org/contact).



location and tested by different laboratories. The range of average strength from these programs was 17.0 MPa to 90 MPa [2500 psi to 13 000 psi].

11.2 *Bias*—There is no accepted reference material suitable for determining the bias of this test method, therefore no statement on bias is made.

## 12. Keywords

12.1 concrete core; concrete cylinder; concrete specimen; concrete strength; compressive strength; core; cylinder; drilled core; strength

## SUMMARY OF CHANGES

Committee C09 has identified the location of selected changes to this standard since the last issue (C39/C39M–23) that may impact the use of this standard. (Approved June 1, 2024.)

- (1) Revised 11.1.2 and moved informative text to current Note 17.
- (2) Moved informative text in previous 11.1.4 to current Note 19.
- (3) Deleted previous Note 18.
- (4) Revised 11.2.

Committee C09 has identified the location of selected changes to this standard since the last issue (C39/C39M–21) that may impact the use of this standard. (Approved December 1, 2023.)

- (1) Revised 11.1.1 and 11.1.2.

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Designation: C31/C31M – 25a

## Standard Practice for Making and Curing Concrete Test Specimens in the Field<sup>1</sup>

This standard is issued under the fixed designation C31/C31M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

*This standard has been approved for use by agencies of the U.S. Department of Defense.*

### 1. Scope\*

1.1 This practice covers procedures for making and curing cylinder and beam specimens from representative samples of fresh concrete for a construction project.

1.2 This practice is not intended for making specimens from concrete not having measurable slump or requiring other sizes or shapes of specimens.

1.3 This practice is not applicable to lightweight insulating concrete or controlled low strength material (CLSM).

NOTE 1—Test Method C495/C495M covers the preparation of specimens and the determination of the compressive strength of lightweight insulating concrete. Test Method D4832 covers procedures for the preparation, curing, transporting and testing of cylindrical test specimens of CLSM.

1.4 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use. (Warning—Fresh hydraulic cementitious mixtures are caustic and may cause chemical burns to exposed skin and tissue upon prolonged exposure.<sup>2</sup>)*

1.6 The text of this standard references notes which provide explanatory material. These notes shall not be considered as requirements of the standard.

1.7 *This international standard was developed in accordance with internationally recognized principles on standard-*

*ization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

### 2. Referenced Documents

2.1 *ASTM Standards:*<sup>3</sup>

- C94/C94M Specification for Ready-Mixed Concrete
- C125 Terminology Relating to Concrete and Concrete Aggregates
- C138/C138M Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
- C143/C143M Test Method for Slump of Hydraulic-Cement Concrete
- C172/C172M Practice for Sampling Freshly Mixed Concrete
- C173/C173M Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
- C192/C192M Practice for Making and Curing Concrete Test Specimens in the Laboratory
- C231/C231M Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
- C330/C330M Specification for Lightweight Aggregates for Structural Concrete
- C403/C403M Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance
- C470/C470M Specification for Molds for Forming Concrete Test Cylinders Vertically
- C495/C495M Test Method for Compressive Strength of Lightweight Insulating Concrete
- C511 Specification for Mixing Rooms, Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cements and Concretes
- C617/C617M Practice for Capping Cylindrical Concrete Specimens
- C1064/C1064M Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete

<sup>1</sup> This practice is under the jurisdiction of ASTM Committee C09 on Concrete and Concrete Aggregates and is the direct responsibility of Subcommittee C09.61 on Testing for Strength.

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<sup>2</sup> See Section on Safety Precautions, Manual of Aggregate and Concrete Testing, *Annual Book of ASTM Standards*, Vol. 04.02.

<sup>3</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [www.astm.org/contact](http://www.astm.org/contact). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

- C1077 Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
- C1611/C1611M Test Method for Slump Flow of Self-Consolidating Concrete
- C1758/C1758M Practice for Fabricating Test Specimens with Self-Consolidating Concrete
- D4832 Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Cylindrical Test Specimens

**3. Terminology**

3.1 *Definitions:*

3.1.1 For definitions of terms used in this practice, refer to Terminology C125.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *acceptance test specimens, n*—standard-cured test specimens intended for evaluating whether the supplied concrete complies with the specification.

3.2.2 *field curing, n*—storing test specimens in the field under an environmental temperature and moisture environment similar to the in-place concrete.

3.2.3 *initial curing, n*—the storage of test specimens in the field after casting and before transporting the specimens to the laboratory.

3.2.3.1 *Discussion*—Initial curing covers the time period from molding to transporting the test specimens.

3.2.4 *initial standard-curing temperature, n*—temperature of the environment surrounding the specimen during initial standard curing.

3.2.4.1 *Discussion*—The environment surrounding standard-cured test specimens may be air, water, or damp sand. The temperature of the environment surrounding standard-cured test specimen might not be the same as the concrete temperature.

3.2.5 *standard curing, n*—storing test specimens in an environment of a specified temperature range, and under conditions that control the loss of moisture from the test specimens while the test specimens are in the field and while in the laboratory.

3.2.5.1 *Discussion*—Standard curing is intended to reduce the influence of variations by standardizing the temperature and moisture environment on the strength development of test specimens. Standard curing includes requirements for the curing environment while the test specimens are in the field (10.1.2) and while the test specimens are in the laboratory (10.1.3).

**4. Significance and Use**

4.1 This practice provides standardized requirements for making, and curing test specimens in the field. This practice also provides requirements for transporting test specimens to the laboratory, and for curing test specimens in the laboratory.

Depending on their purpose, test specimens are either standard-cured, or field-cured.

4.2.1 Acceptance testing for specified concrete strength,

NOTE 2—Specification C94/C94M requires compressive-strength test specimens for acceptance to be standard-cured.

4.2.2 Checking adequacy of mixture proportions for concrete strength, and

4.2.3 Quality control.

4.3 Uses of test results of field-cured test specimens include the following purposes:

4.3.1 Estimation of the in-place concrete strength,

4.3.2 Comparison with test results of standard-cured specimens or with test results from various in-place test methods,

4.3.3 Adequacy of curing and protection of concrete in the structure,

4.3.4 Form or shoring removal time requirements, or

4.3.5 Post-tensioning.

**5. Apparatus**

5.1 *Molds, General*—Molds for specimens or fastenings thereto in contact with the concrete shall be made of steel, cast iron, or other nonabsorbent material, nonreactive with concrete containing portland or other hydraulic cements. Molds shall hold their dimensions and shape under all conditions of use. Molds shall be watertight during use as judged by their ability to hold water poured into them. Provisions for tests of water leakage are given in the Test Methods for Elongation, Absorption, and Water Leakage section of Specification C470/C470M. A suitable sealant, such as heavy grease, modeling clay, or microcrystalline wax shall be used where necessary to prevent leakage through the joints. Positive means shall be provided to hold base plates firmly to the molds. Reusable molds shall be lightly coated with mineral oil or a suitable nonreactive form release material before use.

5.2 *Cylinder Molds*—Molds for casting concrete test specimens shall conform to the requirements of Specification C470/C470M. Cardboard cylinder molds shall not be used for standard-cured specimens.

5.3 *Beam Molds*—Beam molds shall be of the shape and dimensions required to produce the specimens stipulated in 6.2. The inside surfaces of the molds shall be smooth. The sides, bottom, and ends shall be at right angles to each other and shall be straight and true and free of warpage. Maximum variation from the nominal cross section shall not exceed 3 mm [ $\frac{1}{8}$  in.] for molds with depth or breadth of 150 mm [6 in.] or more. Molds shall produce specimens at least as long but not more than 2 mm [ $\frac{1}{16}$  in.] shorter than the required length in 6.2.

5.4 *Tamping Rod*—A round, smooth, straight, steel rod with a diameter conforming to the requirements in Table 1. The length of the tamping rod shall be at least 100 mm [4 in.] greater than the depth of the mold in which rodding is being

**TABLE 1 Tamping Rod Diameter Requirements**

Diameter of Cylinder	
or Width of Beam mm [in.]	Diameter or Rod mm [in.]

performed, but not greater than 600 mm [24 in.] in overall length. The rod shall have the tamping end or both ends rounded to a hemispherical tip of the same diameter as the rod.

5.5 *Vibrators*—External and internal vibrators, if used, shall meet the requirements found in Practice **C192/C192M**.

5.6 *Mallet*—A mallet with a rubber or rawhide head weighing 0.6 kg **6** 0.2 kg [1.25 lb **6** 0.50 lb] shall be used.

5.7 *Placement Tools*—of a size large enough so each amount of concrete obtained from the sampling receptacle is representative and small enough so concrete is not spilled during placement in the mold. For placing concrete in a cylinder mold, the acceptable tool is a scoop. For placing concrete in a beam mold, either a shovel or scoop is permitted.

5.8 *Finishing Tools*—a handheld float or a trowel.

5.9 *Slump Apparatus*—The apparatus for measurement of slump shall conform to the requirements of Test Method **C143/C143M**.

5.10 *Sampling Receptacle*—The receptacle shall be a suitable heavy gauge metal pan, wheelbarrow, or flat, clean nonabsorbent board of sufficient capacity to allow easy remixing of the entire sample with a shovel or trowel.

5.11 *Air Content Apparatus*—The apparatus for measuring air content shall conform to the requirements of Test Methods **C173/C173M** or **C231/C231M**.

5.12 *Temperature Measuring Devices*—The temperature measuring devices shall conform to the applicable requirements of Test Method **C1064/C1064M**.

## 6. Testing Requirements

6.1 *Cylindrical Specimens*—Compressive or splitting-tensile-strength specimens shall be cylinders cast and allowed to set in an upright position. The cylinder diameter shall be at least 3 times the nominal maximum size of the coarse aggregate. The length of the cylinder shall be twice the diameter of the cylinder. If the nominal maximum size of the aggregate is 37.5 mm [1½ in.] or larger, acceptance test specimens for compressive strength shall be 150 mm by 300 mm [6 in. by 12 in.] cylinders. If the nominal maximum size of the aggregate is less than 37.5 mm [1½ in.], acceptance test specimens for compressive strength shall be either 150 mm by 300 mm [6 in. by 12 in.] cylinders or 100 mm by 200 mm [4 in. by 8 in.] cylinders.

NOTE 3—See 7.2 for concrete containing coarse aggregate larger than 50 mm [2 in.] nominal maximum size.

NOTE 4—If molds in SI units are required and not available, molds of equivalent size in inch-pound units should be permitted. If molds in inch-pound units are required and not available, molds of equivalent size in SI units should be permitted.

**TABLE 2 Minimum Cross-Sectional Dimension of Beams**

Nominal	
Maximum Aggregate Size (NMAS)	Minimum Cross-Sectional Dimension

6.2 *Beam Specimens*—Flexural strength specimens shall be beams of concrete cast and hardened in the horizontal position. The length shall be at least 50 mm [2 in.] greater than three times the depth as tested. The ratio of width to depth as molded shall not exceed 1.5.

6.2.1 The minimum cross-sectional dimension of the beam shall be as stated in **Table 2**. Unless otherwise specified, the standard beam shall be 150 mm by 150 mm [6 in. by 6 in.] in cross section.

6.2.2 When the nominal maximum size of the coarse aggregate exceeds 50 mm [2 in.], the concrete sample shall be treated by wet sieving through a 50 mm [2 in.] sieve as described in Practice **C172/C172M**.

6.2.3 The same specimen size shall be used for comparing results and for mixture qualification and acceptance testing.

NOTE 5—The modulus of rupture can be determined using different specimen sizes. However, measured modulus of rupture generally increases as specimen size decreases.<sup>4,5</sup> The strength ratio for beams of different sizes depends primarily on the maximum size of aggregate.<sup>6</sup> Experimental data obtained in two different studies have shown that for maximum aggregate size between 19.0 mm and 25.0 mm [¾ in. and 1 in.], the ratio between the modulus of rupture determined with a 150 mm by 150 mm [6 in. by 6 in.] and a 100 mm by 100 mm [4 in. by 4 in.] may vary from 0.90 to 1.07<sup>4</sup> and for maximum aggregate size between 9.5 mm and 37.5 mm [¾ in. and 1½ in.], the ratio between the modulus of rupture determined with a 150 mm by 150 mm [6 in. by 6 in.] and a 115 mm by 115 mm [4.5 in. by 4.5 in.] may vary from 0.86 to 1.00.<sup>5</sup>

6.3 *Field Technicians*—The field technicians making and curing specimens for acceptance testing shall meet the personnel qualification requirements of Practice **C1077**.

## 7. Sampling Concrete

7.1 Sample the concrete in accordance with Practice **C172/C172M** after all adjustments, including water and admixture additions, have been made.

7.2 If the nominal maximum size of the coarse aggregate exceeds 50 mm [2 in.], wet sieve the concrete sample through a 50 mm [2 in.] sieve as described in Practice **C172/C172M**.

7.3 Record the identification of the sample with respect to the location of the concrete represented and the time of casting.

## 8. Fresh Concrete Tests

8.1 Perform the following tests for each sample of concrete from which specimens are made for acceptance testing for strength:

<sup>4</sup> Tanesi, J; Ardani, A. Leavitt, J. “Reducing the Specimen Size of Concrete Flexural Strength Test (AASHTO T97) for Safety and Ease of Handling,” *Transportation Research Record: Journal of the Transportation Research Board*, No. 2342, Transportation Research Board of National Academies, Washington, D.C., Carrasquillo, P.M. and Carrasquillo, R. L. “Improved Concrete Quality Control Procedures Using Third Point Loading”, *Research Report 119-1F*, Project 3-9-87-1119, Center for Transportation Research, The University of Texas at Austin, November 1987.

<sup>5</sup> Carrasquillo, P.M. and Carrasquillo, R. L. “Improved Concrete Quality Control

Procedures Using Third Point Loading”, *Research Report 119-1F*, Project 3-9-87-1119, Center for Transportation Research, The University of Texas at Austin, November 1987.



TABLE 4 Requirements for Consolidation by Rodding

Specimen Type and Size	Number of Layers of Approximately Equal Depth	Number of Roddings per Layer
Cylinders:		
Diameter, mm [in.]		
100 [4]	2	25
150 [6]	3	25
225 [9]	4	50
Beams:		
Width, mm [in.]		
100 [4] to 200 [8]	2	see 9.4
>200 [8]	3 or more equal depths, each not to exceed 150 mm [6 in.].	see 9.4

8.1.1 Slump or Slump Flow—After remixing the sample in

the receptacle, measure and record the slump or slump flow in accordance with Test Method C143/C143M or Test Method C1611/C1611M, respectively.

8.1.2 Air Content—Determine and record the air content in accordance with either Test Method C173/C173M or Test Method C231/C231M. The concrete used in performing the air content test shall not be used in fabricating test specimens.

8.1.3 Temperature—Determine and record the temperature in accordance with Test Method C1064/C1064M.

NOTE 6—Some specifications may require the measurement of the unit weight of concrete. The volume of concrete produced per batch may be desired on some projects. Also, additional information on the air content measurements may be desired. Test Method C138/C138M is used to measure the unit weight, yield, and gravimetric air content of freshly mixed concrete.

9. Casting Specimens

9.1 Place of Casting—Cast specimens on a level, rigid surface, free of vibration and other disturbances. Cast specimens as near as practicable to the specimens' storage location.

9.2 Self-Consolidating Concrete—If casting a specimen of self-consolidating concrete, use the mold filling procedure in Practice C1758/C1758M instead of the procedures in 9.3 (for cylinders) and 9.4 (for beams). After filling the mold, finish the specimen in accordance with 9.6, without further consolidation.

9.3 Casting Cylinders—Select the proper tamping rod from 5.4 and Table 1 or the proper vibrator from 5.5. Determine the method of consolidation from Table 3, unless another method is specified. If the method of consolidation is rodding, determine requirements from Table 4. If the method of consolida-

tion is vibration, determine requirements from Table 5. Select a scoop of the size described in 5.7. While placing the concrete in the mold, move the scoop around the perimeter of the mold opening to ensure an even distribution of the concrete with minimal segregation. Each layer of concrete shall be consolidated as required. In placing the final layer, add an amount of concrete that will fill the mold after consolidation.

9.4 Casting Beams—Select the proper tamping rod from 5.4 and Table 1 or proper vibrator from 5.5. Determine the method of consolidation from Table 3, unless another method is specified. If the method of consolidation is rodding, determine the requirements from Table 4. If the method of consolidation is vibration, determine the requirements from Table 5. Determine the number of rodgings per layer, one for each 14 cm² [2 in.²] of the top surface area of the beam. Select a placement tool as described in 5.7. Using the scoop or shovel, place the concrete in the mold to the height required for each layer. Place the concrete so that it is uniformly distributed within each layer with minimal segregation. Each layer shall be consolidated as

TABLE 5 Requirements for Consolidation by Vibration

Specimen Type and Size	Number of		Approximate Depth of Layer, mm [in.]
	Layers	Vibrator Insertions per Layer	
Cylinders:			
Diameter, mm [in.]			
100 [4]	2	1	one-half depth of specimen
150 [6]	2	2	one-half depth of specimen
225 [9]	2	4	one-half depth of specimen
Beams:			
Width, mm [in.]			
100 [4] to 200 [8]	1	see 9.5.2	depth of specimen
over 200 [8]	2 or more	see 9.5.2	200 [8] as near as practicable

TABLE 3 Method of Consolidation Requirements

Slump, mm [in.]	Method of Consolidation
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required. In placing the final layer, add an amount of concrete that will fill the mold after consolidation.

9.5 *Consolidation*—The methods of consolidation for this practice are rodding or internal vibration.

9.5.1 *Rodding*—Place the concrete in the mold in the required number of layers of approximately equal volume. Rod each layer uniformly over the cross section with the rounded end of the rod using the required number of strokes. Rod the bottom layer throughout its depth. In rodding this layer, use care not to damage the bottom of the mold. For each upper layer, allow the rod to penetrate through the layer being rodded and into the layer below approximately 25 mm [1 in.]. After each layer is rodded, tap the outsides of the mold 10 to 15 times with the mallet to close any holes left by rodding and to release any large air bubbles that may have been trapped. Use an open hand to tap cylinder molds that are susceptible to denting or other permanent distortion if tapped with a mallet. After tapping, spade each layer of the concrete along the sides and ends of beam molds with a trowel or other suitable tool. Underfilled molds shall be adjusted with representative concrete during consolidation of the top layer. Overfilled molds shall have excess concrete removed.

NOTE 7—The tapping force should be sufficient to close holes left by the rod (or vibrator). A higher tapping force will be needed for stiffer concrete mixtures. Specimens in plastic molds usually require a lighter tapping force than specimens in metal molds.

9.5.2 *Vibration*—Maintain a uniform duration of vibration for the particular kind of concrete, vibrator, and specimen mold involved. Continue vibration only long enough to achieve proper consolidation of the concrete (see [Note 8](#)). Fill the molds and vibrate in the required number of approximately equal layers. Place all the concrete for each layer in the mold before starting vibration of that layer. If using an internal vibrator, insert the vibrator slowly, then slowly withdraw the vibrator. Do not allow the internal vibrator to rest on the bottom or sides of the mold. When placing the final layer, avoid overfilling by more than 6 mm [ $\frac{1}{4}$  in.].

**NOTE 8**—The duration of vibration required will depend upon the workability of the concrete and the effectiveness of the vibrator. Usually, sufficient vibration has been applied as soon as the surface of the concrete has become relatively smooth and large air bubbles cease to break through the top surface. Generally, no more than 5 s of vibration should be required for each insertion to adequately consolidate concrete with a slump greater than 75 mm [3 in.]. Longer times may be required for lower slump concrete, but the vibration time should rarely have to exceed 10 s per insertion.

9.5.2.1 *Cylinders*—The number of insertions of the vibrator per layer is given in [Table 5](#). When more than one insertion per layer is required distribute the insertion uniformly within each layer. Allow the vibrator to penetrate through the layer being vibrated, and into the layer below, about 25 mm [1 in.]. After each layer is vibrated, tap the outsides of the mold at least 10 times with the mallet, to close holes that remain and to release entrapped air voids. Use an open hand to tap molds that are susceptible to denting or other permanent distortion if tapped with a mallet.

9.5.2.2 *Beams*—Insert the vibrator at intervals not exceeding 150 mm [6 in.] along the center line of the long dimension of the specimen. For specimens wider than 150 mm [6 in.], use alternating insertions along two lines. Allow the shaft of the vibrator to penetrate into the bottom layer about 25 mm [1 in.]. After each layer is vibrated, tap the outsides of the mold 10 to 15 times with the mallet to close any holes left by vibrating and to release any large air bubbles that may have been trapped. (See [Note 7](#).)

9.6 *Finishing*—Perform all finishing with the minimum manipulation necessary to produce a flat even surface that is level with the rim or edge of the mold and that has no depressions or projections larger than 3.3 mm [ $\frac{1}{8}$  in.].

9.6.1 *Cylinders*—After consolidation, finish the top surfaces by striking them off with the tamping rod where the consistency of the concrete permits or with a handheld float or trowel. If desired, cap the top surface of freshly made cylinders with a thin layer of stiff portland cement paste which is permitted to harden and cure with the specimen. See section on Capping Materials of Practice [C617/C617M](#).

9.6.2 *Beams*—After consolidation of the concrete, use a handheld float or trowel to strike off the top surface to the required tolerance to produce a flat, even surface.

9.7 *Identification*—Mark the specimens to positively identify them and the concrete they represent. Use a method that will not alter the top surface of the concrete. Do not mark the removable caps. Upon removal of the molds, mark the test specimens to retain their identities.

## 10. Curing

10.1 *Standard Curing*—Standard curing is the curing method used when the specimens are made and cured for the purposes stated in [4.2](#).

10.1.1 *Storage*—The supporting surface on which specimens are stored shall be level to within 20 mm/m [ $\frac{1}{4}$  in./ft]. If specimens are not made in the location where they will receive initial curing, move the specimens to the initial-curing location no later than 15 min after casting operations for that sample have been completed. If a specimen in a single-use mold is moved, support the bottom of the mold. If the top surface of a specimen is disturbed during movement to the place of initial storage, refinish the surface.

**NOTE 9**—Some single-use molds, such as cylinder molds constructed of sheet metal or treated cardboard, may be permanently distorted if moved without proper support. Using a large trowel or a hand to support the bottom of these molds are acceptable means to prevent permanent deformation. It is acceptable to slightly tilt the mold to facilitate lifting and supporting the mold. If a cover is to be placed on the top of a specimen, the cover should be placed on the specimen after moving the specimen to the initial-curing location to ensure the required finish of the top surface of the specimen. For example, if a specimen will be stored in water for initial curing, it would be appropriate to perform a final check of the surface finish prior to placing the cover and setting the specimen into the water.

10.1.2 *Initial Standard Curing*—Store standard-cured test specimens for a period up to 48 h after molding to maintain the specified temperature and moisture conditions described in [10.1.2.1](#) and [10.1.2.2](#).

**NOTE 10**—Generally, just covering the specimens is not sufficient to maintain the environment required for initial standard curing.

10.1.2.1 For concrete mixtures with a specified compressive strength less than 40 MPa [6000 psi], maintain the initial standard-curing temperature between 16 °C and 27 °C [60 °F and 80 °F]. For concrete mixtures with a specified compressive strength of 40 MPa [6000 psi] or greater, maintain the initial standard-curing temperature between 20 °C and 26 °C [68 °F and 78 °F]. Shield test specimens from direct exposure to sunlight and, if used, radiant heating devices. Record the minimum temperature and maximum temperatures achieved for each set of test specimens during the initial standard-curing period.

**NOTE 11**—A satisfactory temperature environment can be created during the standard curing of the specimens by one or more of the following procedures: (1) use of ventilation; (2) use of ice; (3) use of cooling devices; or (4) use of heating devices such as electrical resistance heaters or light bulbs. Other suitable methods may be used provided the temperature requirements are met.

**NOTE 12**—Early-age strength test results may be lower if specimens are stored at temperatures lower than the specified range. At later ages, strength test results may be lower if specimens are exposed to initial curing temperatures higher than the specified range.

10.1.2.2 Store the specimens in an environment that controls the loss of moisture.

**NOTE 13**—A satisfactory moisture environment can be created during the initial standard curing of the specimens by one or more of the following procedures: (1) immerse test specimens with plastic lids in water; (2) store test specimens in a container or enclosure; (3) place test specimens in damp sand pits; (4) cover test specimens with plastic lids; (5)

place test specimens inside plastic bags; or (6) cover specimens with wet fabric.

NOTE 14—Immersion in water may be the easiest method to maintain required moisture and temperature conditions during initial standard curing.

### 10.1.3 Final Curing:

NOTE 15—Specification C330/C330M allows an alternative method, if specified, for curing compressive-strength specimens of structural concrete containing lightweight aggregate.

10.1.3.1 *Cylinders*—Upon completion of initial curing and within 30 min after removing the molds, cure specimens with free water maintained on their surfaces at all times at a temperature of 23.0 °C  $\pm$  2.0 °C [73.5 °F  $\pm$  3.5 °F] using water storage tanks or moist rooms complying with the requirements of Specification C511, except when capping with sulfur mortar capping compound and immediately prior to testing. When capping with sulfur mortar capping compound, the ends of the cylinder shall be dry enough to preclude the formation of steam or foam pockets under or in cap larger than 6 mm [ $\frac{1}{4}$  in.] as described in Practice C617/C617M. For a period not to exceed 3 h immediately prior to test, standard-curing temperature is not required provided free moisture is maintained on the cylinders and ambient temperature is between 20 °C and 30 °C [68 °F and 86 °F].

10.1.3.2 *Beams*—Beams are to be cured the same as cylinders (see 10.1.3.1) except that the beams shall be stored in water saturated with calcium hydroxide at 23.0 °C  $\pm$  2.0 °C [73.5 °F  $\pm$  3.5 °F] at least 20 h prior to testing. Drying of the surfaces of the beam shall be prevented between removal from water storage and completion of testing.

NOTE 16—Relatively small amounts of surface drying of flexural specimens can induce tensile stresses in the extreme fibers that will markedly reduce the indicated flexural strength.

10.2 *Field Curing*—Field curing is the curing method used for the specimens made and cured as stated in 4.3.

10.2.1 *Cylinders*—Store cylinders in or on the structure as near to the point of deposit of the concrete represented as possible. Protect all surfaces of the cylinders from the elements in as near as possible the same way as the formed work. Provide the cylinders with the same temperature and moisture environment as the structural work. Test the specimens in the moisture condition resulting from the specified curing treatment. To meet these conditions, specimens made for the purpose of determining when a structure is capable of being put in service shall be removed from the molds at the time of removal of form work.

10.2.2 *Beams*—As nearly as practicable, cure beams in the same manner as the concrete in the structure. Remove the specimens from their molds 48 h  $\pm$  4 h after casting operations for that sample have been completed. Store specimens representing pavements or slabs on ground by placing them on the

ground as cast, with their top surfaces up exposed to the specified curing treatment. Store specimens representing structure concrete as near the point in the structure they represent as possible, and afford them the same temperature protection and moisture environment as the structure. At the end of the curing period leave the specimens in place exposed to the weather in the same manner as the structure. Remove all beam specimens from field storage and store in water saturated with calcium

hydroxide at 23.0 °C  $\pm$  2.0 °C [73.5 °F  $\pm$  3.5 °F] for 24 h  $\pm$  4 h immediately before time of testing to ensure uniform moisture condition from specimen to specimen. Observe the precautions given in 10.1.3.2 to guard against drying between time of removal from curing to testing.

## 11. Transportation of Specimens to Laboratory

11.1 Prior to transporting, cure and protect specimens as required in Section 10. Specimens shall not be transported until at least 8 h after final set. (See Note 17). During transporting, protect the specimens with suitable cushioning material to prevent damage from jarring. During cold weather, protect the specimens from freezing with suitable insulation material. Prevent moisture loss during transportation by wrapping the test specimens in plastic, wet burlap, by surrounding them with damp sand, or tight fitting plastic caps on plastic molds. Transportation time shall not exceed 4 h.

NOTE 17—Setting time may be measured by Test Method C403/C403M.

## 12. Report

12.1 Report the following information to the laboratory that will test the specimens:

12.1.1 Specimen identification,

12.1.2 Serial number of delivery ticket, if available,

12.1.3 Location of concrete represented by the samples,

12.1.4 Date, time and name of individual making specimens,

12.1.5 Slump or slump flow, air content, and concrete temperature, test results and results of any other tests on the fresh concrete, and any deviations from referenced standard test methods, and

12.1.6 *Curing Method*—For standard-curing method, report the initial curing method with maximum and minimum temperatures and final curing method. For field-curing method, report the location where stored, manner of protection from the elements, temperature and moisture environment, and time of removal from molds.

## 13. Keywords

13.1 beams; casting samples; concrete; curing; cylinders; testing

## SUMMARY OF CHANGES

Committee C09 has identified the location of selected changes to this practice since the last issue, C31/C31M–25, that may impact the use of this practice. (Approved February 15, 2025.)

- (1) Revised 6.2.1 and 6.2.3.
- (2) Practice C192/C192M was added to Section 2, Referenced Documents.
- (3) Removed ACI 309R from Section 2, Referenced Documents.
- (4) Revised 5.5 and 9.5.2.
- (5) Removed previous note Note 4 and renumbered subsequent notes.

Committee C09 has identified the location of selected changes to this practice since the last issue, C31/C31M–24c, that may impact the use of this practice. (Approved February 1, 2025.)

- (1) Revised 9.5.1 and 9.5.2.2.
- (2) Added Note 7.
- (3) Deleted previous 10.3.
- (4) Added Note 15.

Committee C09 has identified the location of selected changes to this practice since the last issue, C31/C31M–24b, that may impact the use of this practice. (Approved December 1, 2024.)

- (1) Revised 3.2.3 and 9.1.
- (2) Removed former Note 3.

Committee C09 has identified the location of selected changes to this practice since the last issue, C31/C31M–24a, that may impact the use of this practice. (Approved June 1, 2024.)

- (1) Revised 10.1.2.1.

Committee C09 has identified the location of selected changes to this practice since the last issue, C31/C31M–24, that may impact the use of this practice. (Approved April 1, 2024.)

- (1) Revised titles of Section 9, Table 4 and Table 5.
- (2) Revised 9.2, 9.3, Note 13, 10.1.1, 10.1.2.2, and 12.1.4.

Committee C09 has identified the location of selected changes to this practice since the last issue, C31/C31M–23, that may impact the use of this practice. (Approved February 1, 2024.)

- (1) 9.2 was added. Former 9.2.1 and 9.3.1 were removed

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Designation: C172/C172M – 17

## Standard Practice for Sampling Freshly Mixed Concrete<sup>1</sup>

This standard is issued under the fixed designation C172/C172M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope\*

1.1 This practice covers procedures for obtaining representative samples of fresh concrete as delivered to the project site on which tests are to be performed to determine compliance with quality requirements of the specifications under which the concrete is furnished (**Note 1**). The practice includes sampling from stationary, paving and truck mixers, and from agitating and nonagitating equipment used to transport central-mixed concrete and from continuous mixing equipment as described in Specification **C685/C685M**.

1.2 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

**NOTE 1**—Composite samples are required by this practice, unless specifically excepted by procedures governing the tests to be performed such as tests to determine uniformity of consistency and mixer efficiency. Procedures used to select the specific test batches are not described in this practice, but it is recommended that random sampling be used to determine overall specification compliance.

1.3 This practice also covers the procedures to be used for preparing a sample of concrete for further testing where it is desirable or necessary to remove the aggregate larger than a designated size. This removal of larger aggregate particles is preferably accomplished by wet-sieving.

1.4 The text of this standard references notes and footnotes which provide explanatory material and shall not be considered as requirements of the practice.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.* (**Warning**—Fresh hydraulic cementitious mixtures are caustic

and may cause chemical burns to skin and tissue upon prolonged exposure.<sup>2</sup>)

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

### 2. Referenced Documents

2.1 *ASTM Standards:*<sup>3</sup>

**C685/C685M** Specification for Concrete Made by Volumetric Batching and Continuous Mixing

**E11** Specification for Woven Wire Test Sieve Cloth and Test Sieves

### 3. Significance and Use

3.1 This practice is intended to provide standard requirements and procedures for sampling freshly mixed concrete from different containers used in the production or transportation of concrete. The detailed requirements as to materials, mixtures, air content, temperature, number of specimens, slump, interpretation of results, and precision and bias are in specific test methods.

### 4. Sampling

4.1 The elapsed time shall not exceed 15 min. between obtaining the first and final portions of the composite sample.

4.1.1 Transport the individual samples to the place where fresh concrete tests are to be performed or where test specimens are to be molded. They shall be combined and remixed with a shovel the minimum amount necessary to ensure uniformity and compliance with the maximum time limits specified in **4.1.2**.

4.1.2 Start tests for slump, temperature, and air content within 5 min after obtaining the final portion of the composite sample. Complete these tests expeditiously. Start molding

<sup>1</sup> This practice is under the jurisdiction of ASTM Committee **C09** on Concrete and Concrete Aggregates and is the direct responsibility of Subcommittee **C09.60** on Testing Fresh Concrete.

Current edition approved Oct. 1, 2017. Published October 2017. Originally approved in 1942. Last previous edition approved in 2014 as C172/C172M-14a. DOI: 10.1520/C0172\_C0172M-17.

<sup>2</sup> Section on Safety Precautions, Manual of Aggregate and Concrete Testing, *Annual Book of ASTM Standards*, Vol 04.02.

<sup>3</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.



specimens for strength tests within 15 min after fabricating the composite sample. Expediently obtain and use the sample and protect the sample from the sun, wind, and other sources of rapid evaporation, and from contamination.

## 5. Procedure

5.1 *Size of Sample*—Make the samples to be used for strength tests a minimum of 28 L [1 ft<sup>3</sup>]. Smaller samples are not prohibited for routine air content, temperature, and slump tests. The size of the samples shall be dictated by the maximum aggregate size.

5.2 The procedures used in sampling shall include the use of every precaution that will assist in obtaining samples that are truly representative of the nature and condition of concrete sampled as follows:

NOTE 2—Sampling should normally be performed as the concrete is delivered from the mixer to the conveying vehicle used to transport the concrete to the forms; however, specifications may require other points of sampling, such as the discharge of a concrete pump.

5.2.1 *Sampling from Stationary Mixers, Except Paving Mixers*—Sample the concrete by collecting two or more portions taken at regularly spaced intervals during discharge of the middle portion of the batch. Obtain these portions within the time limit specified in Section 4. Combine into one composite sample for testing purposes. Do not obtain portions of the composite sample from the very first or last part of the batch discharge (Note 3). Perform sampling by passing a receptacle completely through the discharge stream, or by completely diverting the discharge into a sample container. If discharge of the concrete is too rapid to divert the complete discharge stream, discharge the concrete into a container or transportation unit sufficiently large to accommodate the entire batch and then accomplish the sampling in the same manner as given above. Take care not to restrict the flow of concrete from the mixer, container, or transportation unit so as to cause segregation. These requirements apply to both tilting and nontilting mixers.

NOTE 3—No samples should be taken before 10 % or after 90 % of the batch has been discharged. Due to the difficulty of determining the actual quantity of concrete discharged, the intent is to provide samples that are representative of widely separated portions, but not the beginning and the end of the load.

5.2.2 *Sampling from Paving Mixers*—Sample the concrete after the contents of the paving mixer have been discharged. Obtain samples from at least five different portions of the pile and combine them into one composite sample for test purposes. Avoid contamination with subgrade material or prolonged contact with and absorptive subgrade.

NOTE 4—Discharging concrete across shallow containers placed on the subgrade, or supported above the subgrade, may be effective in precluding contamination or absorption by the subgrade. If used, the concrete from the shallow containers should provide a composite sample that is in agreement with the maximum aggregate size.

5.2.3 *Sampling from Revolving Drum Truck Mixers or Agitators*—Sample the concrete by collecting two or more portions taken at regularly spaced intervals during discharge of the middle portion of the batch. Take the samples so obtained within the time limit specified in Section 4 and combine them

into one composite sample for test purposes. In any case do not obtain samples until after all of the water and any admixtures have been added to the mixer; also do not obtain samples from the very first or last portions of the batch discharge (Note 3). Sample by repeatedly passing a receptacle through the entire discharge stream or by completely diverting the discharge into a sample container. Regulate the rate of discharge of the batch by the rate of revolution of the drum and not by the size of the gate opening.

5.2.4 *Sampling from Continuous Mixers*—Sample the concrete after the discharge of at least 140 L [5 ft<sup>3</sup>] of concrete, following all mixture proportioning adjustments. Sample the concrete at the frequency specified by collecting two or more portions taken at regularly spaced intervals during discharge of the concrete. Take the portions so obtained within the time limit specified in Section 4, and combine them into one composite sample for test purposes. Do not obtain samples from the very first or last portions of a mixer's continuous discharge (Note 3). Sample by repeatedly passing a receptacle through the entire discharge stream or by completely diverting the discharge into a sample container. After obtaining the composite sample, wait a minimum of 2 minutes and a maximum of 5 minutes before beginning tests (Note 5).

NOTE 5—The waiting period prior to commencing the testing is needed because the mix water is input only seconds before discharge from the continuous mixer.

5.2.5 *Sampling from Open-Top Truck Mixers, Agitators, Nonagitating Equipment, or Other Types of Open-Top Containers*—Take samples by whichever of the procedures described in 5.2.1, 5.2.2, or 5.2.3 is most applicable under the given conditions.

## 6. Additional Procedure for Large Maximum Size Aggregate Concrete

6.1 When the concrete contains aggregate larger than that appropriate for the size of the molds or equipment to be used, wet-sieve the sample as described below except perform density (unit weight) tests for use in yield computations on the full mix.

NOTE 6—The effect of wet-sieving on the test results should be considered. For example, wet-sieving concrete causes the loss of a small amount of air due to additional handling. The air content of the wet-sieved fraction of concrete is greater than that of the total concrete because the larger size aggregate which is removed does not contain air. The apparent strength of wet-sieved concrete in smaller specimens is usually greater than that of the total concrete in larger appropriate size specimens. The effect of these differences may need to be considered or determined by supplementary testing for quality control or test result evaluation purposes.

### 6.2 Definition:

6.2.1 *wet-sieving concrete*—the process of removing aggregate larger than a designated size from the fresh concrete by sieving it on a sieve of the designated size.

### 6.3 Apparatus:

6.3.1 *Sieves*, as designated, conforming to Specification E11.

6.3.2 *Receptacle*—A container of suitable size having a nonabsorbent surface.



6.3.3 *Wet-Sieving Equipment*—Equipment for wet-sieving concrete shall be a sieve as noted in 6.3.1 of suitable size and conveniently arranged and supported so that one can shake it rapidly by either hand or mechanical means. Generally, a horizontal back and forth motion is preferred. The equipment shall be capable of rapidly and effectively removing the designated size of aggregate.

6.3.4 *Hand Tools*—Shovels, hand scoops, plastering trowels, and rubber gloves as required.

6.4 *Procedure:*

6.4.1 *Wet-Sieving*—After sampling the concrete, pass the concrete over the designated sieve and remove and discard the aggregate retained. This shall be done before remixing. Shake or vibrate the sieve by hand or mechanical means until no undersize material remains on the sieve. Mortar adhering to the

aggregate retained on the sieve shall not be wiped from it before it is discarded. Place only enough concrete on the sieve at any one time so that after sieving, the thickness of the layer of retained aggregate is not more than one particle thick. The concrete which passes the sieve shall fall into a batch pan of suitable size which has been dampened before use or onto a clean, moist, nonabsorbent surface. Scrape any mortar adhering to the sides of the wet-sieving equipment into the batch. After removing the larger aggregate particles by wet-sieving remix the batch with a shovel the minimum amount necessary to ensure uniformity and proceed testing immediately.

7. **Keywords**

7.1 air content; batch; composite sample; concrete; slump; temperature; wet-sieving

**SUMMARY OF CHANGES**

Committee C09 has identified the location of selected changes to this practice since the last issue, C172/C172M–14a, that may impact the use of this practice. (Approved October 1, 2017)

(1) Revised 5.2.2.

(2) Revised Note 4.

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Designation: C470/C470M – 23

# Standard Specification for Molds for Forming Concrete Test Cylinders Vertically<sup>1</sup>

This standard is issued under the fixed designation C470/C470M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

*This standard has been approved for use by agencies of the U.S. Department of Defense.*

## 1. Scope\*

1.1 This specification covers molds for use in forming cylindrical concrete specimens. The provisions of this specification include the requirements for both reusable and single-use molds.

NOTE 1—Sizes included are molds having diameters from 50 mm [2 in.] to 900 mm [36 in.].

1.2 The text of this standard refers to notes and footnotes that which provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the standard.

1.3 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and the values from the two systems shall not be combined.

1.4 The following safety hazards caveat pertains only to the test method described in this specification: *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee C09 on Concrete and Concrete Aggregates and is the direct responsibility of Subcommittee C09.61 on Testing for Strength.

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## 2. Referenced Documents

2.1 *ASTM Standards:*<sup>2</sup>

C31/C31M Practice for Making and Curing Concrete Test Specimens in the Field

C33/C33M Specification for Concrete Aggregates

C125 Terminology Relating to Concrete and Concrete Aggregates

C192/C192M Practice for Making and Curing Concrete Test Specimens in the Laboratory

C1077 Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation

D256 Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics

D570 Test Method for Water Absorption of Plastics

## 3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of terms used in this test specification, refer to Terminology C125.

## 4. General Requirements

4.1 The following provisions apply to both reusable and single-use molds:

4.1.1 Molds shall be constructed in the form of right circular cylinders which stand with the cylindrical axis vertical and the top open to receive the concrete. They shall be made of materials that do not react with concrete containing portland or other hydraulic cements. They shall be watertight and sufficiently strong and tough to permit their use without tearing, crushing, or deforming.

NOTE 2—Reusable lids may be used on molds to reduce moisture loss.

4.1.2 Molds shall have a nominal inside height equal to twice the nominal inside diameter. The diameter of a mold,

<sup>2</sup> For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

consisting of the average of two measurements taken at right angles to each other at the top of the mold, shall not differ from the nominal diameter by more than 1 %. The height, determined by averaging two measurements taken 180° apart, shall not differ from the nominal height by more than 2 %. The planes of the top rim of the mold and the bottom shall be perpendicular to the axis of the mold within 0.5 degrees— approximately equivalent to 3 mm in 300 mm [ $\frac{1}{8}$  in. in 12 in.]. No diameter of a mold shall differ from any other diameter of the same mold by more than 2 % except that molds that fail to meet this requirement may be used when the user is able to demonstrate that no diameter of hardened concrete specimen produced in a similar mold differs from any other diameter on the same specimen by more than 2 % (see **Note 3**).

**NOTE 3**—Certain single-use molds may require the use of a special device such as a tube of heavy-gage metal around the mold during molding to maintain the dimensional tolerances specified in **4.1.2**.

**4.1.3** The bottom inside surface of the mold shall not depart from a plane by more than 2 mm in 150 mm [ $\frac{1}{16}$  in. in 6 in.] (1 % of the diameter of the mold).

## 5. Reusable Molds

**5.1** Reusable molds are those which are designed to be used more than a single time. Reusable molds shall be made of nonabsorptive materials, and constructed as either one piece or several pieces (see **Note 4**).

**5.2** Reusable molds shall be provided with a closure or base on the lower end at right angles to the axis of the cylinder. Molds may be single piece molds or made from castings with a separate detachable base plate or a base that is an integral part of the sidewall. The mold shall be either coated or made of a material that will prevent adherence to the concrete. At the time of use, molds shall not leak water. An inside fillet, if any, at the bottom of the side wall shall have an indentation around the circumference no more than 3 mm [ $\frac{1}{8}$  in.] in the vertical direction or no more than 5 mm [ $\frac{3}{16}$  in.] in the horizontal direction.

**5.3** Reusable molds shall be tested for water leakage as described in **7.4**, for resistance to damage as described in **7.3.1**, and for dimensional stability in accordance with **4.1.2** and **4.1.3** initially and after every 50 uses or every six months, whichever comes first.

**NOTE 4**—Satisfactory molds can be made from lengths of steel tubing or pipe that is slit on one side parallel to the axis and fitted with a means of closing the vertical slit as well as a means of attaching a base plate. The required dimensional tolerances must be maintained after slitting, clamping, and attaching the base plate. Other nonabsorptive materials which have been used include iron, brass, steel, and various plastics. Although aluminum and magnesium alloys have been used, some of these

alloys may be reactive with cement constituents and are therefore unacceptable.

## 6. Single-Use Molds

**6.1** Single-use molds are molds designed to be used once and discarded. They are permitted to be made of sheet metal, plastic, suitably treated paper products, or other materials and shall conform to the requirements of this specification.

**6.2 Physical Requirements**—The molds as prepared for use shall comply with the following:

**6.2.1 Water Leakage**—When tested as described in Section **7**, there shall be no visible leakage.

**6.2.2 Absorptivity**—When tested as described in Section **7**, the absorption shall not exceed the values given in **Table 1**. Intermediate values are proportional to the square of the height.

**6.2.3 Elongation**—When tested as described in Section **7**, the elongation after test shall not exceed 0.2 % of height.

**6.3 Single-use Plastic Molds**—Molds shall conform to the following additional requirements when plastic is the predominant material used in construction:

**6.3.1 Wall Thickness**—The side walls shall be of sufficient stiffness to meet the requirements of **4.1** (See **Note 5**).

**NOTE 5**—This can be achieved through sufficient side wall thickness alone, or in combination with a stiffened top.

**6.3.2 Bottom Design**—The bottom shall be designed so that it will be flush with the bottom of the sidewall within a tolerance of 2 mm [ $\frac{1}{16}$  in.]. An inside fillet, if any, at the bottom of the sidewall shall have an indentation around the circumference no more than 4 mm [ $\frac{1}{8}$  in.] in the vertical direction or no more than 5 mm [ $\frac{3}{16}$  in.] in the radial direction. The bottom shall be of adequate rigidity to prevent permanent deformation when specimens are molded in accordance with the applicable provisions of Practice **C31/C31M** or **C192/C192M**.

**6.3.3 Material**—The mold manufacturer shall certify that: (1) the plastic material used in molds has a maximum water absorption of less than 0.5 % in 24 h when tested in accordance with Test Method **D570**; (2) the plastic has an Izod impact toughness of at least 117 J/m [ $2.2 \text{ ft lb/in.}$ ] of notch for a 4 mm [ $\frac{1}{8}$  in.] thick specimen tested in accordance with Test Methods **D256**; and (3) after being held at  $-12 \text{ }^\circ\text{C}$  [ $10 \text{ }^\circ\text{F}$ ] for 24 h, the plastic shall not fracture when subject to tapping and jarring that is judged to be typical of what occurs when specimens are molded in accordance with the applicable provisions of Practice **C31/C31M** or **C192/C192M**.

**6.4 Paper Molds**—When paper or other potentially absorptive fiber material is used as the primary structural material in the construction of the side walls or bottom of the mold, the mold shall conform to the following additional requirements:

**6.4.1 Side Walls**—The side walls of paper molds shall be made with a minimum of three plies having a combined thickness of not less than 2 mm [ $0.070 \text{ in.}$ ]. Seams on the inside of the mold shall not be open by more than 2 mm [ $\frac{1}{16} \text{ in.}$ ].

**NOTE 6**—The minimum thickness of material used in side walls and

**TABLE 1 Limits for Absorption and Elongation**

Nominal Mold		
mm [in.]		mm [in.]
100 [4]	2.7	0.2 [0.008]
150 [6]	Absorptio	Elongatio
200 [8]	11	0.4 [0.016]
300 [12]	24	0.6 [0.024]
450 [18]	54	0.9 [0.036]
600 [24]	96	1.2 [0.048]
900 [36]	216	1.8 [0.072]



bottoms is considered adequate for cylinders up to 150 mm [6 in.] in diameter. For larger cylinders thicker material may be required to meet requirements of 4.1.

6.4.2 *Bottom Caps*—The bottom cap of the mold shall be made of either metal or paper. If metal, it shall not be less than 0.23 mm [0.009 in.] in thickness and coated to prevent corrosion (Note 6). It shall be designed so that it will be flush with the bottom edge of the side wall within a tolerance of 2 mm [ $\frac{1}{16}$  in.] and the inside crimp, if any, shall produce an indentation around the circumference of the cylinder no more than 5 mm [ $\frac{3}{16}$  in.] in the radial, and no more than 4 mm [ $\frac{1}{8}$  in.] in the vertical direction. If made of paper, the bottom cap of the mold shall be of parchment-lined cap stock not less than 0.7 mm [0.028 in.] thick (Note 6). It shall be glued to the outside of the walls by means of a flange not less than 19 mm [ $\frac{3}{4}$  in.] high. The glue shall be water-insoluble adhesive of the resin type that will not react with fresh concrete. Only the practicable minimum amount of adhesive shall be exposed on the inner side of the bottom of the mold.

6.4.3 *Waterproofing*—The mold made from paper or fiber shall be completely coated on inside and outside, side walls, and bottom with a suitable waterproofing medium (Note 7). The top edge shall be waterproofed, or coated, to limit absorption. The surfaces of metal bottoms, which must comply with 6.4.2, need not be coated. Any waterproofing coating used in this application shall have a melting point not less than 49 °C [120 °F] (Note 8). The coating shall provide a film over the inside that will minimize adherence of the concrete to the side walls and the bottom.

NOTE 7—Paraffin coating for this use may be of the grade known to the trade as crude scale wax or of any superior grade. In general, a film of paraffin of sufficient thickness to accomplish the intended purposes will permit one to raise a curl of paraffin with the thumbnail.

NOTE 8—Such coatings may be unsuitable for molds that are subjected to temperatures above 49 °C [120 °F], either before or after filling with concrete.

6.5 *Single-Use Sheet Metal Molds*—Molds shall conform to the following additional requirements when light-gage sheet metal is the predominant material used in their construction:

6.5.1 *Metal Thickness*—The side wall of steel sheet metal molds shall be manufactured from sheet metal not thinner than can-making quality blackplate and shall have a minimum metal thickness corresponding to that of 48.5 kg [107 lb] blackplate, which is approximately 0.300 mm [0.0118 in.] thick or 30½ gage. The metal for the bottom of the mold shall have a minimum thickness of 0.23 mm [0.009 in.] (Note 6).

6.5.2 *Bottom Design*—The bottom shall be so designed that it will be flush with the bottom of the side wall within a tolerance of 2 mm [ $\frac{1}{16}$  in.]. An inside crimp, if used, shall produce an indentation around the circumference of the cylinder no more than 4 mm [ $\frac{1}{8}$  in.] in the vertical or 5 mm [ $\frac{3}{16}$  in.] in the radial direction.

6.5.3 *Top Edge*—The top edge of the side wall shall be curled or beaded to strengthen the mold and protect the user from sharp edges. If such bead protrudes to the inside of the mold, the indentation produced in the concrete cylinder shall not exceed 4 mm [ $\frac{1}{8}$  in.] in either a radial or vertical direction.

6.5.4 *Coating*—If the mold is made of material which will rust, corrode, react, or adhere to the freshly mixed or hardened

concrete, it must be coated with a protective coating of lacquer or other suitable material.

#### 6.6 *Packaging*:

6.6.1 The manufacturer shall state on containers of single-use molds that molds are intended to be used a single time.

6.6.2 Containers of single-use molds shall be marked with the manufacturer's lot number or date of manufacture.

6.6.3 Containers of single-use molds shall be marked with a directional arrow indicating orientation of the vertical axis of the molds.

NOTE 9—Shipping and storing single-use molds with their axis in the vertical position reduces the incidence of distortion.

## 7. Test Methods for Elongation, Absorption, and Water Leakage

7.1 *Apparatus*—The assembly used for the absorption-elongation test shall follow the principles illustrated in Fig. 1.

7.2 *Specimens*—Molds shall be selected as described in Section 2. Single-use molds shall not be reused nor the same mold retested.

#### 7.3 *Test Procedure for Molds*:

7.3.1 Samples of all types of single-use molds and reusable plastic molds shall be subjected to the dry rodded coarse aggregate test as described in 7.3.2 to evaluate their resistance to damage under use and to the water leakage test described in 7.3.3 and 7.3.4. Paper or other potentially absorptive molds shall additionally be tested for absorptivity and elongation described in 7.3.5. Plastic and sheet metal molds need not be tested for elongation and absorption, but should be tested for water leakage. Dimensional requirements for all molds shall be verified.

7.3.2 Prepare the mold for test by filling with dry crushed stone coarse aggregate meeting the grading requirements of Specification C33/C33M size No. 57, 25.0 to 4.75 mm [1 in. to No. 4] or No. 67, 19.0 to 4.75 mm [ $\frac{3}{4}$  in. to No. 4]. Fill and compact the mold by the rodding procedure specified in Practice C192/C192M for compression test specimens using the tamping rod, number of layers and number of strokes per layer specified. It will generally not be possible to obtain the penetration of the tamping rod specified in Practice C192/C192M. After rodding the final layer, empty the coarse aggregate, wipe lightly with a dry cloth and examine the mold for physical damage.

7.3.3 After completion of 7.3.2, determine the mass of the mold and record to the nearest 0.004 g/mm [0.1 g/in.] of mold height. Place the mold on a firm, flat surface and fill with water at room temperature to a depth of 90 % to 95 % of the mold height. Then place the mold on the dial stand, cover with the glass or metal plate and record the initial length by dial micrometer to the nearest 0.025 mm [0.001 in.].

7.3.4 Allow the mold to stand for 3 h and take a final reading of the micrometer. Examine and record any visible leakage. Empty water from the mold, dry lightly with a towel and record the final mass to the nearest 0.04 g/cm [0.1 g/in.] of mold height.

7.3.5 Calculate the elongation as the difference between the final length and initial length. Calculate the absorption as the difference between the final mass and initial mass of the mold.

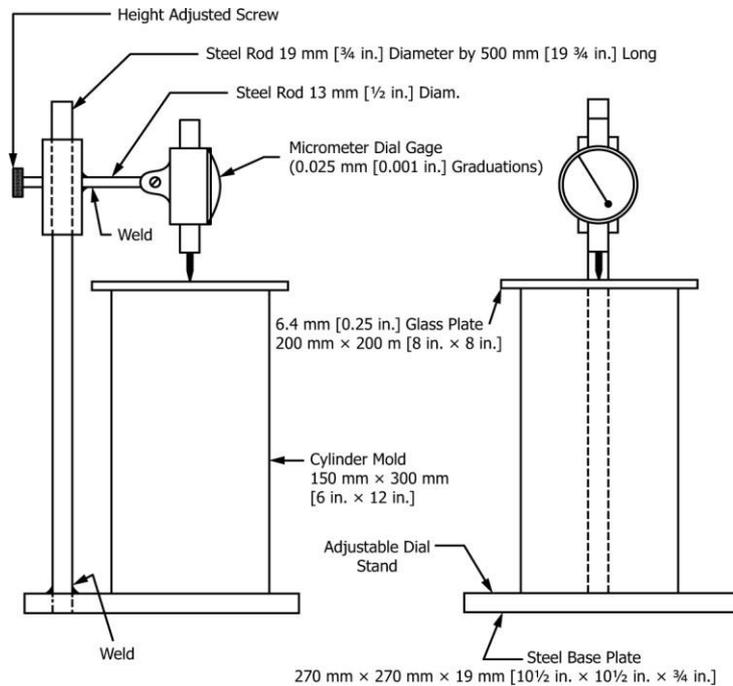


FIG. 1 Apparatus for Absorption-Elongation Test of Paper Molds

7.3.6 Verify all dimensional requirements.

7.4 *Water Leakage Test for Reusable Molds:*

7.4.1 Prepare reusable molds with the sealant to be used, if required. Fill molds with water to a depth of 90 % to 95 % of the nominal height. Subject the mold to tapping and jarring which is judged to be typical of what occurs when specimens are molded in accordance with the applicable provisions of Practice C31/C31M or C192/C192M.

7.4.2 One hour after tapping, examine for visible leakage.

8. **Sampling and Rejection**

8.1 At least three single-use and reusable molds shall be selected at random from each shipment by the purchaser to ensure that the molds are in compliance with this specification.

8.2 Failure of any one of the three molds to comply with this specification shall be basis for rejection of the shipment.

9. **Record to be Prepared by the Purchaser**

9.1 Where applicable for the type of mold tested, record and retain in accordance with Practice C1077 the following information for each mold tested:

- 9.1.1 Brand or source of molds,
- 9.1.2 Shipment or lot from which the mold was taken,
- 9.1.3 Date sampled and date tested,

- 9.1.4 Brief general description of the mold including nominal dimensions, type of mold, and materials of which it is made,
- 9.1.5 Total absorption, g, if specified,
- 9.1.6 Total expansion, mm [in.], if specified, and
- 9.1.7 Water leakage reported in terms of compliance, or failure by leakage.

9.2 Where applicable for the type of mold tested, record and retain the following information for samples which do not meet the requirements of the specification:

- 9.2.1 Average diameter or height, mm [in.],
- 9.2.2 Maximum and minimum diameters or heights, mm [in.],
- 9.2.3 Nonconformance with required perpendicularity of rim or base to the axis of the mold,
- 9.2.4 Apparent reaction between mold materials and concrete or mortar or corrosion of metal in contact with concrete,
- 9.2.5 Melting point less than 49 °C [120 °F],
- 9.2.6 Minimum thickness of materials in side walls or bottom, and
- 9.2.7 Dimension of crimp in bottom, top edge or construction of paper bottom.

10. **Keywords**

- 10.1 concrete; molds; test cylinders



SUMMARY OF CHANGES

Committee C09 has identified the location of selected changes to this specification since the last issue, C470/C470M – 15, that may impact the use of this specification. (Approved June 1, 2023.)

- (1) Revised 1.2 and 1.3.
- (2) Added Section 3 on terminology and revised 2.1.
- (3) Revised the low temperature value in 6.3.3.

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Designation: C511 – 21

# Standard Specification for Mixing Rooms, Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cements and Concretes<sup>1</sup>

This standard is issued under the fixed designation C511; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reappraisal. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reappraisal.

## 1. Scope\*

1.1 This specification includes requirements for mixing rooms where paste and mortar specimens are prepared; and for moist cabinets, moist rooms, and water storage tanks where paste, mortar, and concrete specimens are stored.

1.2 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard. Values in SI units shall be obtained by measurement in SI units or by appropriate conversion, using the Rules for Conversion and rounding given in Standard [IEEE/ASTM SI 10](#), of measurements made in other units.

1.3 The text of this standard references notes and footnotes which provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of this standard.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

## 2. Referenced Documents

2.1 *ASTM Standards:*<sup>2</sup>

[C51 Terminology Relating to Lime and Limestone \(as Used by the Industry\)](#)

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee C01 on Cement and is the direct responsibility of Subcommittee C01.95 on Coordination of Standards.

Current edition approved Dec. 1, 2021. Published December 2021. Originally approved in 1968. Last previous edition approved in 2019 as C511 – 19. DOI: 10.1520/C0511-21.

<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[E77 Test Method for Inspection and Verification of Thermometers](#)

[C125 Terminology Relating to Concrete and Concrete Aggregates](#)

[C219 Terminology Relating to Hydraulic and Other Inorganic Cements](#)

[IEEE/ASTM SI 10 Standard for Use of the International System of Units \(SI\): The Modern Metric System](#)

## 3. Terminology

3.1 *Definitions:*

3.1.1 Refer to Terminology [C125](#) and Terminology [C219](#) for definitions of terms used in this test method.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *mixing room, n*—a room with controlled temperature and relative humidity where cement paste and mortar specimens are prepared.

3.2.2 *moist cabinet, n*—a compartmented storage facility of moderate dimensions with controlled temperature and relative humidity.

3.2.3 *moist room, n*—a “walk-in” storage facility with controlled temperature and relative humidity, commonly called a fog room when the prescribed relative humidity is achieved by the atomization of water.

## 4. Requirements for Cement Mixing Rooms

4.1 The temperature of the air in the vicinity of the mixing slab, molds, and base plates shall be maintained at  $23.0 \pm 4.0$  °C and at a relative humidity of not less than 50 %.

4.2 The temperature of the mixing water used to prepare cement paste and mortar specimens shall be  $23.0 \pm 2.0$  °C.

## 5. Temperature Measuring Devices

5.1 *Reference Temperature Measuring Device*—used to verify the temperature recorder, must be accurate and readable to 0.5 °C. A copy of the certificate or report which verifies the accuracy shall be available in the laboratory.

NOTE 1—The ice-point method described in Test Method [E77](#) may be used to ensure that no damage to the reference thermometer has occurred during shipping.

5.2 *Temperature Recorder*—shall record temperatures every 15 min or less and shall be accurate and readable to 1 °C. The data from the recorder shall be evaluated at a minimum of once each week. A record of this evaluation documenting the date checked, a confirmation that the data is within the required temperature range, and the name of the individual performing this evaluation shall be maintained in the laboratory. (Note 2)

NOTE 2—This requirement may be satisfied by an initialed and dated temperature recorder chart. Brief changes in the temperature due to door openings should be ignored.

5.2.1 The temperature recorder shall be verified at least every six months or whenever there is a question of accuracy.

5.2.1.1 For moist cabinets and rooms, position the reference temperature measuring device in a readable position in air as near as practical to the temperature recorder probe. Keep the door closed for at least 5 min prior to taking readings. Record the temperature readings of both the temperature recorder and the reference temperature measuring device. When taking these readings, the reference temperature measuring device shall remain in the moist cabinet or room and read immediately upon opening the door.

5.2.1.2 For water storage tanks, position the reference temperature measuring device in a readable position in water as near as practical to the temperature recorder probe. Without removing the reference temperature measuring device from the water, record the temperature readings of both the temperature recorder and the reference temperature measuring device after the temperatures have stabilized.

5.2.1.3 Verify the accuracy of the temperature recorder by comparing the reading of the temperature recorder with that of the reference temperature measuring device during the normal operation of the moist cabinet, moist room or water storage tanks. If the difference between the temperature readings is greater than 1 °C, the temperature recorder shall be adjusted to within 0.5 °C of the reference temperature measuring device.

6. Requirements for Moist Cabinets and Moist Rooms

6.1 *General*—Except during those times when specimens are being placed into or removed from storage, maintain the atmosphere in a moist cabinet or moist room at a temperature of 23.0 ± 2.0 °C and a relative humidity of not less than 95 %. Maintain atmospheric conditions within a moist cabinet or moist room such that test specimens in storage are saturated with moisture to the degree needed to ensure that the exposed surfaces of all specimens in storage both look moist and feel moist (see Note 5). Equip all moist cabinets and moist rooms with a temperature recorder. The use of humidity recording devices is optional. Keep shelves on which fresh specimens are placed level.

6.1.1 The air temperature inside the moist cabinet or moist room shall be controlled with provisions made for heating or cooling, or both, as may be necessary. This shall be accomplished in one of two ways:

6.1.1.1 Thermostatically control the air temperature within the moist cabinet or moist room when surrounding space is not conditioned. In this case the sensing element for the controls shall be located inside the moist cabinet or moist room.

6.1.1.2 Thermostatically control the space surrounding the moist cabinet or moist room and manually control the temperature within the moist cabinet or moist room.

6.1.2 In either of the preceding cases, the laboratory shall demonstrate the ability of the controls to maintain the required temperature in the moist cabinet or moist room over an extended period of time. Data from the temperature recorder that indicates that the temperatures are within the temperature limits specified in 6.1 shall be required as evidence of this ability.

6.2 *Moist Cabinets*—A moist cabinet shall be constructed of durable materials and the doors shall be tight-fitting. The specified relative humidity shall be maintained by the use of one or more fog sprays, water sprays, or curtains of water on the inner walls that are so directed that the discharge will collect in a pool at or near the bottom of the moist storage section.

6.3 *Moist Rooms:*

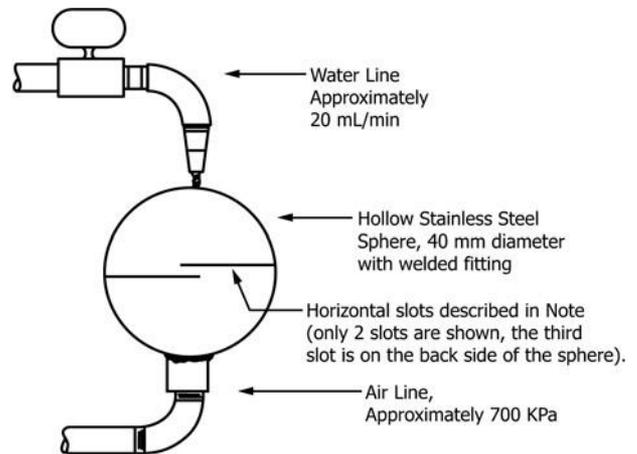
6.3.1 *General*—The walls of a moist room shall be constructed of durable materials, and all openings shall be provided with tight-fitting doors or windows (Note 3). Maintain the specified relative humidity by any convenient and suitable manner (Note 4).

NOTE 3—Well insulated walls will substantially help maintain necessary conditions.

NOTE 4—A fog spray found suitable for this purpose is shown in Fig. 1.

6.3.2 *Moist Rooms Used in Cement Testing*—Durable shelving that is properly shielded to prevent droplets of water from falling on the surfaces of freshly molded specimens shall be available within each moist room.

6.3.3 *Moist Rooms Used in Concrete Testing*—Maintain atmospheric conditions within each moist room such that test specimens in storage both look moist and feel moist (see Note 5). Do not expose specimens to dripping or running water.



NOTE 1—Cut three horizontal air slots around circumference of hollow sphere using a 0.20 mm thick diamond lapidary saw covering 120° to 150° each and spaced approximately 5 mm apart. Air passing through these slots strikes the water (which is flowing over the outer surface of the sphere) to produce a spray.

FIG. 1 Example of a Fog Spray for Maintaining Relative Humidity in Moist Rooms (Full Scale)

NOTE 5—Maintenance of adequate water spray(s) and adequate spray distribution in the moist room will result in stored specimens looking and feeling moist and will maintain the required humidity. Inadequate numbers of spray nozzles, partially obstructed spray nozzles, or disturbances in the moist air system such as open doors, air-conditioning or heating drafts, or overly crowded shelf space may result in relative dry spots. Specimen surface texture and age can influence the surface appearance and should be considered when specimens in localized areas do not look and feel moist.

## 7. Requirements for Water Storage Tanks

7.1 *General*—Tanks shall be constructed of non-corroding materials. Maintain storage water temperature at  $23.0 \pm 2.0$  °C, except for those times when specimens are being placed into or removed from storage, or tank maintenance is being performed.

7.1.1 *Tank Temperature Controls*—Provision for automatic control of water temperature at  $23.0 \pm 2.0$  °C shall be made where a tank is located in a room not having temperature controlled within the specified range and in any other instance where difficulty in maintaining temperatures within the specified range is encountered. With the exception of water storage tanks located in a moist room or moist cabinet, all water storage tanks shall be equipped with a temperature recorder with its sensing element in the storage water. For the purpose of temperature recording, a group of water storage tanks may be considered one tank if the following three conditions are met: (1) all the tanks are interconnected with tubing that allows the water to flow between the tanks, (2) some means of circulation is provided between tanks, and (3) temperature variation between the tanks must not exceed 1.0 °C when checked and recorded weekly.

7.2 *Tank Storage Water*—The water in a storage tank shall be potable water saturated with calcium hydroxide to prevent leaching of calcium hydroxide from the specimens (Note 6). Water not saturated with calcium hydroxide (high-calcium hydrated lime) may affect test results due to leaching of lime from the test specimens and shall not be used in storage tanks. To maintain saturation with calcium hydroxide, excess calcium hydroxide shall be present. For the purposes of lime saturation to prevent leaching, lime means high-calcium hydrated lime, not calcium carbonate (limestone)—see Terminology C51. The water in the storage tank shall be thoroughly stirred at intervals not to exceed one month to help replace calcium ions that have depleted. Tanks shall be cleaned and refilled with potable water containing 3 g/L of calcium hydroxide at intervals not to exceed 24 months (Note 7).

NOTE 6—pH is not a reliable indicator of lime saturation in storage tank water since severe reductions in dissolved calcium ions can occur before pH values are significantly reduced.

NOTE 7—The 3 g/L level is intended to provide a quantity of calcium hydroxide approximately two times that required for initial saturation.

7.2.1 Do not use continuously running potable water or reagent water in storage tanks because it may affect test results due to excessive leaching. The use of a closed system, circulating the saturated lime water between or among storage tanks, is permitted.

## 8. Keywords

8.1 cement paste; concrete; mixing room; moist cabinets; moist rooms; mortar; water storage tanks

## SUMMARY OF CHANGES

Committee C01 has identified the location of selected changes to this standard since the last issue (C511 – 19) that may impact the use of this standard. (Approved Dec. 1, 2021.)

(1) Revised subsections 7.2 and 7.2.1.

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Designation: C1231/C1231M – 23

# Standard Practice for Use of Unbonded Caps in Determination of Compressive Strength of Hardened Cylindrical Concrete Specimens<sup>1</sup>

This standard is issued under the fixed designation C1231/C1231M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval.

A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

## 1. Scope\*

1.1 This practice covers requirements for a capping system using unbonded caps for testing concrete cylinders molded in accordance with Practice C31/C31M or C192/C192M, or cores obtained in accordance with Test Method C42/C42M. Unbonded neoprene caps of a defined hardness are permitted to be used for testing for a specified maximum number of reuses without qualification testing up to a certain concrete compressive strength level. Above that strength, level neoprene caps will require qualification testing. Qualification testing is required for all elastomeric materials other than neoprene regardless of the concrete strength.

1.2 Unbonded caps are not to be used for acceptance testing of concrete with compressive strength below 10 MPa [1500 psi] or above 80 MPa [12 000 psi].

1.3 The text of this standard refers to notes and footnotes that provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the standard.

1.4 *Units*—The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two systems shall not be combined. Combining values from the two systems may result in non-conformance with the standard.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.* (**Warning**—Concrete specimens tested with unbonded caps rupture more violently than comparable specimens tested with

bonded caps. The safety precautions given in the Manual of Aggregate and Concrete Testing are recommended.<sup>2</sup>)

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

## 2. Referenced Documents

2.1 ASTM Standards:<sup>3</sup>

C31/C31M Practice for Making and Curing Concrete Test Specimens in the Field

C39/C39M Test Method for Compressive Strength of Cylindrical Concrete Specimens

C42/C42M Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete

C192/C192M Practice for Making and Curing Concrete Test Specimens in the Laboratory

C617/C617M Practice for Capping Cylindrical Concrete Specimens

D2000 Classification System for Rubber Products in Automotive Applications

## 3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *pad, n*—an unbonded elastomeric pad.

3.1.2 *unbonded cap, n*—a metal retainer and an elastomeric pad.

## 4. Significance and Use

4.1 This practice provides for using an unbonded capping system in testing hardened concrete cylinders made in accordance with Practices C31/C31M or C192/C192M, or cores obtained in accordance with Test Method C42/C42M in lieu of the capping systems described in Practice C617/C617M.

<sup>1</sup> This practice is under the jurisdiction of ASTM Committee C09 on Concrete and Concrete Aggregates and is the direct responsibility of Subcommittee C09.61 on Testing for Strength.

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<sup>2</sup> Section on Safety Precautions, Manual of Aggregate and Concrete Testing, *Annual Book of ASTM Standards*, Vol 04.02.

<sup>3</sup> For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

4.2 The elastomeric pads deform in initial loading to conform to the contour of the ends of the test specimens and are restrained from excessive lateral spreading by plates and metal rings to provide a uniform distribution of load from the bearing blocks of the testing machine to the ends of the concrete or mortar specimens.

## 5. Materials and Apparatus

5.1 Materials and equipment necessary to produce ends of the reference specimens that conform to planeness requirements of Test Method **C39/C39M** and the requirements of Practice **C617/C617M**. This may include grinding equipment or capping materials and equipment to produce neat cement paste, high strength gypsum plaster, or sulfur mortar caps.

### 5.2 Elastomeric Pads:

5.2.1 Pads shall be 13 mm  $\pm$  2 mm [ $\frac{1}{2}$  in.  $\pm$   $\frac{1}{16}$  in.] thick and the diameter shall not be more than 2 mm [ $\frac{1}{16}$  in.] smaller than the inside diameter of the retaining ring.

5.2.2 Pads shall be made from polychloroprene (neoprene) meeting the requirements of Classification **D2000** as follows:

Shore A Durometer	Classification <b>D2000</b> Line Call-Out
50	M2BC514
60	M2BC614
70	M2BC714

The tolerance on Shore A durometer hardness is 65. **Table 1** provides requirements for use of caps made from material meeting the requirements of Classification **D2000**, above.

5.2.3 Other elastomeric materials that meet the performance requirements of qualification tests in Section 8 are permitted.

5.2.4 Elastomeric pads shall be supplied with the following information:

5.2.4.1 The manufacturer's or supplier's name,

5.2.4.2 The Shore A hardness, and

5.2.4.3 The applicable range of concrete compressive strength from **Table 1** or from qualification testing.

5.2.5 The user shall maintain a record indicating the date the pads are placed in service, the pad durometer, and the number of uses to which they have been subjected.

5.3 *Retainers* are a pair of metal fixtures used to provide support for and alignment of the neoprene pads and the test specimen ends (**Note 1** and **Fig. 1**). Each retainer (upper and lower) includes a (retaining) ring that is welded to or manufactured integrally with a base plate. The height of the retaining ring shall be 25 mm  $\pm$  3 mm [1.0 in.  $\pm$  0.1 in.]. The inside

diameter of the retaining ring shall not be less than 102 % or greater than 107% of the diameter of the specimen. For test specimens having nominal diameters of 100 mm [4 in.] or less, the thickness of the retaining ring shall be at least 9 mm [0.35 in.] and the thickness of the baseplate shall be at least 8 mm [0.30 in.]. For test specimens having nominal diameters greater than 100 mm [4 in.], the thickness of the retaining ring and baseplate shall be at least 12 mm [0.47 in.]. The surface of the baseplate that contacts the bearing block of the testing machine shall be plane to within 0.05 mm [0.002 in.]. The bearing surfaces of the retainers shall not have gouges, grooves, protrusions, or indentations greater than 0.25 mm [0.010 in.] deep or greater than 32 mm<sup>2</sup> [0.05 in.<sup>2</sup>] in surface area.

**NOTE 1**—Retainers made from steel and some aluminum alloys have been found acceptable.

## 6. Test Specimens

6.1 Specimens shall be cylinders made in accordance with Practices **C31/C31M** or **C192/C192M**, or cores obtained in accordance with Test Method **C42/C42M**.

6.2 Depressions under a straight edge measured with a round wire gage across any diameter shall not exceed 5 mm

[0.20 in.]. If the specimen ends do not meet this tolerance, the specimen shall not be tested unless irregularities are corrected by sawing or grinding.

## 7. Procedure

7.1 Unbonded caps are permitted to be used on one or both ends of a test specimen in lieu of a cap or caps meeting Practice **C617/C617M**, provided the caps meet the requirements of Section 5. Pad hardness shall be in accordance with **Table 1**.

**NOTE 2**—The specified strength in the contract documents is for various stages of construction. This may include strength test requirements for formwork removal or release of prestress in addition to the test requirements for verification of specified compressive strength. Therefore, pad selection is based on the strength requirement for the designated stage of construction.

7.2 Replace pads that do not meet the dimensional requirements of 5.2 or that exceed the maximum reuse limits of **Table 1**. Insert pad in the retainer before it is placed on the specimen.

**NOTE 3**—Some manufacturers recommend dusting the pads and the ends of the specimens with corn starch or talcum powder prior to testing.

7.3 Complete the load application, testing, calculation, and reporting of results in accordance with Test Method **C39/C39M**.

**NOTE 4**—Some users have reported damage to testing machines from the sudden release of energy stored in the elastomeric pads.

**NOTE 5**—Occasionally, specimens tested with unbonded caps may

**TABLE 1 Requirements for Use of Polychloroprene (Neoprene) Pads**

Compressive Strength, <sup>A</sup> MPa [psi]	Shore A Durometer Hardness	Qualification Tests Required	Maximum Reuses
Less than 10 [1 500] 10 to 40 [1 500 to 6 000]	50	Not permitted None	100

develop early cracking, but continue to carry increasing load. For this reason Test Method **C39/C39M** requires test specimens to be loaded until it is certain that they have been compressed beyond their ultimate

17 to 50 [2 500 to 7 000]	60	None	100
28 to 50 [4 000 to 7 000]	70	None	100

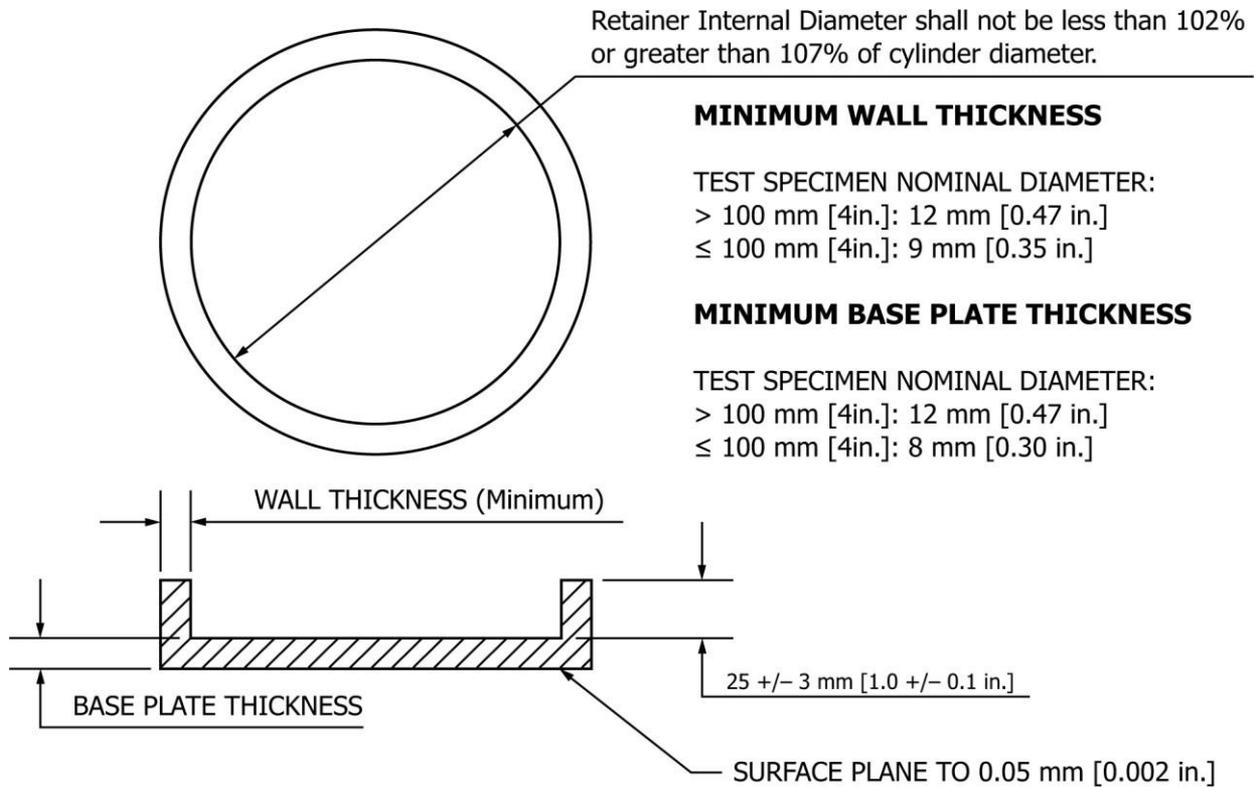


FIG. 1 Example of Retaining Ring and Base Plate

hardness. Unbonded pads made of other elastomeric materials must be qualified using the procedures in this section.

8.2 When qualification tests are required they must be made by either the supplier or user of the unbonded pads. The user of the pads must retain a copy of the current qualification test report to demonstrate compliance with this practice. See X1.1.

8.3 The compressive strength of molded cylinders tested with unbonded caps shall be compared with that of companion cylinders tested with ends ground or capped to meet requirements of Test Method C39/C39M and Practice C617/C617M.

8.4 To be acceptable, tests must demonstrate that at a 95 % confidence level ( $\alpha = 0.05$ ), the average strength obtained using unbonded caps is not less than 98 % of the average strength of companion cylinders capped or ground in accordance with 8.3.

8.4.1 When required, qualification tests in accordance with 8.5 shall be made on initial use of an unbonded cap at both the highest and lowest strength levels anticipated to establish an acceptable range of cylinder strength for use. In practice individual cylinders shall not have strengths more than 10 % greater than the high strength level or more than 10 % less than the low strength level qualified or specified in Table 1. Qualification tests shall be repeated whenever there is a change in the design or dimensions of the retaining rings, or when there is a change in pad composition or thickness, or the Shore A hardness changes by more than five units. Initial qualification tests shall include verification that after the specified maximum number of reuses the pads meet the requirements of 8.4.

8.4.2 When tests are made to establish a permissible number of reuses exceeding those in Table 1, only those tests or reuses which are within 14 MPa [2000 psi] of the highest strength level to be qualified will be included in the reuse count. Laboratories must maintain records of the number of times pads are reused.

NOTE 6—Pad life depends on the hardness and type of pad material, the strength of the concrete, the difference between the outside diameter of the cylinder and the inside diameter of the retaining ring, the unevenness and roughness of the ends of the cylinder, and other factors. Based on available information, scuffing or abrasion of the perimeter of the pad is normal, provided it does not reduce the thickness of the pad around the perimeter.

8.5 *Specimen Preparation for Qualification and Pad Reuse Testing:*

8.5.1 Pairs of individual cylinders shall be made from a sample of concrete and cured as nearly alike as possible: one cylinder per pair is to be tested after grinding or capping in accordance with 8.3 and the other is to be tested using the unbonded cap system.

8.5.2 A minimum of 10 pairs of cylinders shall be made at both the highest and lowest strength levels desired or anticipated (Note 7). The “strength level” is the average of the strengths of the 20 or more cylinders whose strengths are within a range of 7 MPa [1000 psi] (Note 8). More than one pair of cylinders can be made from a single concrete sample, but cylinders must come from a minimum of two samples made on different days for each concrete strength level (Note 9).

NOTE 7—If the Practice C617/C617M capped and unbonded capped

specimens produce equal strengths, the number of pairs of cylinders that will be needed to demonstrate compliance will range from 9 to more than 60 depending on the variability of test results. If the two capping systems produce equal strengths, about 10 % of laboratories will require more than 60 tests and 10 % of the laboratories will require 9 tests to demonstrate statistical compliance.

NOTE 8—Note that the range of strengths permitted in qualification testing to define the strength level is 7 MPa [1000 psi], but that in counting number of reuses only cylinders within a range of 14 MPa [2000 psi] are included in the reuse count.

NOTE 9—Cylinders for qualification tests can be from pairs of cylinders

tested in routine laboratory operations and, in most instances, special trial batches should not be required for qualification tests.

## 9. Calculation

9.1 For each strength level, compute the difference in strength for each pair of cylinders, and compute the average strength of the cylinders with reference caps and the average strength of the cylinders with unbonded caps, as follows:

$$d_i = x_{pi} - x_{si} \quad (1)$$

$$\bar{x}_s = (x_{s1} + x_{s2} + x_{s3} \dots + x_{sn})/n$$

$$\bar{x}_p = (x_{p1} + x_{p2} + x_{p3} \dots + x_{pn})/n$$

where:

$d_i$  = difference in strength of a pair of cylinders computed as the strength of unbonded capped cylinder minus the strength of the cylinder prepared according to Practice C617/C617M (may be positive or negative),

$x_{pi}$  = cylinder strength using unbonded cap,

$x_{si}$  = cylinder strength using Practice C617/C617M,

$n$  = number of pairs of cylinders tested for the strength level,

$\bar{x}_s$  = average strength of Practice C617/C617M capped cylinders for a strength level, and

$\bar{x}_p$  = average strength of unbonded cap cylinders for a strength level.

9.2 Compute the average difference,  $\bar{d}$ , and standard deviation of the difference,  $s_d$ , for each strength level, as follows:

$$\bar{d} = (d_1 + d_2 \dots + d_n)/n \quad (2)$$

$$s_d = \left[ \frac{\sum (d_i - \bar{d})^2}{n - 1} \right]^{1/2}$$

9.3 To comply with this practice the following relationship must be satisfied:

$$\bar{x}_p \leq 0.98 \bar{x}_s + (t_{\alpha})(s_d)/(n)^{1/2} \quad (3)$$

where  $t$  is the value of “students  $t$ ” for  $(n - 1)$  pairs at  $\alpha = 0.05$  from the following table:

$(n - 1)$	$t(\alpha = 0.05)^A$
9	1.833
14	1.761
19	1.729
100	1.662

<sup>A</sup> Use linear interpolation for other values of  $(n - 1)$  or refer to appropriate statistical tables.

## 10. Keywords

10.1 cap; compressive strength; concrete; concrete test; elastomeric; neoprene; pad cap; rubber; unbonded cap

## APPENDIX

### (Nonmandatory Information)

#### X1. SAMPLE REPORT AND CALCULATION

##### X1.1 Sample Report

X1.1.1 *Pad Material*—Lot 3742, Shore A = 52, Thickness 13 mm [0.51 in.].

X1.1.2 *Retaining Ring*—Set A manufactured 1–87.

X1.1.3 *Concrete Cylinders*: Job 1207, Nos. 1–10, January 2 to 5, 1987.

X1.1.4 *Sulfur Mortar*—Lot 3420. Compressive Strength of 48.2 MPa [6985 psi].

X1.1.5 All Tests 28 days age.

Cylinder	Neoprene	Sulfur	Difference,
Pair	Pad	Cap	d

**X1.2 Summary**

$x_s = 25.35 \text{ MPa [3679 psi]}$ ,

$x_p = 25.26 \text{ MPa [3663 psi]}$ ,  
 $s_d = 0.328 \text{ MPa [46.06 psi]}$ ,  
 $n = 10$ , and  
 $t = 1.833$ .



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	MPa	psi	MPa	psi	MPa	psi
1	24.9	3605	24.7	3580	0.20	25
2	24.9	3605	25.4	3690	-0.50	-85
3	24.7	3585	24.7	3595	0.00	-10
4	24.6	3570	25.0	3625	-0.40	-55
5	25.0	3625	25.1	3640	-0.10	-15
6	25.2	3660	25.8	3740	-0.60	-80
7	25.9	3750	25.6	3720	0.30	30
8	25.7	3725	25.6	3720	0.10	5
9	25.5	3700	25.7	3725	-0.20	-25
10	26.2	3805	25.9	3755	0.30	50

Average xp 25.26 3663 xs  
 25.35 3679 d -  
 0.090 -16  
 Std.  
 Dev.  
 sd  
 0.328  
 46.06

**X1.3 Calculation**

X1.3.1 Using Eq 3 in 9.3:

SI Units:

$$25.26 \leq (0.98)(25.35) + (1.833)(0.328)/(10)^{1/2}$$

$$25.26 > 25.03$$

(System Qualifies)



*Inch-Pound Units:*

$$3663 \text{ \$} = (0.98)(3679) + (1.833)(46.06)/(10)^{1/2}$$

3663 > 3632 (system qualifies at 3670 psi)

X1.4.1 caps; capping cylinders; compressive strength; pads; strength; unbonded capping system

### SUMMARY OF CHANGES

Committee C09 has identified the location of selected changes to this standard since the last issue (C1231/C1231M – 14) that may impact the use of this standard. (Approved Dec. 1, 2015.)

(1) Section 1.3 was added.

(2) Section 1.4 was revised.

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## ANEXO VIII

### Clientes atendidos por Control Mix Express S.A.C.

## RELACIÓN DE CLIENTES

1	JJC CONTRATISTAS GENERALES S.A.	41	LA VENTUROSA S.A.
2	CORBUS EDIFICACIONES	42	ARQUITECTURA & CONTRATISTAS GENERALES S.A.C.
3	PDK SAC	43	LARES INMOBILIARIA S.A.C.
4	COSAPI SA	44	VIVIENDAS DEL PERU S.A.C.
5	CONSTRUCTORA PROSPERA	45	PAT. EN FID., D.LEG.861, TÍT.XI-SUMAQA, NO INS. EN LA SMV, DIR. A INV. INST.
6	MC METCO	46	CONSTRUCTORA MAGNIFICA S.A.C.
7	CONSORCIO EJECUTOR AGRARIA II	47	CONSORCIO CONSTRUCTOR MC
8	DESARROLLO INMOBILIARIO FG	48	LTA INGENIEROS S.A.C.
9	DESARROLLO INMOBILIARIO FT	49	ACEROS Y CONCRETOS SAC
10	INVERSIONES FIDENZA	50	CONSTRUCTORA ESPIRAL CONICA S.A.C.
11	PAT.ENFID.NOINS.ENLASMV.DIR.AINV.INST.PROYECTO ALTO LIMA PARK	51	CONSTRUCTORA CYGNUS SAC
12	INVERSIONES INMOBILIARIAS DEL IGUAZU	52	ESPACIOS Y ESTRUCTURAS INMOBILIARIA S.A.C.
13	CONSTRUCTORA TERRAZUL	53	INMOBILIARIA ALEMANIA S.A.
14	INVERSIONES INMOBILIARIAS ARTICO	54	CONSTRUCTORA CAPON S.A.C.
15	INVERSIONES INMOBILIARIAS OCEANICA	55	VIVIENDAS DEL PERU S.A.C.
16	CONSORCIO OHLA-HV	56	GREEN HOME S.A.C
17	RINOL PAVIMENTA	57	CHECOR INGENIERIA Y CONSTRUCCION SAC
18	TALLER DE DISEÑO CONSTRUCTIVO	58	SIENA CONSTRUCTORES S.A.C.
19	GCC VIVIENDAS	59	PROYECTO BORGÑO S.A.C.
20	CONSTRUCTORA INARCO PERU	60	LTA INGENIEROS S.A.C.
21	MADRID EDIFICACIONES S.A.C.	61	S5 CONSTRUCTORA S.A.C.
22	DESARROLLO TANGUIS S.A.C.	62	ISIS C.E.I. S.A.C.
23	YANGZHOU RONGFEI CONSTRUCTION ENGINEERING CO. SUCURSAL DEL PERÚ	63	NEXO INGENIERIA S.A.C.
24	CONSTRUCTORA GERED S.A.C.	64	BERKES CONSTRUCCION Y MONTAJES S.A., SUCURSAL DEL PERU
25	CONSORCIO LAS RETAMAS S.A.C.	65	SAN LUCAS INVERSIONES INMOBILIARIAS S.A.C
26	INVERSIONES CUATRO REYNAS E.I.R.L.	66	INVERSIONES M HENDERSON SAC
27	DESARROLLO Y CONSTRUCCIONES URBANAS S.A. DE C.V. SUCURSAL DEL PERU	67	ESPACIOS Y ESTRUCTURAS INMOBILIARIA S.A.C.
28	E & P INGENIERIA Y DISEÑO S.A.C.	68	MYE GRUPO INMOBILIARIO S.A.C.
29	GERENCIA DE PROYECTO Y CONSTRUCCION S.A.C.	69	GRUPO CONSTRUCTOR EN CRECIMIENTO S.A.C.
30	CONSULTORIA & CONSTRUCCION GRUPO PERGOLA S.A.C.	70	GC REPUBLICA HIPOLITO S.A.C.
31	CONSTRUCCION Y SERVICIOS S.R.L	71	CPA INGENIEROS SAC
32	LARGOS RESIDENCIAL S.A.C.	72	TNC CONTRATISTAS S.A.C.
33	CONSTRUCTORA RIVERA FEIJOO S.A.C.	73	ENTRACAR SIERRA S.A.C.
34	FGA INGENIEROS SA	74	INMOBILIARIA LA CASTELLANA S.A.C.
35	GRUPO CONSTRUCTOR EN CRECIMIENTO S.A.C.	75	PRAGA PROYECTOS SAC -
36	ECO VITAL INMOBILIARIA S.A.C.	76	DECAL PROPERTIES S.A.C.
37	BRICONS S.A.I.C.F.I. SUCURSAL DEL PERU	77	MOVIHER CONTRATISTAS GENERALES S.A.C.
38	INVERSIONES Y DESARROLLO INMOBILIARIO SANTA MARIA S.A.C.	78	MINEROS CONTRATISTAS DEL PERU S.A.C.
39	S4 CONSTRUCTORA S.A.C.	79	EMPRESA DE SERVICIOS MULTIPLES ORELLANA & SERRANO S.A.C.
40	ARMANDO CONSTRUCTOR S.A.C.	80	CUATRO TORRES S.A.C. - Edificio Mar 170

81	Claudia Marsano Conroy	125	LOPEZ INGENIEROS S.A.
82	HILARIA CONSTRUCTORA E INMOBILIARIA SAC	126	DBASE CONSTRUCCIONES Y PROYECTOS S.A.C.
83	MOENIA BUILDING S.A.C. - Bristol	127	ROOT NUTRITION S.A.C.S
84	INSTELECT GROUP S.A	128	CONSTRUCTORA CORAL S.A.C.
85	DISEÑA CONSTRUCTORA S.A.C.	129	LA MURALLA GERENCIA Y CONSTRUCCION SAC
86	RM PROYECTOS E INVERSIONES S.A.C.	130	DG LATAM S.A.C.
87	ARCADA INMOBILIARIA E.I.R.L	131	MB CORP CONTRATISTAS S.A.C.
88	ENTRACAR SIERRA S.A.C.	132	CONSORCIO TORRE ROSALES
89	INVERSIONES SAURIS S.A.C.	133	VIALTO S.A.C.
90	INVERSIONES BOSTON SRL	134	CONSORCIO INGENIERIA I
91	JK INVERSIONES INMOBILIARIAS S.A.C.	135	INMOBILIARIA LOS AIRES DE CASTILLA S.A.C.
92	TAC GERENCIA Y CONSTRUCCION S.A.C.	136	VIVIENDAS DEL PERU S.A.C.
93	CONSTRUCCIONES Y TRANSPORTES HARD S.A.C.	137	INMOBILIARIA LA CASTELLANA S.A.C.
94	EE GALILEO S.A.C	138	ESPACIOS Y ESTRUCTURAS INMOBILIARIA S.A.C.
95	CONSORCIO GALVEZ CHIPOCO	139	COSAPI SA
96	DESARROLLO INMOBILIARIO FT S.A.C.	140	CONSORCIO SAN MARTIN HV
97	MACADAM PERU S.A.C	141	COSAPI SA
98	INMOBILIARIA MILENIO ASOCIADOS S.A.C.	142	CORPORACION VENTURA S.A.C.
99	TNC CONTRATISTAS S.A.C.	143	CONSORCIO LAMAR S.A.C
100	CASA BLANCA INMOBILIARIA S.A.C.	144	PROYECTO INMOBILIARIO M01 S.A.C.
101	P.A.DESARROLLOS INMOBILIAR.Y CONST.S.A.C	145	VIVA NEGOCIO INMOBILIARIO S.A.C.
102	INMOBILIARIA PAJUELO S.A.C.	146	MC METCO SAC
103	ARMANDO CONSTRUCTOR S.A.C.	147	4C GRUPO INMOBILIARIO S.A.C
104	R.E.S.Y. INGENIEROS S.A.C.	148	PDK PERU S.R.L.
105	PROMOTORA SAN VICENTE S.A.	149	GAIA CONSTRUCTORA S.A.C.
106	SMALL Y ASOCIADOS S.A. CONTRAT.GENERALES	150	PDK PERU S.R.L
107	TERRA INMOBILIARIA Y CONSTRUCTORA S.A.C	151	INMOBILIARIA VALKIRIA S.A.C.
108	DISEÑA CONSTRUCTORA S.A.C	152	INVERSIONES 4SD S.A.C.
109	BECA INGENIERIA, CONSTRUCCION Y GESTION S.A.C	153	E & P INGENIERIA Y DISEÑO S.A.C.
110	CAMPITELLI INMOBILIARIA S.A.C.	154	ARSENAL DE PREFABRICADOS DE CONCRETO S.A.C.
111	MADRID 01 S.A.C.	155	CONSTRUCTORA E INMOBILIARIA 10 DE ABRIL S.A.C
112	CORPORACION ALPE PERU INGENIERIA S.A.C.	156	JCB ESTRUCTURAS EIRL
113	INMOBILIARIA LA HABANA S.A.C.	157	YANGZHOU RONGFEI CONSTRUCTION ENGINEERING CO. SUCURSAL DEL PERÚ
114	FEVAVICVA CONSTRUCTORA S.A.C.	158	CONSTRUCTORA FRAME S.A.C
115	Armando Gabriel Ichikawa Oka	159	VALICO S.A.C.
116	ENFOCA REAL STATE S.A.C	160	DAGOSI S.A.C.
117	DESARROLLO PLAZA GRAU S.A.C	161	FUAN MENA INGENIERIA & CONSTRUCCION S.A.C.
118	EP EDIFICACIONES S.A.C.	162	A Y A EDIFICACIONES S.A.C.
119	MADRID 02 SOCIEDAD ANONIMA CERRADA	163	SALERNO INMOBILIARIA S.A.C.
120	E & P INGENIERIA Y DISEÑO S.A.C	164	GRUPO TALL TOWER S.A.C.
121	GRUPO CHACARILLA SUR S.A.C.	165	INGENIERIA Y CONSTRUCCIONES - HMBA S.A.C.
122	URSA CONSTRUCTORA S.A.C	166	INVERSIONES INMOBILIARIAS DEL SUDOESTE S.A.
123	LOAYZA & DIAZ CONSTRUCTORES S.A.C	167	ASUNCION SERVICIOS GENERALES S
124	CONSTRUCTORA MARTE S.A.		





# ANEXO IX

## Certificación ISO 9001:2015

Esta es una traducción del certificado PE14/175309

El sistema de gestión de

# CONTROL MIX EXPRESS S.A.C.

Parque Industrial El Lúcumo, Calle 8, Mz I1, Lote 9,10, Lurín, Lima, Perú.

ha sido evaluado y certificado que cumple con los requisitos de

## ISO 9001:2015

Para las siguientes actividades

Sistema Control Mix Express para el control de calidad del concreto en obras en lima, que incluye las actividades en forma integral de:

- Capacitación y certificación en muestreo y moldeo de probetas al personal del cliente.
- Control y ensayo: Suministro de módulos de muestreo, transporte, curado, ensayo de resistencia a la compresión de probetas de concreto, emisión y envío de certificados de ensayo de línea.

Este certificado es válido desde 4 de febrero de 2026 hasta 3 de febrero de 2029 y su validez está sujeta al resultado satisfactorio de las auditorías de seguimiento.

Edición 7. Certificada desde 4 de febrero de 2014

*L. Moran*

Autorizado por

Liz Moran

Business Manager

SGS United Kingdom Ltd

Rossmore Business Park, Ellesmere Port, Cheshire, CH65 3EN, UK

t +44 (0)151 350-6666 - [www.sgs.com](http://www.sgs.com)



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Certificate PE14/175309

The management system of

# CONTROL MIX EXPRESS S.A.C.

Parque Industrial El Lúcumo, Calle 8, Mz I1, Lote 9,10, Lurín, Lima, Perú.

has been assessed and certified as meeting the requirements of

**ISO 9001:2015**

For the following activities

Control Mix Express System for quality control of concrete at construction jobsites in Lima, Who jointly includes the following processes:

- Training and certification of client's personnel in sampling and molding of concrete specimens.
- Control and testing : supply of sampling modules, transportation, curing, compression testing of concrete specimens, issuance and delivery online of testing reports.

This certificate is valid from 04 February 2026 until 03 February 2029 and remains valid subject to satisfactory surveillance audits.

Issue 7. Certified since 04 February 2014

*L. Moran*

Authorised by

Liz Moran

Business Manager

SGS United Kingdom Ltd

Rossmore Business Park, Ellesmere Port, Cheshire, CH65 3EN, UK

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**ANEXO X**  
**Certificado de Acreditación**  
**INACAL - NTP-ISO/IEC 17025:2017.**  
**Requisitos Generales para la Competencia de los**  
**Laboratorios de Ensayo y Calibración**

# Certificado



**INACAL**  
Instituto Nacional  
de Calidad  
Acreditación

La Dirección de Acreditación del Instituto Nacional de Calidad – INACAL, en el marco de la Ley N° 30224, OTORGA el presente certificado de Renovación de la Acreditación a:

## CONTROL MIX EXPRESS S.A.C.

Laboratorio de Ensayo

En su sede ubicada en: Parque Industrial El Lúcumo, Calle 8, Mz. I1, Lote 9.10, distrito de Lurín, provincia y departamento de Lima.

Con base en la norma

**NTP-ISO/IEC 17025:2017 Requisitos Generales para la Competencia de los Laboratorios de Ensayo y Calibración**

Facultándolo a emitir Informes de Ensayo con Símbolo de Acreditación. En el alcance de la acreditación otorgada que se detalla en el DA-acr-06P-21F que forma parte integral del presente certificado llevando el mismo número del registro indicado líneas abajo.

Fecha de Acreditación: 30 de diciembre de 2024

Fecha de Vencimiento: 29 de diciembre de 2028



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**PATRICIA AGUILAR RODRÍGUEZ**  
Directora, Dirección de Acreditación - INACAL

Fecha de emisión: 27 de mayo de 2025



Cédula N° : D000196-2024-INACAL/DA  
Contrato N° : Adenda N° 01 del contrato N°088-2021/INACAL-DA  
Registro N° : LE - 168

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DA-acr-01P-02M Ver. 03