

Clarke, Modet & C^o
COLOMBIA

SEÑORES

DIVISIÓN DE NUEVAS CREACIONES

SUPERINTENDENCIA DE INDUSTRIA Y COMERCIO

E.

S.

D.

SUPERINTENDENCIA DE INDUSTRIA Y COMERCIO
Rad: 03-105202- -00005-0000
Fec: 2006-09-07 16:21:32 Dep. 2020 NUECREACIONES
Tra. 2 PATENTES
Eve: 1 REGDEPOSITO
Act 444 RESPUESTA REQUE Folios: 12

COD: 008

RE.: SOLICITUD DE PATENTE EN COLOMBIA

EXPEDIENTE N° 03105202

TITULO: PISOS Y RECUBRIMIENTOS PREFABRICADOS
CON ACTIVIDAD ANTIMICROBIANA

SOLICITANTE: CEMEX TRADEMARKS WORLDWIDE, LTD

FECHA SOLICITUD: NOVIEMBRE 28, 2000

ASUNTO: CONTESTACIÓN A REQUERIMIENTO OFICIAL

DILIA RODRIGUEZ D'ALEMAN, en mi condición de apoderada de la sociedad solicitante, por el presente escrito doy respuesta a su auto notificado por estado de 8 de junio de 2006, que vence 8 de septiembre de 2006 y me permito presentar las siguientes aclaraciones:

En procura de superar las objeciones relativas a la claridad y la excepción a la patentabilidad debida a que la Superintendencia de Industria y Comercio considera que algunas reivindicaciones hacen referencia al uso de agentes microbianos, el solicitante presenta un nuevo capítulo reivindicatorio en el cual se ha precisado la solicitud, señalando como objeto de la invención los pisos o recubrimientos prefabricados definidos por la mezcla de componentes que los constituyen

El nuevo capítulo reivindicatorio se modifica en virtud del artículo 34 toda vez que constituye una delimitación de la invención que no implica una ampliación del objeto divulgado inicialmente.

Clarke, Modet & C^o

COLOMBIA

Claridad

- La Superintendencia de Industria y Comercio ha determinado que el capítulo reivindicatorio no es claro ya que todo lo que el solicitante considera como nuevo lo basa en los resultados eficaces y duraderos que dependen del uso, lo cual resulta etéreo.

Para superar este cuestionamiento el nuevo capítulo reivindicatorio está dirigido a un producto, pisos y recubrimientos prefabricados con actividad antimicrobiana, elaborados a base de concreto, caracterizados por los componentes químicos que constituyen la mezcla a partir de la cual se producen los pisos reivindicados.

- Igualmente, advierte que no son aceptables en las reivindicaciones términos ambiguos como aproximadamente.

En el nuevo capítulo reivindicatorio se ha eliminado la mención del término "aproximadamente".

Para dar respuesta a esta objeción el solicitante ha redactado las nuevas reivindicaciones siguiendo los lineamientos indicados en el Manual Andino, que establece en su página 31: "Un ejemplo de reivindicaciones con dos partes son las siguientes: 'Composición que comprende A, B y C, caracterizada por que la concentración de A es menor a 3%.' En este caso es adecuada puesto que composiciones que comprenden los componentes A, B y C ya se conocen en el estado de la técnica (preámbulo) y la aportación de la invención es la concentración limitante de A (porción caracterizante)."

Así las cosas, basándose en las indicaciones del Manual, el solicitante reivindica un piso o recubrimiento prefabricado (la Composición en el Manual Andino) caracterizado porque comprende el material base (compuesto A) y el agente orgánico microbicida (compuesto B compuesto B), este último presente en la composición en una concentración de 0.01 a 0.5% en peso del compuesto A.

Clarke, Modet & C^o

COLOMBIA

En consecuencia, con el fin de superar los problemas que el examinador había indicado, el solicitante presenta específicamente un nuevo capítulo reivindicatorio que ahora se refiere a:

1. Pisos y recubrimientos prefabricados con actividad antimicrobiana, elaborados a base de concreto, caracterizados porque comprenden un material base y de 0.01% a 5% en peso del material base de por lo menos un agente orgánico microbicida seleccionado del grupo que consiste de derivados de fenol, organotinas, tetrahidrato de o-fenilfenato de sodio o cloruro de alquildimetil bencil amonio, y una mezcla de los mismos, homogéneamente distribuido en el material base.
2. Pisos y recubrimientos prefabricados con actividad antimicrobiana, elaborados a base de concreto, de conformidad con la reivindicación 1, caracterizado además porque dicho material base está compuesto por: de 5 a 50% en peso de cemento, hasta 50% en peso de agregados finos, de 20 a 30% en peso de agregados gruesos, de 0.01 a 5% en peso de aditivos.
3. Pisos y recubrimientos prefabricados con actividad antimicrobiana, elaborados a base de concreto, de conformidad con la reivindicación 1, caracterizado además porque dichos derivados de fenol son preferiblemente derivados de 2,4,4'-tricloro-2'-hidroxifenol, y dicha organotina es preferiblemente maleato de butilestaño.

Nuevo uso:

- La Superintendencia de Industria y Comercio afirma que la presente solicitud busca proteger un nuevo uso de agentes microbicidas para pisos y recubrimientos prefabricados. La legislación es muy clara en establecer que

69

Clarke, Modet & C^o
COLOMBIA

este tipo de invención no gozará de protección. No existe nada que aporte la solicitud a parte de un nuevo uso de un producto conocido en el estado del arte y que ya es aplicado en plásticos y muchos otros productos.

Respecto a la objeción mencionada en el párrafo anterior donde el examinador considera que la invención solicitada es un nuevo o segundo uso de los agentes microbicidas, nos permitimos respetuosamente controvertir dicha afirmación pues en ningún momento las reivindicaciones reclaman el uso de una sustancia, y como lo advierte el Manual Andino en su página 31, que sirvió de base para el actual capítulo reivindicatorio, las reivindicaciones están limitadas a un producto los pisos que comprenden un material base y un agente microbicida, donde la concentración de este último en la mezcla no supera el 5% de la cantidad de material base, y al proceso para su producción. Lo anterior demuestra de manera evidente que el objeto de la presente invención no es ni el agente microbicida ni su uso, es más, la palabra "uso" ni siquiera es mencionada en el nuevo capítulo reivindicatorio.

Complementando lo mencionado anteriormente, es de subrayar que el agente microbicida como tal no presenta ningún nuevo uso, pues el compuesto en si es reconocido como agente antimicrobiano y el solicitante no reclama ni ese uso ni un uso distinto.

Finalmente, el solicitante hace énfasis en el hecho que la mayoría de las formulaciones que constantemente obtienen patente en ese Despacho, independientemente del campo al que pertenezca, son **nuevas mezclas de compuestos ya conocidos** y no por eso puede afirmarse que el solicitante de dichas formulaciones esté reivindicando un uso distinto de uno de los elementos que conforman la mezcla.

Con todo respeto, la afirmación que realiza ese despacho cuando indica que la formulación de la mezcla para hacer el piso o el recubriendo es un nuevo uso del agente microbicida es errada, pues su aceptación sería tanto como aseverar que cualquier composición que comprende alcohol reivindica un nuevo uso de ese

40
6

Clarke, Modet & C^o

COLOMBIA

compuesto y por consiguiente, dichas composiciones no serían patentables, aún cuando cumplieran con los requisitos de patentabilidad.

En ese orden de ideas, ninguna nueva formulación o composición sería patentable, si ella está constituida por compuestos ya conocidos. Esta Posición resulta contraria a lo indicado en el Manual Andino que establece en su página 31, que incluso aquellas composiciones que comprenden componentes conocidos en el estado de la técnica podrían ser patentables si el aporte de la invención es la concentración limitante de uno de los componentes.

Novedad

En relación con la información a que hace referencia la Superintendencia de Industria y Comercio cuando indica la existencia de plásticos y otros productos que comprenden agentes microbicidas, el solicitante desea hacer énfasis en que la presente solicitud no está relacionada con el simple nuevo uso de agentes microbicidas, sino con un producto tal como un piso y/o recubrimiento prefabricado a base de concreto especialmente desarrollado, que posee propiedades antimicrobianas que son duraderas y eficaces contra la fijación, crecimiento y propagación de microbios sobre su superficie y que no posee las desventajas o inconvenientes de productos similares divulgados en el estado de la técnica, tales como propiedades antimicrobianas temporales o que se reducen por el uso o desgaste del producto.

Ninguno de los documentos encontrados en el estado del arte se relaciona con pisos y recubrimientos prefabricados con actividad antimicrobiana.

Aunque ese despacho no hace mención a ningún documento específico y por ende no es posible hacer un análisis más detallado sobre el cumplimiento de este requisito por parte de la invención reivindicada. El solicitante manifiesta que ha determinado que el estado de la técnica más cercano se relaciona específicamente con la protección de elementos metálicos de refuerzo embebidos en concreto, en este caso se aplica un

Clarke, Modet & C^o

COLOMBIA

aditivo químico antimicrobiano sobre la superficie. Esta aproximación es completamente distinta a la que se plantea en la presente solicitud, primero porque no se realiza una mezcla de compuestos, lo cual implica el trabajar en una formulación donde la combinación de los componentes no afecten las características propias de los elementos individuales, se garantice la obtención de una mezcla homogénea que conserve un buen acabado a la vista del consumidor y se logre una larga duración del efecto antimicrobiano; segundo porque se requiere establecer las cantidades en que se proporcionaran cada uno de los elementos, problema que no se presenta cuando se trabaja con metales y la sustancia se aplica en la superficie; y tercero porque en el caso de los metales se intenta evitar la biocorrosión, la cual es ocasionada por microorganismo distintos a los que atacan el concreto y por ende, las sustancias aplicadas son diferentes.

Existe otro tipo de aditivos bactericidas que se incorporan en un material cementante con el propósito de incrementar el rango de actividad bactericida y reducir la absorción de agua del concreto. En este sentido, la aproximación del estado de la técnica es totalmente distinta a la que se plantea es la solicitud en cuestión pues la incorporación de un agente o mezcla de agentes antimicrobianos en la presente invención no tienen efectos sobre la absorción de agua. Adicionalmente, la duración del efecto antimicrobiano es mayor que la alcanzada cuando el agente tiene tan solo actividad bactericida.

Otra aplicación de agentes microbicidas está relacionada con la protección de miembros de concreto tales como paredes subacuáticas de concreto y tuberías de concreto, por medio de un forro o pared de concreto que comprende un agregado el cual ha sido impregnado con tóxicos químicos para los organismos marinos incrustantes. En el caso en estudio, el agente microbicida hace parte de la pasta homogénea que se coloca en los moldes para producir los pisos, como se indica en las reivindicaciones 4 y 5; su concentración ha sido determinada en un rango entre 0.01 y 5%, hay que recordar que los pisos tendrán contacto directo con humanos y animales así que la cantidad de agentes antimicrobianos deberá tener en cuenta este hecho; y

42
x

Clarke, Modet & C^o COLOMBIA

lo mejor, no se requiere de elementos adicionales, tales como forros o paredes para impregnarlo con los agentes químicos.

Nivel inventivo

El examinador no aporta ninguna referencia o documento donde se divulgue o sugiera la aplicación de agentes microbicidas en pisos o recubrimientos prefabricados que dé como resultado un producto con características microbicidas duraderas y eficaces.

El examinador afirma que las propiedades microbicidas obtenidas por la incorporación de un agente microbicida en un material plástico son iguales para un producto prefabricado a base de concreto. Sin embargo, para un experto en la materia no sería obvio que el efecto obtenido en una materia plástica sea asimilable a un material a base de concreto debido a sus diferentes propiedades fisicoquímicas. De la información aportada por la Superintendencia de Industria y Comercio no es posible establecer que los agentes microbicidas adicionados a la materia plástica sean los mismos y en la misma cantidad que se divulga en la solicitud en estudio.

Además, cómo podría deducir de manera evidente que el uso de aditivos microbicidas específicos empleados en una materia plástica produciría un efecto duradero y eficaz en una materia a base de concreto, cuando los elementos constitutivos de un material plástico son completamente distintos a los componentes de materiales a base de concreto?

Partiendo de los argumentos expuesto es claro que el resultado obtenido en la presente invención no es obvio ni deducible para una persona con conocimientos medios en la materia.

Además, una persona con conocimientos en el área no estaría en posición de determinar que el efecto de los aditivos conocidos en la técnica sería extrapolable en la fabricación de pisos y recubrimientos prefabricados en virtud de que las condiciones de

93
8

Clarke, Modet & Cº
COLOMBIA

producción a las cuales se someten son totalmente diferentes. Por lo consiguiente, no sería obvia para un experto en el área la selección de los agentes antimicrobianos para fabricar pisos o recubrimientos que posean una actividad antimicrobiana **eficaz y prolongada** que evita la fijación, crecimiento y propagación de microbios sobre su superficie, sin que exista ninguna afectación en la homogeneidad de la pasta ni en la calidad del producto; y sin que la incorporación de dicha sustancia ocasiona efectos adversos al contacto con humanos y animales.

En vista de los argumentos expuestos, se solicita respetuosamente a la Oficina de Patentes Colombiana retirar todas las objeciones.

Agradezco continuar con el presente trámite.

Señor Jefe,


DILIA RODRIGUEZ D'ALEMAN

MRO/srch



**FORMULARIO ÚNICO DE CORRECCIONES Y MODIFICACIONES
2000-10**

1) **SOLICITUD DE:**

☐ Corrección de error material

☒ Modificación a una solicitud

2)
SOLICITANTE

Nombre: CEMEX TRADEMARKS
WORLDWIDE, LTD.

Dirección: Romerstrasse 13, 2555
Brugg, Suiza
Nacionalidad o Domicilio: Brugg,
Suiza

Lugar de Constitución: Suiza

Teléfono:
E. Mail:

Fax:

IDENTIFICACIÓN

C.C. ☐ NIT: ☐

C.E. ☐ OTRO ☐

NÚMERO

3)
**REPRESENTANTE
O APODERADO**

Nombre: DILIA MARÍA
RODRÍGUEZ D'ALEMAN

Dirección: Carrera 11 N°. 86-53
Piso 6 Bogotá D.C.

Teléfono: 6181088 Fax: 6350824
E. Mail: info@clarkemodet.com.co

IDENTIFICACIÓN

C.C. ☒ NIT: ☐

C.E. ☐ OTRO ☐

NÚMERO: 41.654.882
TP: 20824 CSJ

4) **NUMERO DE EXPEDIENTE: 03105202**

5) **DESCRIPCIÓN DE LA CORRECCIÓN O MODIFICACIÓN SOLICITADA:**

Se presenta nuevo capítulo reivindicatorio

6) **Comprobante de pago No. 06-63,695**

Fecha: Agosto 22, 2006

7) **Anexos:**

☒ Comprobante de la tasa

☐ Poderes, si fuere el caso

☐ Certificado de Existencia y Representación legal, cuando el solicitante sea persona Jurídica

8)

Nombre: DILIA RODRÍGUEZ D'ALEMAN

Firma:

C.C.: 41.654.882 TP: 20824 CSJ

75/10

SUPERINTENDENCIA DE INDUSTRIA Y COMERCIO

NIT : 800176089-2

SUPERINTENDENCIA DE INDUSTRIA Y COMERCIO
Rad: 03-105202-00005-0000
Fec: 2006-09-07 15:21:32 Dep. 2020 NUECREACIONES
Tra. 2 PATENTES
Eve: 1 REGDEPOSITO
Act 444 RESPUESTAREQUE Folios: 12

RECIBO OFICIAL DE CAJA : 06 - 63,695
FECHA : AGOSTO 22 DE 2006

***** CONSIGNACION *****

DEPOSITANTE	TIPO PAGO	BANCO	CUENTA	No. PAGO	FECHA PGO	Vr. PAGO
CLARKE MODET Y CO. COLOMB	CONSIGNACION	BANCO POPULAR	050-00110-6	53271367	18/08/2006	6,382,000.00

***** C O N C E P T O *****

CANT.	RENTISTICO	CONCEPTO	TOTAL CONCEPTO	
1	50005-01-03	CAMBIO DE MODALIDAD Y MODIFICA	12 MARCAS Y LEMAS COMERCIALES	95,000.00
TOTAL :			\$ 95,000.00	

SGN: NOVENTA Y CINCO MIL PESOS

RESPONSABLE : _____

RECIBO DE CAJA APLICADO AL EXPEDIENTE No. _____

11/76

REIVINDICACIONES

1. Pisos y recubrimientos prefabricados con actividad antimicrobiana, elaborados a base de concreto, caracterizados porque comprenden un material base y de 0.01% a 5% en peso del material base de por lo menos un agente orgánico microbici da seleccionado del grupo que consiste de derivados de fenol, organotinas, tetrahidrato de o-fenilfenato de sodio o cloruro de alquildimetil bencil amonio, y una mezcla de los mismos, homogéneamente distribuido en el material base.
2. Pisos y recubrimientos prefabricados con actividad antimicrobiana, elaborados a base de concreto, de conformidad con la reivindicación 1, caracterizado además porque dicho material base está compuesto por: de 5 a 50% en peso de cemento, hasta 50% en peso de agregados finos, de 20 a 30% en peso de agregados gruesos, de 0.01 a 5% en peso de aditivos.
3. Pisos y recubrimientos prefabricados con actividad antimicrobiana, elaborados a base de concreto, de conformidad con la reivindicación 1, caracterizado además porque dichos derivados de fenol son preferiblemente derivados de 2,4,4'-triclora-2'-hidroxifenol, y dicha organotina es preferiblemente maleato de butilestaño.
4. Método para fabricar pisos y recubrimientos con actividad antimicrobiana caracterizado porque comprende los siguientes pasos:
 - a. dosificar un material base que está compuesto de cemento, agregados finos, agregados gruesos, aditivos y agua, en las proporciones adecuadas

Ugohort
O'Garke

17/12

acorde al diseño de resistencia requerido por la aplicación que se dará al piso o recubrimiento;

- b. añadir una cantidad efectiva de por lo menos un agente orgánico microbici­da;
- 5 c. mezclar los componentes del material base para formar una pasta homogénea;
- d. vaciar la pasta homogénea en moldes de forma y tamaño adecuados de acuerdo con al diseño de los pisos y recubrimientos;
- e. prensar la pasta homogénea contenida en los moldes para eliminar el
10 exceso de agua y obtener una pasta desaguada con densidad y porosidad adecuadas;
- f. desmoldar la pasta homogénea desaguada del molde;
- g. curar la pasta homogénea desaguada a temperatura ambiente durante 48 horas o mediante el uso de vapor de agua durante 24 horas para obtener
15 un piso o recubrimiento curado, prefabricado;
- h. calibrar el piso o recubrimiento curado para rectificar sus dimensiones; y
- i. pulir y abrillantar el piso o recubrimiento prefabricado.

5. El método para fabricar pisos y recubrimientos con actividad antimicrobiana de
20 conformidad con la reivindicación 4, caracterizado porque la cantidad efectiva de agente microbici­da adicionada en el paso b) varía de 0.01% a 5% en peso del material base.

**SUPERINTENDENCIA DE INDUSTRIA Y COMERCIO
DIVISIÓN DE NUEVAS CREACIONES**

2020

Bogotá, D. C., 3 de Octubre de 2006

P-520

Doctora

DILIA RODRÍGUEZ D' ALEMÁNRepresentante **CEMEX TRADEMARKS WORLDWIDE**

ASUNTO

Radicación No. **03-105202**

Trámite 002

Evento 001

Actuación 430

Oficio

Folios 028

11679

Como resultado del examen de fondo, realizado con fundamento en el artículo 45 de la Decisión 486 de la Comisión de la Comunidad Andina, se le comunica

1) Documentos estudiados:

- a) Para el presente estudio se tendrán en cuenta el capítulo descriptivo, comprendido en los folios 8 a 20 de la solicitud en estudio.
- b) Para el presente estudio se tendrá en cuenta el capítulo reivindicatorio que comprende 5 reivindicaciones en los folios 76 a 77 de la solicitud en estudio.
- c) Conforme lo establece los artículos 9, 10 y 11 de la decisión 486 de la Comisión de la Comunidad Andina, la presente solicitud en estudio fue presentada el 28 de noviembre de 2003, y en el momento de la radicación **SI** se reclamo prioridad de la primera solicitud presentada en México MX/PA/a/2002/012236

2) Objeto de la invención

- a) Las reivindicaciones 1 a 5 de la solicitud en estudio se refieren a pisos y recubrimientos prefabricados con actividad antimicrobiana, elaborados a base de concreto, caracterizados porque comprenden un material base y de 0,01% a 5% en peso del material base de por lo menos un agente orgánico microbicida seleccionado del grupo que consiste de derivados de fenol, organotinas, tetrahidrato de o-fenilfenato de sodio o cloruro de alquildimetilbencil amonio, y una mezcla de los mismos, homogéneamente distribuido en el material base
- b) El anterior producto busca mejorar las propiedades de ciertos pisos.
- c) Según la Clasificación Internacional de Patentes, la codificación para esta solicitud corresponde a E 04B 1/35

3) Claridad de la Solicitud, Reivindicaciones en referencia a un nuevo uso y Argumentos del Solicitante

El artículo 30 de la Decisión 486 de la Comisión de la Comunidad Andina establece que

"Las reivindicaciones definirán la materia que se desea proteger mediante la patente. Deben ser claras y concisas y estar enteramente sustentadas por la descripción. Las reivindicaciones podrán ser independientes o dependientes. Una reivindicación será independiente cuando defina la materia que se desea proteger sin referencia a otra reivindicación anterior. Una reivindicación será dependiente cuando defina la materia que se desea proteger refiriéndose a una reivindicación anterior. Una reivindicación será dependiente cuando defina la materia que se desea proteger refiriéndose a una reivindicación anterior.- Una reivindicación que se refiera a dos o más reivindicaciones anteriores se considerará reivindicación dependiente múltiple."

El art. 21 de la Decisión 486 de la Comisión de la Comunidad Andina establece:

"Los productos o procedimiento ya patentados, comprendidos en el estado de la técnica, no serán objeto de nueva patente, por el simple hecho de atribuirse un uso distinto al originalmente comprendido por la patente inicial."

El capítulo reivindicatorio continúa siendo ambiguo, y aun más los son las respuestas salidas de contexto enviadas por el solicitante y que evidencian un desconocimiento del arte y de los conceptos del sistema de patentes en Colombia.

Con respecto al uso, el solicitante hace una supuesta demostración "de manera evidente" que la "presente invención" no es ni el agente microbicida ni su uso, donde la palabra "uso" ni siquiera se menciona.... En primer lugar una reivindicación de uso no se determina simplemente porque en la reivindicación se encuentre explícitamente la palabra "USO"; esta se da de acuerdo al contenido de la reivindicación o la materia que el solicitante desee proteger, como ocurre en el presente caso. Si bien en la presente solicitud las reivindicaciones se encabezan como "pisos y recubrimientos prefabricados", el piso como tal comprende un material base (o sea, cualquier cosa), a la que se le suma un principio activo cuya actividad corresponde a un microbicida, de forma tal que dicho microbicida lo que hace es cumplir con su actividad antimicrobiana y proporcionar esta propiedad al "material base". Esto es lo que se desprende del contenido de las reivindicaciones, y de lo divulgado en la memoria descriptiva. Por esta razón esta oficina afirma que se trata de un nuevo uso, dado que lo que realmente se pretende proteger es un piso con actividad antimicrobiana lo cual se logra por la adición de una cantidad efectiva de un microbicida conocido a un material para pisos también conocido en el arte previo, con el propósito de que el piso tenga propiedades antimicrobianas. Este efecto, para cualquier persona del nivel medio, se consigue mediante la adición simple de un principio activo adecuado, al material que se quiere proteger de la actividad microbiana, o sea mediante el uso o utilización del microbicida en un material que en este caso corresponde al "material base" para pisos,

Con relación a que "la afirmación que realiza ese despacho cuando indica que la formulación de la mezcla para hacer el piso o el recubrimiento es un nuevo uso del agente microbicida es errada, pues su aceptación sería tanto como aseverar que cualquier composición que comprende alcohol reivindica un nuevo uso de ese compuesto y por consiguiente, dichas composiciones no serían patentables, aún cuando cumplieran con los requisitos de patentabilidad" deja entrever un desconocimiento explícito de lo que es un sistema de patentes.

En primer lugar, lo que afirma esta oficina es que la solicitud no aporta nada de acuerdo a la materia que se reivindica, porque tal como se presenta la reivindicación N° 1 (folio 21) lo que considera la parte característica de la invención (o sea lo que el solicitante considera novedoso) corresponde como ya se indico a un "material base" que no se define. Por lo tanto dicho aparte es totalmente ambiguo pues no se está refiriendo a ningún material en concreto. Cuando se habla de "Una cantidad efectiva de por lo menos un agente orgánico microbici da que proporcione un efecto eficaz y duradero", lo único que realmente se puede determinar es que se utiliza un agente orgánico microbici da que puede combinarse con cualquier material con el propósito de proporcionar un efecto antimicrobiano.

En segundo lugar, la comparación que se hace con relación a que "aceptar que corresponde a un nuevo uso sería tanto como aseverar que cualquier composición que comprende alcohol reivindica un nuevo uso de ese compuesto", resulta absurda, con una clara falta de criterio y totalmente fuera de contexto, puesto que para poder realizar tal afirmación es necesario ubicarse en el campo técnico a que pertenece la composición, la forma como se presenta, la finalidad que cumpliría el alcohol como componente, y un largo etcétera. Una cosa es especificar una composición con todos sus componentes de formulación y proporción de los mismos, y otra muy diferente tomar cualquier composición conocida y adicionar un componente (como por ejemplo alcohol antiséptico) para impartirle esta propiedad sin cambiar en esencia la composición original y la finalidad de la misma.

Como tercer punto, se tiene que enunciar que "un material base" o una composición general conocida en el estado de la técnica donde su característica sea que posee actividad antimicrobiana, se da justamente por el uso de un compuesto activo que es antimicrobiano, pero es claro que el material base como tal no cambia su esencia ni su utilización como piso o recubrimiento. De la misma forma, si se analiza el método para fabricar pisos según se reivindica (reivindicaciones 6 a 9, folios 22 y 23 o nuevas reivindicaciones 4 a 5 folios 76 y 77) se encuentra que la única característica que el solicitante considera como novedosa es el paso de añadir una cantidad efectiva de un agente orgánico microbici da, lo cual se efectúa en el momento de la dosificación de todos los componentes para su posterior homogenización. Nótese que se indica que la cantidad efectiva del agente microbici da dependerá del uso y condiciones ambientales del lugar donde se aplicará el piso, para evitar la fijación, crecimiento y propagación de microbios sobre la superficie. Aún más, en el folio 17 de la descripción se indica expresamente que *"el método preferido para añadir al menos un agente microbici da es simplemente mezclándole agente microbici da junto con los componentes del material base, por medios convencionales bien conocidos en el estado de la técnica"* y se indica que se obtiene una mezcla de concreto con actividad microbiana, de manera que todo se reduce a adicionar una cantidad efectiva de un componente activo para lograr un efecto antimicrobiano en un material para pisos cuya composición es universalmente conocida. No se muestra tampoco en el método reivindicado ninguna condición específica o tratamiento o forma de adicionar el componente activo a la formulación base, que permita determinar que el principio activo tenga una actividad duradera y eficaz; además puede ser utilizado cualquier agente microbiano o sea que no existe nada que permita determinar que se trata de un proceso y un producto específico. Lo que si se puede determinar es que simplemente se utiliza un agente antimicrobiano que puede ser adicionado a cualquier formulación de material base para pisos, en el mismo paso donde se dosifican los demás componentes y homogenizado simultáneamente con ellos.

Por otra parte, es claro que para lograr un efecto antimicrobiano se utiliza un agente o principio activo antimicrobiano, en el lugar, objeto o material que se desee proteger. Por tanto, es congruente afirmar que se trata de un nuevo uso en el sentido de que se adiciona un agente antimicrobiano a un material diferente a plásticos y otros productos donde ya se ha utilizado para producir el mismo efecto microbicida. Es más, el mismo solicitante aporta información sobre el estado de la técnica más próximo. Cabe anotar al respecto que realmente en el documento en estudio no se muestra ningún tipo de concreto o piso específico, así como tampoco existe sustento alguno que demuestre la efectividad y durabilidad del efecto antimicrobiano del piso o recubrimiento y tampoco se muestra ningún ejemplo comparativo frente al arte más próximo.

El solicitante hace algunos comentarios sobre la novedad y el nivel inventivo de la invención con respecto al arte más próximo. No aporta ningún documento, y al contrario, solamente presenta comentarios donde se afirma que: se conoce la protección de elementos metálicos de refuerzo embebidos en concreto donde se aplica un aditivo químico antimicrobiano sobre la superficie y, que esta aproximación, es completamente distinta a la que se plantea en la solicitud porque implica trabajar con una mezcla de compuestos donde no se afecten las características de los elementos individuales, se garantice la obtención de una mezcla homogénea que conserve un buen acabado y se logre una larga duración del efecto antimicrobiano. Aunque no es del caso entrar a discutir sobre estos requisitos de patentabilidad, al respecto cabe anotar que puede ser que se trate de materiales diferentes pero realmente lo que se busca es un efecto antimicrobiano que se da en ambos casos por la utilización de, precisamente, un agente antimicrobiano. El material y la formulación del mismo no son objeto de discusión por cuanto se tratan de un material base en general que no ha sido producto de la invención y de hecho se sabe que para cualquier formulación es necesario combinar componentes compatibles.: De la misma forma la mezcla debe ser homogénea y la "larga duración del efecto antimicrobiano", como ya se explicó, no muestra ninguna condición o forma de realización específica en el método que permita lograr esa larga durabilidad del efecto mencionado. La proporción de cada uno de los elementos no es relevante en este caso porque se trata de materiales base para pisos o recubrimientos tal como se desprende tanto de la descripción como de las reivindicaciones y el que las sustancias aplicadas sean diferentes porque se trata de microorganismos diferentes, lo único que indica es que se debe utilizar, como es lógico, un agente antimicrobiano que sea específico para un tipo de microorganismo (si este es específico), o utilizar agentes antimicrobianos en general o de amplio espectro, según los requerimientos o necesidades. Es decir que corresponde al uso del microbicida de acuerdo al efecto antimicrobiano que se quiera lograr en el material en el cual se aplique, independientemente de que sea en la formulación, en la superficie etc.

Expresa también el interesado que: existe otro tipo de aditivos bactericidas que se incorporan en un material cementante con el propósito de incrementar el rango de actividad bactericida y reducir la absorción de agua del concreto y que en este sentido la aproximación del estado de la técnica es distinta porque en la solicitud el agente antimicrobiano no tiene efecto sobre la absorción de agua y que la duración del efecto microbiano es mayor que la alcanzada cuando se tiene tan solo actividad bactericida. Al respecto cabe anotar que lo único que se puede concluir de lo dicho por el interesado es que se conoce en el arte previo la utilización de compuestos activos como bactericidas que resultan más específicos que los microbicidas, en materiales como concreto, cemento etc. para proporcionar la actividad microbicida o bactericida a dichos materiales. En cuanto a que la duración del efecto antimicrobiano es mayor que la alcanzada cuando el agente tiene tan solo actividad bactericida es algo que carece de sentido, porque

un principio activo no presenta un efecto más duradero frente a otro por el hecho de que su actividad este dirigida a una especie, o tipo de microorganismo específico, de manera que un agente antimicrobiano no presenta una actividad más duradera frente un bactericida simplemente por ser antimicrobiano y el otro bactericida. La actividad más o menos duradera y la eficacia del componente activo en una formulación o producto está dada por otros parámetros y condiciones en su proceso de obtención y/o en la forma de formulación, parámetros y condiciones que para una persona del nivel medio resultan obvios tener en cuenta y los cuales no se muestran en la divulgación de la materia a proteger ni forman parte de lo característico de lo reivindicado.

Se reafirma aún más el uso de agentes microbicidas según lo expresa el mismo interesado cuando indica que "otra aplicación de agentes microbicidas esta relacionada con la protección de miembros de concreto por medio de un forro o pared que comprende un agregado el cual ha sido impregnado con tóxicos químicos". El hecho de que la solicitud en estudio indique una concentración que deba estar de acuerdo a las condiciones de uso que se va a dar al piso, resulta obvia, puesto que una composición o una formulación de un producto se debe hacer con base en el campo técnico al cual se dirige y a los efectos que se quiere lograr. En realidad nuevamente solo se determina que se trata de un uso, pues el indicar la cantidad del microbicida que se adiciona no constituye un salto cualitativo en la regla técnica, siempre es necesario determinar la cantidad de principio activo de acuerdo a la aplicación final y al efecto que se quiera lograr y en este caso particular el producto consistente en un piso o recubrimiento a base de concreto es conocido y lo único que provee la invención es un efecto antimicrobiano mediante la utilización precisamente de un agente antimicrobiano. La forma como se aplica o incorpora el microbicida realmente no es la característica de la invención, dado que justamente en la solicitud en estudio no se ha hecho ningún aporte en este sentido, solo adicionar a la composición el principio activo para lograr un efecto antimicrobiano, que igual se logra en el caso de los miembros de concreto por medio de un forro o pared de concreto que incorpora igualmente un principio activo.

Con respecto al nivel inventivo son validos igualmente los argumento expuestos anteriormente, no obstante, y de acuerdo a la materia a proteger contemplada en las reivindicaciones y a la divulgación hecha en la memoria descriptiva, lo único que se puede deducir es que se ha utilizado un principio activo antimicrobiano, ampliamente conocido para lograr un efecto antimicrobiano en una composición base para pisos o recubrimientos. No se muestra ni existe sustento técnico que demuestre que las características del producto sean duraderas y eficaces, de hecho si son más duradera y eficaces es porque existen en el arte previo productos iguales o similares. De lo contrario no tiene sentido tal afirmación. De otra parte, la incorporación de un agente microbicida en un material plástico, es igual a la incorporación a un material a base de concreto, en el sentido de que su aplicación en el material seleccionado de efectúa para lograr un mismo fin como es el de proporcionar un material con propiedades antimicrobianas. Ahora bien, puede ser cierto que los materiales presentan propiedades fisicoquímicas diferentes, pero también lo es el hecho de que en la solicitud en estudio no se evidencia nada específico en la forma de realización e incorporación del principio activo que permita afirmar, como lo hace el interesado, que se obtiene un producto con característica microbicidas duraderas y eficaces y por ende se deduce que solo se aporta como inventivo la utilización de un agente antimicrobiano, algo muy obvio para una persona del nivel medio, así como también la selección de los principios activos adecuados para lograr el efecto deseado como ya se dijo de acuerdo al lugar y condiciones de uso del piso o recubrimiento en este caso. Es importante resaltar que los antimicrobianos

utilizados no son selecciones específicas y que son ampliamente conocidos así como sus propiedades, utilización tanto para uso humano, animal y en otro tipo de productos desde detergente, limpiadores, así como para protección de diferentes materiales,

Por último, y tomando la ambigüedad del solicitante, los pisos y recubrimientos prefabricados, (que comprenden cualquier material base) con las proporciones que coloca como características, son ampliamente conocidos por un técnico medio desde mucho antes del 1918 como lo demuestran apartes de un libro de texto de la época. Igualmente se anexa un libro de texto de 1954. Mucho menos lo es el procedimiento. Las técnicas las domina cualquier persona del oficio. Todo lo que el solicitante consideraría nuevo es agregar un microbicida. Pero eso no quiere decir que existe ni proceso nuevo ni producto nuevo, en la medida que el piso que intenta proteger cumple exactamente la misma función que lo que la técnica revela, el ingrediente adicional cumple con la función que se le encomienda y por tanto no existe efecto técnico nuevo o inesperado. El proceso continúa siendo el mismo, pues no cambia por el hecho de agregar un ingrediente extra, en proporciones mínimas. El solicitante mismo afirma que lo que le interesa proteger es pisos y recubrimientos prefabricados con actividad microbiana, donde a cualquier persona que pretenda solucionar el problema considera aplicar un microbicida tradicional a un piso tradicional. No existe ningún efecto inesperado y por tanto no se cumple la definición de invención. Simplemente se trata de usar un microbicida en un sitio en el que se necesita su aplicación. El procedimiento de fabricación del piso no tiene absolutamente nada que ver con el uso del microbicida.

En conclusión, la presente solicitud busca proteger un nuevo uso de agentes microbicidas, para pisos y recubrimientos prefabricados. La legislación es muy clara en establecer que este tipo de protecciones no serán otorgados. No existe nada que aporte la solicitud aparte de un nuevo uso de un producto muy conocido en el estado del arte y que ya es aplicado en plásticos, y muchos otros productos.

.De acuerdo a lo anterior, el capítulo reivindicatorio no cumple con el requisito de claridad de acuerdo a lo establecido en el Art. 30 de la Decisión 486 y lo que el solicitante pone a consideración para protección corresponde a un nuevo uso el cual no es objeto de protección de acuerdo a lo que contempla la legislación.

4) **Notificación**

En cumplimiento del artículo 45 de la Decisión 486 de la Comisión de la Comunidad Andina, se le indica que dentro del término de sesenta días contados a partir de la fecha de la notificación de la presente comunicación debe responder a la notificación. En caso de no dar respuesta al presente requerimiento, o si a pesar de la respuesta subsistieran los impedimentos para la concesión, se denegará la patente.

Notifíquese el presente oficio conforme a lo dispuesto por el numeral 5.2, literal e) del capítulo quinto del título primero de la Circular Única N° 10 de 2001

ALIX CARMENZA CÉSPEDES DE VERGEL
Jefe División de Nuevas Creaciones

El anterior requerimiento fue notificado por fijación en la lista, de fecha 12 OCT. 2006

Concepto Técnico N°	EXAMINADOR TÉCNICO	EXAMINADOR JURÍDICO
1571	Código No. 202013	Código No.

DESIGN OF
CONCRETE STRUCTURES

LEONARD CHURCH URQUHART

*Porter, Urquhart, McCreary & O'Brien
Consulting Engineers*

CHARLES EDWARD O'ROURKE

*Late Professor of Structural Engineering
Cornell University*

GEORGE WINTER

*Professor and Head of Department of Structural Engineering
Cornell University*

FIFTH EDITION

McGRAW-HILL BOOK COMPANY, INC.

New York Toronto London

1954

Owing to the untimely death of Professor F. O'Rourke, the coauthor of the first four editions, the present fifth edition has been prepared by L. C. Urquhart and George Winter.

Acknowledgment is made to Professor W. McGuire of Cornell University for his extensive contributions in revising Sections 8 and 11 and to H. Jack Leonard of East Orange, N.J., for his assistance on Section 11.

L. C. URQUHART
GEORGE WINTER

CONTENTS

PREFACE	v
SECTION 1	1
PLAIN CONCRETE	1
Concrete and Cements, 1. Aggregates, 3. Proportioning, 9. Design of Mortar Mixtures, 10. Water-Cement Ratio, 11. Yield and Strength, 13. Concrete Mixtures, 14. Design of Concrete Mixtures, 15. Control of Concrete Mixtures, 19. Mixing and Placing, 20. Curing, 21. Effect of Freezing, 22. Admixtures, 23. Compressive, Tensile, Transverse, and Shearing Strengths, 25. Elasticity, 26. Plastic Flow, 27. Contraction and Expansion, 28. Bond, 29. Weight, 29. Resistance to Fire, 29. Weathering Qualities, 30. Abrasive Resistance, 30. Effect of Various Substances on Hardened Concrete, 31.	
SECTION 2	33
GENERAL PROPERTIES OF REINFORCED CONCRETE	33
Types of Reinforcement, 33. Grade of Steel, 34. Coefficient of Expansion, 35. Modulus of Elasticity, 35. Bond between Concrete and Steel, 35. Development of Full Strength of Reinforcement in Bond, 39. Reinforced Concrete in Tension, 40.	
SECTION 3	41
BEAMS AND SLABS	41
Stresses in Homogeneous Beams, 41. Assumptions in the Theory of Flexure, 42. Plain Concrete Beams, 43. Flexure Analysis of Reinforced Concrete Beams, 44. Application to Design and Review, 48. Approximate Design Moments, 49. Placing the Reinforcement, 51. Allowable Unit Stresses, 52. Tables for Rectangular Beams, 56. The Transformed Section, 58. Slabs Supported on Two Sides, 63. Temperature Reinforcement, 64. Slabs Supported on Four Sides, 69. Diagonal Tension, 77. Reinforcement for Diagonal Tension, 83. Design of Web Reinforcement, 87. Spacing of Vertical Stirrups, 88. Arrangement of Bent-up Bars, 89. Bond Stresses, 91. Anchorage of Web Reinforcement, 92. T Beams, 93. Flexure Analysis of T Beams, 95. Shearing Strength of T Beams, 97. Beams Reinforced for Compression, 106. Formulas for Design, 107. Formulas for Review, 109. Diagrams for Review of Beams Reinforced for Compression, 112. Continuous T Beams, 116.	

SECTION 4

COLUMNS 122

Columns with Spiral and Longitudinal Reinforcement, 122. Columns with Longitudinal Reinforcement and Lateral Ties, 127. Composite, Combination, and Pipe Columns, 128. Unsupported Length and Limiting Dimensions, 129. Flexural Stresses in Columns, 130. Column Tables, 131.

SECTION 5

BENDING AND AXIAL STRESS 134

General Theory, 134. Rectangular Sections, 136. Circular Sections, 138. Allowable Stresses, 140. Design of Columns, 141. Illustrative Examples, 145.

SECTION 6

CONTINUOUS BEAMS AND FRAMES 150

Continuity of Reinforced Concrete Structures, 150. Continuous Beams, 152. Slope-deflection Method, 154. Tables of Fixed-end Moments, 163. Sidesway, 169. Moment-distribution Method, 173. With Sidesway, 181. Building Frame, Vertical Loads, 186. Building Frame, Horizontal Loads, 197. Effective Spans, Moments of Inertia, Support Conditions, 201. Preliminary Design, 204.

SECTION 7

FOOTINGS 207

Bearing Capacity of Soils, 207. Proportioning of Footing Areas, 209. Wall Footings, 215. Single-column Footings, 217. Multiple-column Footings, 224. Strap Footings, 235. Footings on Piles, 240.

SECTION 8

REINFORCED CONCRETE BUILDINGS 243

Floor and Roof Loads, 244. Floor and Roof Systems, 245. Walls and Partitions, 259. Stairways, 264. Design of Beam-and-Girder Floor, 266. Design of Ribbed Floor, 278. Flat-slab Floors, 287. Design of Flat-slab Building, 298.

SECTION 9

RETAINING WALLS 327

Earth Pressure, 328. External Stability, 334. Drainage and Other Details, 337. Design of Gravity Wall, 338. Design of Cantilever Wall, 340. Design of Counterfort Wall, 346.

SECTION 10

ARCHES 350

Types, Uses, Advantages, 350. Theory of Two-hinged Arches, 354. Theory of Fixed Arches, 359. Evaluation of Integrals, 366. Preliminary Design, 367. Shape of Axis, 367. Tables of Moments and Reactions in

Roof and Bridge Arches, 369. Hinges in Reinforced Concrete Structures, 375. Design of a Two-hinged Roof Arch, 377.

SECTION 11

SLAB, BEAM, AND GIRDER BRIDGES 387

Types of Bridges, 387. Loads and Design Specifications, 389. Abutments, 397. Construction Details, 400. Design of Slab Bridge, 402. Design of Deck-girder Bridge, 404. Design of Through-girder Bridge, 413. Composite Bridge Construction, 418.

SECTION 12

MODERN DEVELOPMENTS IN CONCRETE DESIGN 424

Ultimate or Plastic Design, 424. Stresses in Beams, 426. Jensen-PCA Method, 428. Whitney Method, 434. Practical Significance of Ultimate Design, 438. Prestressed Concrete, 441. Principles and History, 441. Stresses on Beams, 444. Design and Construction of Prestensioned Beams, 446. Design and Construction of Posttensioned Beams, 450. Additional Information, 454.

APPENDIX A. Standard Notations. 457

APPENDIX B. Allowable Unit Stresses (ACI Code). 459

APPENDIX C. Flat Slabs with Square or Rectangular Panels (ACI Code). 461

APPENDIX D. Tables and Diagrams 468

APPENDIX E. Columns Subjected to Axial Load and Bending. 500

INDEX 507

One of the best measures of the grading as it affects the workability of the mixture is the *fineness modulus*. The fineness modulus is an abstract number which is the summation of the percentages *retained* on the standard series of sieves, enumerated above, divided by 100. It is a definite indication of the surface area of the aggregate. Many combinations of different-sized particles may possess similar fineness moduli but for any particular type of aggregate similar fineness moduli will give reasonable assurance of similar plastic properties when incorporated in a concrete mixture. Typical sands, used as fine aggregate for concrete mixtures, have a fineness modulus varying from 2.4 to 3.2, with an average value of about 2.9. In general, sands with a fineness modulus less than 2.5 should not be used for concrete. It is often specified that any shipment of fine aggregate, made during the progress of the work, which shows a variation in fineness modulus greater than $0.20 \pm$ from the original sample be rejected or that a complete redesign of the concrete mixture be required.

Organic Impurities and Deleterious Substances. Organic impurities in sand, usually coatings deposited by water filtering through sand deposits, may be detected by the colorimetric test.¹ Foreign substances such as clay lumps, coal, and lignite, if present in any great amount, make the sand which contains them an undesirable aggregate. Any aggregate having more than $1\frac{1}{2}$ per cent by weight of clay lumps or more than 1 per cent by weight of coal and lignite should be rejected. The amount of coal and lignite may be determined by the test specified in ASTM C 123-44, while the amount of clay lumps may be determined by examining the various fractions which remain after the test for grading. Any particles that can be broken up with the fingers shall be classified as clay lumps, and the total percentage by weight of all the clay lumps shall be determined as a percentage of the original weight of the sample.

Extremely fine particles, such as will pass a No. 200 sieve, are not desirable in any great amount and it is recommended that aggregates containing more than 5 per cent of such particles for all concrete mixtures be rejected, with a limit of 3 per cent for those concretes which are subject to abrasion. The amount in any aggregate may be determined by the test specified in ASTM C 117-49.

Mortar Strength. A final test for a sand as a fine aggregate may be made by comparison with standard Ottawa sand.² It is generally specified that mortar specimens made with the fine aggregate when tested in

¹ ASTM C 40-48.

² Standard Ottawa sand is a natural sand obtained at Ottawa, Ill., passing a screen having 20 meshes and retained on a screen having 30 meshes per linear inch, prepared and furnished by the Ottawa Silica Co., Ottawa, Ill.

accordance with the mortar-strength test¹ shall have an average compressive strength of at least 90 per cent of the strength of similar specimens made with the same cement and Ottawa sand when tested at the age of not less than 7 days.

Soundness. Where the finished concrete is to be exposed to the weather or other destructive agencies, it is important that the aggregates be sound and hard so that the varying effects of the weathering or other destructive agencies will not act upon the exposed surface to produce pitting and disruptive action. Where such exposure is anticipated, the aggregates should be subjected to the accelerated soundness test as specified in ASTM Designation C 88-46T. When an aggregate is subjected to five alterations of this test the loss of weight should not exceed 8 per cent and in no case exceed 12 per cent for a fine aggregate, with corresponding limits of 12 and 15 per cent for a coarse aggregate.

1.6. Water. Water used for concrete should be clean and free from oil, acid, alkali, organic matter, or other deleterious matter. Sea water is not so desirable as fresh water, although where it has been used in structures subject to the weathering action of sea water no greater disintegration has resulted.

1.7. Proportioning of Ingredients. Haphazard and careless proportioning of the ingredients of concrete was formerly the rule rather than the exception, but the number of resultant failures is surprisingly small. In the early years of concrete construction little attention was paid to any of the ingredients except the cement. Specifications might require a clean, sharp sand and a coarse aggregate of a specified crushed stone, but there was little emphasis on the grading of the aggregates or on the amount of water to be used. On the other hand, on almost all work of any magnitude, frequent and exhaustive tests of the cement were required. Under those conditions the practice grew of specifying certain arbitrary proportions for the mix, such as 1:2:4, or 1:3:6. When a concrete of high structural strength was desired, a rich mix was specified, and mixtures as rich as 1:1:2 have occasionally been used, while for less important or more massive work, mixtures as lean as 1:4:8 have been specified. Unfortunately this practice of arbitrary proportioning has persisted to some extent to the present day, although it is now generally recognized that the relative consistency (amount of water used) has some relation to the strength of the resultant concrete.

The measuring of the quantities of the constituent materials is done either by volume or by weight. The latter method is much more accurate, but the former method requiring less equipment and having been in use for so many years was hard to replace. However, in the last few

¹ ASTM C 87-52.

years the uniformly better results which have been obtained where measurement by weight has been used has caused the construction industry to accept it without question for projects of any magnitude or importance. The development of the ready-mixed concrete industry in the last few years has contributed greatly to adoption of measurement by weight. As each ready-mix plant distributes concrete to a large number of projects, the cost of the weighing equipment and its accompanying facilities is readily amortized.

The proportions referred to above are proportions by volume, i.e., a 1:2:4 mixture indicates 1 cu ft of cement, 2 cu ft of fine aggregate, and 4 cu ft of coarse aggregate. Since the volume occupied by a given weight of cement varies by as much as 30 per cent for different degrees of compactness, it is necessary that the degree of compactness when used be known. For this reason it is usual to specify that one bag of cement weighing 94 lb shall be considered as 1 cu ft. Cement is sold by the bag, or in barrels of four bags each, or in bulk. Where used in bulk, means must be provided for weighing the loose cement in order to ensure the proper proportions.

The space occupied by a given number of sand grains varies considerably with the moisture content. Increases in volume of 25 per cent or more, caused by the addition of water to dry sand, are not uncommon.¹ Natural sand as it comes from the bank ordinarily contains from 2 to 4 per cent moisture by weight. Sand used in the laboratory is often entirely free from moisture, and sand used on the work may have either more or less moisture content than natural sand. For accurate proportioning, the moisture content must be taken into consideration when the measuring is done by volume. The bulking factor at the usual degree of moisture must be ascertained and proper allowances made, while at the same time the degree of moisture must be maintained as nearly constant as possible.

1.8. Design of Mortar Mixtures. In selecting the proportions of materials that are to go into a mortar it is often necessary and usually desirable to be able to predict the strength, permeability, and the amount of mortar that will result from a given proportion of the ingredients. If there are no air voids in a wet mortar (and tests show that this is practically true for consistencies used in practice), the resultant volume² of the mortar is equal to the absolute volume of the cement plus the absolute volume of the sand, plus the volume of water used. In the average cubic foot of cement (1 sack of 94 lb) there is 0.487 cu ft of solids. In 1 cu ft of sand the amount of solids depends upon the grading and the

¹ See *Proc. ASTM*, vol. 20, part II, p. 147.

² The absolute volume is the volume of the solid material, or the gross volume minus the volume of voids.

size of the grains. In beach sand there are from 0.60 to 0.63 cu ft and in commercial building sands about 0.68 cu ft of solids. The exact amount may be determined for any sand by obtaining its weight per cubic foot and its specific gravity.¹

Strength. The water in a mixture chemically reacts upon the cement and produces a colloidal coating on the particles. The finest particles of cement become completely colloidal, while some of the larger particles are never completely penetrated. This colloidal coating is the whole cementing action, and once sufficient water is present to produce this reaction, additional water tends to weaken the cementing material. Therefore, it is reasonable to expect that the strength of a mortar at any given age will vary with the amount of mixing water per unit quantity of cement, and the larger the amount of water, the weaker the mortar.

In Fig. 1.1 are shown the results of studies of several investigators. The increased strength shown by the later studies is due to the stronger cements produced today in comparison with those of 30 or more years ago. Figure 1.1 brings out clearly the direct relation between strength and *water-cement ratio*. Figure 1.2 shows the same relation, but here the water-cement ratio is expressed in gallons of water per sack of cement. This relation was first stated by Abrams² in 1918, whose curve of that date is shown in the figure. A more recent curve³ by the same investigator shows the improvement in cement in later years, and since the strength of plastic mixtures is independent of the amount and gradation of the aggregates, this later curve is applicable to the design of mortars for strength which use present-day portland cements. This curve cannot be used unless damp curing conditions are maintained.

In the measurement of water in a mixture all water outside the solid particles is included. Most sand is delivered in a more or less damp condition and the moisture that is carried must be determined and allowance made in determining the amount of water to add.

Permeability. The permeability of a mortar is measured by the rate at which water under a given pressure will pass through a given thickness of the material. When the mortar is mixed, not all the water reacts with the cement, and a large portion of it is really free water necessary in the mix to make it workable. As the mortar hardens, this free water gradually evaporates, thus providing air voids. The longer the mortar is cured in a damp condition, the greater the amount of water in permanent combination with the cement, and the less the amount of air voids. Excess water in the original mix will, of course, increase the air voids and make the mortar more permeable. Repeated tests have shown that a

¹ ASTM C 128-42.

² *Eng. News-Record*, May 2, 1918.

³ *Proc. ACI*, 1931, p. 1330.

reasonably watertight mortar cannot be obtained with a water-cement ratio greater than 7½ gal of water per sack of cement. In addition to a low water-cement ratio and prolonged curing, as dense a mixture as possible should be used.

Density. Other things being equal, a coarse-graded sand will produce a denser mortar than fine-graded sand. For any given proportion of

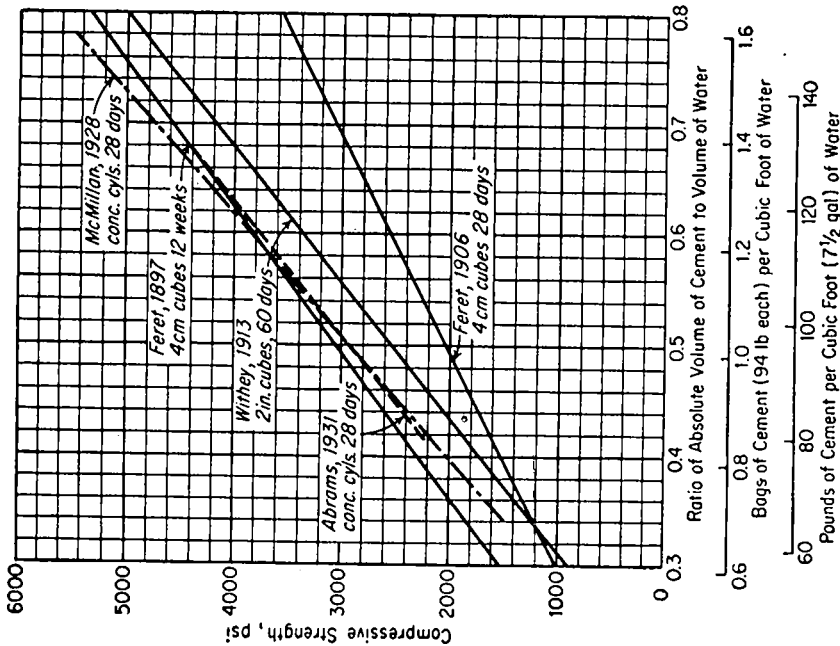


FIG. 1.1. Relation between compressive strength and absolute volume of cement to volume of water.

sand to cement, the voids in the mortar will vary with the volume of the mixing water used. In a very dry mortar the percentage of voids may be greater than in a wetter mix so that the voids decrease as water is added until the point of minimum voids (minimum volume of mortar) is reached. The addition of more water increases the voids. The exact proportions of cement, sand, and water that will produce the densest mortar vary for each sand, depending upon its gradation. In general, coarse sands take less water and less cement than fine sands.

Workability. There are so many factors affecting the workability of a mortar that no satisfactory method of measuring it has ever been developed. Gradation, shape of particles, and proportions all have their effect. A mortar allowed to stand for 1 or 2 hr and then reworked often is found more workable than the original mortar. Fine sand makes a more workable mortar than coarse sand, but since its water requirement is higher, the strength is decreased. In providing a workable mortar, care must be taken that strength and durability are not sacrificed.

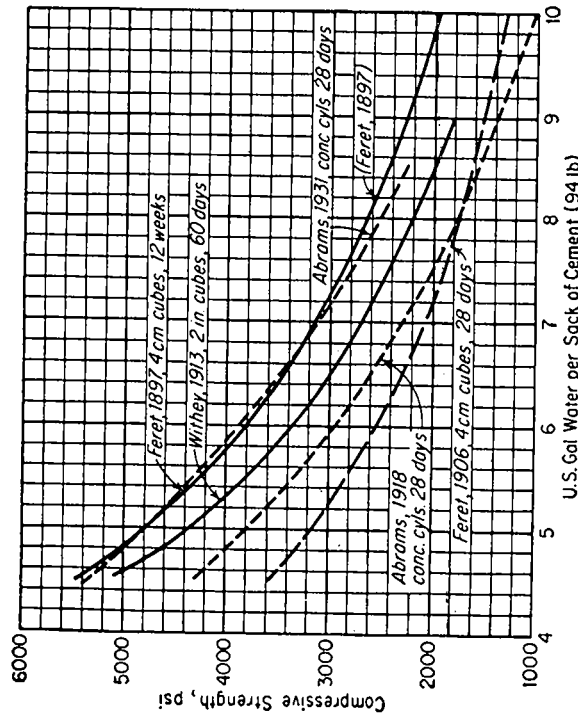


FIG. 1.2. Relation between compressive strength and water-cement ratio.

1.9. Determination of Yield and Strength. It is desired to supply 100 cu yd of 1:3 mortar which will reach a strength of 3000 psi in 28 days. The sand available has 35 per cent voids, weighs 100 pcf when dry, and contains 2 per cent of moisture by weight, in which condition it weighs 83 pcf. What quantities of materials are required?

Reference to Abram's curve in Fig. 1.2 shows that a 3000-psi mortar, cured damp for 28 days, should have 7.2 gal of water per sack of cement. A one-sack batch will yield

$$0.487 + 3 \times 0.65 + 7.2 \times 0.134 = 3.40 \text{ cu ft} = 0.126 \text{ cu yd}$$

In 100 cu yd there will be

$$100 \div 0.126 = 793 \text{ one-sack batches}$$

Therefore the quantities required are

Cement: 793 sacks

Sand: $3 \times 793 \div 27 = 88.1$ cu yd dry

Water: $7.2 \times 793 = 5710$ gal

However, since the sand contains 2 per cent moisture, the number of cubic yards in its moist condition is

$$100/83 \times 88.1 = 106 \text{ cu yd}$$

If this mortar were to be mixed in approximately 1-cu-yd batches (8 sacks), the sand and water for each batch would be as follows:

$$\text{Sand: } 3 \times 8 \times 100/83 = 28.9 \text{ cu ft}$$

$$\text{Water: } 7.2 \times 8 - (0.02 \times 28.9 \times 83) \div 8.35 = 52 \text{ gal}$$

In actual work some of the water in the mix is lost either by absorption by adjacent materials or by evaporation so that the actual yield is reduced from 2 to 4 per cent. This should be considered in making estimates of quantities of materials required for a given volume of mortar.

1.10. Concrete Mixtures. Concrete may be considered as a mortar mixture into which the coarse aggregate particles have been mixed, or it may be considered as a combination of the separate ingredients. In any case the factors governing the strength of a mortar hold true for a concrete, provided a suitable coarse aggregate is used. Since the water in the mixture has to wet the surfaces of the coarse aggregate particles as well as those of the cement and sand grains, it follows that the larger the size of the coarse aggregate, the less the water that will be required for a given consistency; hence greater strength and durability.

Design specifications have not kept pace with the improvement in cement in recent years. For this reason caution should be exercised in designing for low specified strengths. With fair curing conditions a compressive strength of 2000 psi in 28 days may be obtained with a very lean mixture, but the resulting concrete will be neither watertight nor capable of withstanding ordinary weather conditions. Experience has shown that concrete exposed to the elements should not have a water content of more than $7\frac{1}{2}$ gal per sack of cement.

A concrete must have a certain degree of workability, but, as for mortars, no method has yet been developed which is an accurate measure of workability. In the case of a concrete, this quality is influenced by the nature and amount of the coarse aggregate, as well as by the amounts of cement and water, and the amount and nature of the fine aggregate. A method of measuring the workability, or more properly the consistency, is the *slump test*.¹ A conical shell of 16-gauge galvanized metal with a base 8 in. in diameter, a top 4 in. in diameter, and a height of 12 in. is filled to overflowing with concrete rodded into the shell in three

¹ ASTM C 143-52.

separate layers, each receiving 25 strokes of a $\frac{5}{8}$ -in. bullet-end rod 24 in. in length. The excess is carefully struck off and the mold is at once lifted slowly vertically. The amount of drop of the top of the mass below the original 12-in. height, measured in inches, is known as the slump. Mass concrete and highway mixtures are workable with a slump of from 1 to 3 in. Concretes for reinforced beams and columns require a greater degree of workability, with slumps of from 4 to 6 in.

As in mortar, excess water in concrete dries out as the concrete ages, so that a watertight concrete should not have a water content of more than $7\frac{1}{2}$ gal per sack of cement. Careful grading of aggregates to obtain as dense a mixture as possible also tends to decrease the permeability, but the waste and consequent additional expense rarely warrant such a procedure.

1.11. Design of Concrete Mixtures. The determination of the relative proportions of cement, fine aggregate, coarse aggregate, and water constitutes the design of a concrete mixture. The requirements to be met are usually specified in terms of strength and workability (or slump). When severe exposure to the elements or other disintegrating agencies are to be expected, the strength requirement usually is superseded by the necessity of designing a concrete of greater strength than that required structurally. The workability or slump specified will be dependent upon the type and size of the members in the structure. In small members or those containing closely spaced reinforcement, a concrete should be designed with a comparatively large slump, while in mass concrete, large members, and lightly reinforced slabs, a concrete with very little slump will prove the most economical.

The *trial-batch* method of design is the one most widely used. From a table or from a curve similar to Fig. 1.3 is selected the water-cement ratio corresponding to the strength desired. To a water-cement paste or slurry of these proportions is added fine and coarse aggregate, until the appearance and successive slump tests indicate that the mixture has reached the specified workability. Normally such a trial batch is hand-mixed, the total weight being from 40 to 50 lb. The aggregates should previously have been brought to a saturated surface-dry condition¹ in order that they neither add nor extract water from the mixture.

From the relative weights of cement, water, and aggregates of the trial batch, it is possible to compute the yield, *i.e.*, the number of cubic feet per sack of cement, the cement factor, *i.e.*, the number of sacks of cement per cubic yard of concrete, and the actual quantities of each material to be incorporated in the size of batch to be used on the project.

The amount of water to be used in the project batch must be corrected for absorption by the aggregates during the period of mixing, if the aggregates are dry, and for the free water in the aggregates, if they are wet and

¹ ASTM C 128-42

carry free moisture. Moisture tests¹ on representative samples of the aggregates as the work progresses furnish the necessary information for this correction.

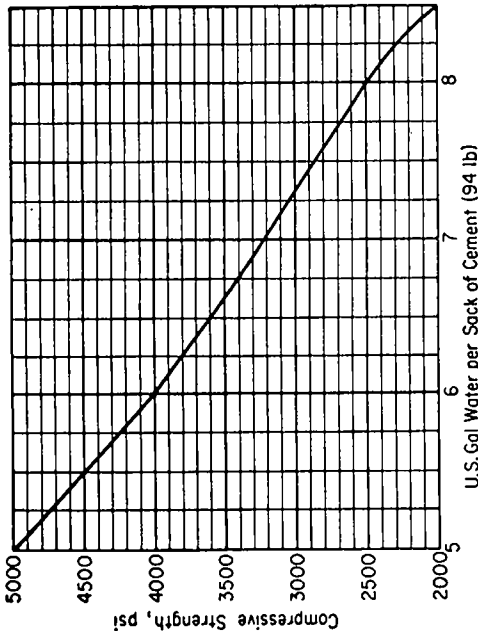


FIG. 1.3. Relation between water-cement ratio and compressive strength at 28 days. (Portland Cement Association Bull. T12, 1945.)

1.12. Illustrative Design by the Trial-batch Method. With accepted aggregates it is required to design a concrete mixture having a 4-in. slump and a 28-day standard-cured² compressive strength of 3000 psi. The specific gravity of both fine and coarse aggregate is 2.65. By reference to Fig. 1.3 it is indicated that 7¼ gal of water per sack of cement should produce a 3000-psi concrete. Five pounds of cement is arbitrarily selected for the trial batch. The amount of water to be used is therefore 5/4 × 7.25 = 0.386 gal = 3.22 lb. By successive additions of fine and coarse aggregate and occasional slump tests after thorough mixing it is found that 12.6 lb of saturated surface-dry fine aggregate and 21.4 lb of saturated surface-dry coarse aggregate produce the mixture desired. By multiplying the respective specific gravities by 62.4 the solid volumes in the batch are computed as follows:

	Weight in batch, lb	Solid weight of 1 cu ft, lb	Solid volume, cu ft
Cement (sp. gr. 3.15).....	5.00	196.6	0.026
Water.....	3.22	62.4	0.052
Fine aggregate.....	12.6	165.4	0.076
Coarse aggregate.....	21.4	165.4	0.129
Total weight and solid volume.....	42.2		0.283

¹ ASTM C 70-47.
² ASTM C 192-49.

The space occupied by the freshly mixed concrete consists of the solid constituents and the voids filled with the total amount of free water and the entrapped air. Unless an air-entraining agent is used (see Art. 1.18), the amount of entrapped air is so small that it may be neglected. The solid volume of the trial batch as computed above is 0.283 cu ft, and dividing the solid volumes of the constituents by 0.283, the relative solid volume of each material in a unit batch of any size is obtained as follows:

Cement: 0.026 ÷ 0.283 = 0.092
Water: 0.052 ÷ 0.283 = 0.183
Fine aggregate: 0.076 ÷ 0.283 = 0.269
Coarse aggregate: 0.129 ÷ 0.283 = 0.456
1.000

The weight of each material in a 1-cu-ft or 1-cu-yd batch can then be obtained as follows:

	Per cu ft, lb	Per cu yd, lb	
Cement:	0.092 × 196.6 = 18.1	× 27 = 489	= 5.20 sacks
Water:	0.183 × 62.4 = 11.4	× 27 = 308	= 36.9 gal
Fine aggregate:	0.269 × 165.4 = 44.6	× 27 = 1205	
Coarse aggregate:	0.456 × 165.4 = 75.6	× 27 = 2041	
	149.7	4043	

This concrete would be termed a 5.20 bag mix,¹ i.e., the cement factor is 5.20, as 5.20 sacks of cement are required per cubic yard of concrete. The yield, i.e., the quantity of concrete for one sack of cement, is
27 ÷ 5.20 = 5.19 cu ft

Proportioning by Volume. The bulk unit weight² of the fine aggregate has been determined to be 104.4 pcf and that of the coarse aggregate 105.0 pcf. The quantities required for 1 cu yd of concrete are

	Cu ft
Cement:	489 ÷ 94 = 5.20 = 5.20 sacks
Water:	308 ÷ 62.4 = 4.94 = 36.9 gal
Fine aggregate:	1205 ÷ 104.4 = 11.54
Coarse aggregate:	2041 ÷ 105.0 = 19.44

The proportions by volume are 5.20:11.54:19.44, or 1:2.22:3.73.

Adjustments for Water Content of Aggregates. In the above calculations from the trial batch the aggregates were assumed to be in the saturated surface-dry condition. In the field this condition rarely exists,

¹ Often referred to the nearest ¼ bag, in which case this would be a 5¼-bag mix.
² ASTM C 29-42.

and the amount of water in the aggregates as they are actually used may, if not considered in the design, seriously affect both the workability and the strength of the resultant concrete.

During the period of mixing and placing the aggregates will absorb a certain amount of water. It is usual to assume that saturated surface-dry aggregates will absorb approximately 1 per cent by weight during this period. For the 1-cu-yd mix designed above, therefore, the fine aggregate will absorb $0.01 \times 1205 = 12.05$ lb and the coarse aggregate $0.01 \times 2041 = 20.41$ lb, a total of 32.46 lb, or 3.9 gal. Thus the mixing water for the 1-cu-yd batch should be increased from 36.9 gal to 40.8 gal. However, such a correction rarely is necessary in the field as the aggregates are very seldom bone dry, but usually contain free water.

The aggregates may carry considerable free moisture, and where batch proportioning is by weight the mixture will, if uncorrected, contain not only an excess amount of water but also lack the proper amount of aggregate. If the accepted aggregates, as used in the field, are found to contain 3.5 per cent of free water and 1.0 per cent of free water in the fine and coarse aggregates, respectively, the weights of the moist aggregates must then be increased and become:

Fine aggregate: $1.035 \times 1205 = 1247$ lb, of which 1205 is fine aggregate and 42 lb is free water.

Coarse aggregate: $1.01 \times 2041 = 2061$ lb, of which 2041 lb is coarse aggregate and 20 lb is free water.

The original weights are now corrected for field use as follows:

	Saturated surface-dry, lb	Corrections, lb	Revised weights, lb
Cement.....	489	0	489
Fine aggregate.....	1205	+42	1247
Coarse aggregate.....	2041	+20	2061
Water.....	308	-62	246 = 29.5 gal

Without the above correction for the free water in the aggregates the total amount of water in the mix would have been $308 + 62 = 370$ lb, or 44.1 gal. This is equivalent to $44.1 \div 5.20 = 8.50$ gal per sack of cement with a consequent reduction in strength to 2000 psi.

As mentioned in Art. 1.7, the bulking effect on fine aggregate containing free water must be considered if proportioning is to be done by volume. In this example the fine aggregate containing $3\frac{1}{2}$ per cent of free water has a weight of 88.1 pcf, while this same quantity when thoroughly dried has a weight of 84.3 lb. Dividing the bulk unit weight of the fine

¹ ASTM C 70-47.

aggregate (104.4 lb) by 84.3 lb, a bulking factor of 1.24 is indicated. Therefore the volumetric proportions shown on page 17 must be corrected in order that sufficient fine aggregate is provided in the mixture, i.e., the amount of fine aggregate must be increased from 11.54 cu ft to $11.54 \times 1.24 = 14.31$ cu ft and the proportions by volume become 5:20:14.31:19.44, or 1:2.75:3.73, instead of 1:2.22:3.73. Unless the coarse aggregate has a grading which contains many small particles, the bulking effect is small and may be neglected.

The correction in the amount of mixing water must be made the same as for proportioning by weight. The fine aggregate contains

$$14.31 \times 84.3 \times 0.035 = 42 \text{ lb of water}$$

and the coarse aggregate (neglecting the slight bulking factor)

$$19.44 \times 105.0 \times 0.01 = 20 \text{ lb}$$

Therefore the amount of mixing water is reduced to 29.5 gal per cu yd, the value determined previously for weight proportioning.

1.13. Control of Concrete Mixtures. Where a small quantity of concrete is to be placed, elaborate examination and inspection of each batch are not warranted and economy is best served by keeping the water-cement ratio within the specified limit.

On the other hand, where large quantities of concrete are to be placed in important structures, special considerations are desirable to ensure economy and a uniform quality of concrete. Once the proportions of the constituent materials are selected, as long as the aggregates come from the same source, little trouble should be encountered in providing in each batch the proper amount of fine aggregate. The coarse aggregate may segregate in the stock pile and in such cases care must be taken to ensure uniformity. The percentage of moisture in the aggregates in the stock pile may have a considerable variance, and, as shown in Art. 1.12, this may have considerable effect on the strength and workability of the concrete. Therefore periodic determinations of the amount of moisture in the aggregate must be made. Whether measurement is to be made by weight or volume, and considerable variance of the amount of water in the aggregates is anticipated, a "job curve" for each aggregate and the amount of mixing water to be added is warranted. Such a series of curves shows the weight or volume of each aggregate and the amount of mixing water for the range of percentages of moisture expected in the aggregates.

In addition, tests of the quality of the concrete are made by taking representative specimens either at the mixer or at the forms for testing, usually at ages of 7 or 28 days after having been standard cured.¹ Job-

¹ ASTM C 39-49.

cured specimens, cured as nearly as possible as the concrete in the job is cured, are also sometimes advisable both to ascertain the quality of the concrete and to determine the safe time of form removal and the ability of the concrete to sustain a portion or all of its design load.

1.14. Mixing. Practically all concrete is machine-mixed. The ordinary mixer consists of a rotating drum, in the interior of which are blades so placed that, as the drum rotates, they lift the ingredients, which in turn slide off the blades and drop to the mass then at the bottom. Mixers vary from small laboratory machines of 1 or 2 cu ft capacity and small job one-bag mixers up to large mixers of 5 or 6 cu yd capacity.

A batch of concrete is normally mixed from 1 to 4 min after all materials are in the mixer, the longer periods being for the larger batches. Overmixing, if not carried to extreme, is objectional only because of the added cost and the grinding action on the fine aggregate, which tends to stiffen the mix.

Mixing for longer periods is the rule where concrete is delivered from a central mixing plant by means of a mixer mounted on a truck known as a "transit mixer." Experience has shown that these transit mixers may continue to rotate the concrete for an hour or more with no injurious effects. However, it is usual to specify that the concrete must be discharged into the forms within $1\frac{1}{2}$ hr from the time of the beginning of the mixing.

1.15. Placing. For many years it was the usual practice either to hoist the fresh concrete to a high tower for chuting or to locate the mixer above the job. The more fluid the mix, the greater the lengths of chutes that could be used, and the larger the area that could be covered from one location. This practice encouraged overwet mixtures, but with the acceptance of the water-cement ratio this practice was gradually discontinued. Placement of most building concrete is now made on horizontal runways by wheelbarrows or buggies that have been brought to the horizontal runways by hoists or elevators. The concrete should be deposited in horizontal even layers and not dumped all in one place and allowed to flow horizontally. It should then be tamped, spaded, or vibrated thoroughly before another layer is deposited. It is especially important that thorough spading or vibrating be done near the face of the form in order to ensure a smooth nonhoneycombed surface.

Excess working of the concrete brings too much of the water and fine aggregate to the upper portion of the layer, which produces a weak chalky layer of material known as laitance. Where continuous deposition is impossible, any such deposit of laitance should be scraped off and the concrete beneath roughened and wetted before placing is resumed. Where the deposition is continuous, which is of course desirable, it is good practice to decrease gradually the water-cement ratio toward the

top of the lift in order to offset the water gain on the surface of the several layers as the work progresses.

1.16. Curing. The principal variations in curing conditions which affect the process of hardening and the strength of the concrete are variations in moisture and temperature conditions. While it is important that the amount of water used in mixing be controlled so that the consistency be kept as nearly normal as possible, it is just as important that the concrete be not allowed to dry out immediately, if the maximum strength is to be obtained. All concrete should be protected against premature drying out for at least 1 week, and for a longer time when low temperatures prevail. This may be accomplished in several ways, the more usual of which follow:

1. Covering with an impervious paper, to minimize evaporation losses, and wetting down under the paper at short intervals to keep surfaces moist.
 2. Covering surfaces with burlap which is kept wet by sprinkling at frequent intervals.
 3. Ponding with earth dykes holding the water.
 4. Covering with earth or straw which is kept moist.
 5. Sprinkling at intervals.
 6. Applying a liquid which forms a membrane which prevents evaporation losses. This is often colored to ensure full coverage.
- The importance of keeping the concrete moist while hardening cannot be too strongly emphasized. Tests show that a concrete allowed to dry out immediately will usually reach a strength of not more than 50 per cent of the strength of similar concrete kept moist over the entire period of curing. Figure 1.4 shows this relation¹ graphically. All test specimens were tested at 4 months, having had various intervals of storage in damp sand. Each value is the average of 24 tests (four each for six consistencies).

The relation between the mean temperature during the curing period and the strength of concrete is illustrated by Fig. 1.5.² The tests from which the curves were plotted covered a wide range of temperature conditions, and the results were fairly consistent. A knowledge of the effect of the mean temperature upon the strength is very necessary in determining the time when forms may be removed and loads applied, and a careful study of Fig. 1.5 will furnish the necessary information for determining the relative length of time the forms should be kept in place under different temperature conditions.

By combining high temperatures with a saturated condition of the atmosphere, it would follow that accelerated hardening of the concrete

¹ Taken from *Lewis Inst. Structural Materials Research Lab. Bull. 2*.

² Taken from *Univ. Ill. Eng. Expt. Sta. Bull. 81*.

94

93

would be obtained. These conditions are brought into being by the application of live steam to concrete while hardening. This method is especially useful in the manufacture of concrete blocks, tile, small pipe, etc., where the saving in forms, storing space, and time is important. By placing the concrete products in a confined space, and applying the steam under pressure, a still more rapid increase in strength will be attained.

Pressures up to 150 psi with temperatures as high as 350° have resulted in the concrete obtaining in a few hours the strength which it would have attained under normal curing conditions in a period of several weeks.

1.17. Freezing. The effect of low temperatures in delaying the hardening of concrete is shown in Fig. 1.5. When water reaches a tempera-

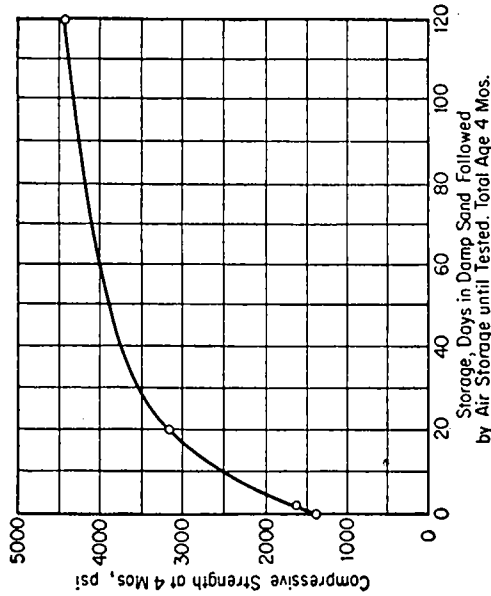


FIG. 1.4

ture of 39°F, some subtle change occurs which decreases its chemical ability for combination. This change becomes more marked as the freezing point is approached, and concretes placed with the temperature near the freezing point take several times as long to obtain a final set as concretes cured at normal temperatures. In case of dry atmospheric conditions much of the water may evaporate before the final set takes place, and insufficient water be left to combine chemically with the cement. In case the temperature falls below the freezing point before final set, the expansion of the water while freezing exerts a force sufficient to destroy the cohesion between the particles of the green concrete.

The injurious effect of freezing is lessened by two factors, namely, that concrete is a very poor conductor of heat, and that the chemical action of setting and hardening generates a certain amount of heat to combat the freezing action of the atmospheric conditions. Thus the serious

injury is usually confined to the surface of the concrete, and rarely penetrates more than an inch or two in depth. In massive members this may not seriously impair the strength, but be harmful only to the appearance. In the smaller members, however, a large percentage of the strength may be lost.

Various methods are used to prevent the freezing of concrete, such as heating the constituent materials and covering the green concrete. In building construction the fresh concrete is often housed in by canvas

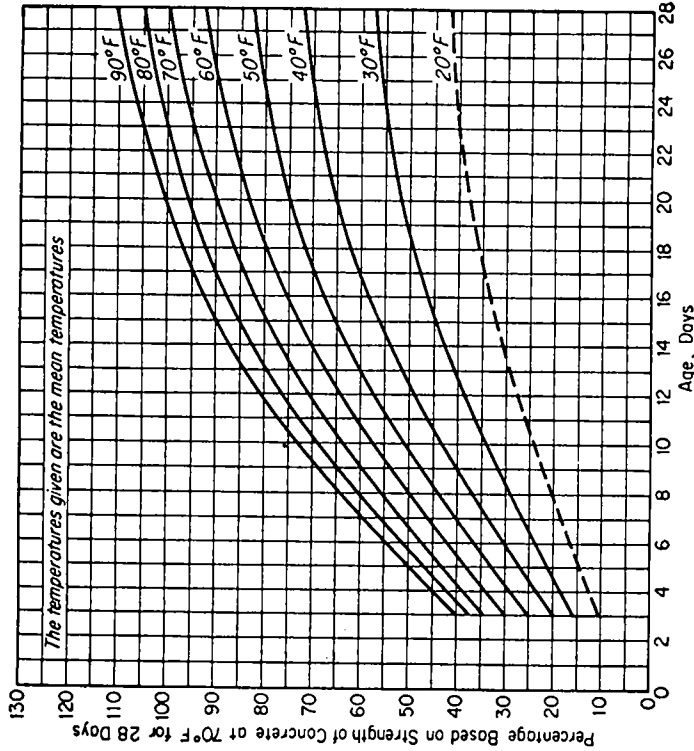


FIG. 1.5

curtains and the interior heated by stoves or "salamanders" to maintain above-freezing temperatures. In such cases it is important that sufficient moisture be supplied by sprinkling or the interjection of live steam in order that the artificial heat not dry out the concrete.

Generally it is advisable to protect the surface of the freshly poured concrete for a period of about a week and in all cases for a period of at least three days against freezing temperatures, keeping the surface temperature of the concrete well above the freezing point.

1.18. Effect of Admixtures. *Air-entraining Agents.* About 15 years ago it was discovered that air bubbles of microscopic proportions in the hardened concrete add greatly to its resistance to deterioration under

alternate freezing and thawing. Air-entraining agents are either introduced as additions interground with the clinker in the manufacture of the cement or introduced later as an admixture. The most commonly used agents are Vinsol resin and Darex. The usual increase in voids by the presence of the entrained air ranges from 3 to 6 per cent. When such an agent is used, the mixture becomes more workable and a higher ratio of coarse to fine aggregate may be used. The amount of water may also be reduced, usually by a percentage equal to about two-thirds of the percentage of the entrained air. Even with this reduction in water-cement ratio the compressive strength of rich mixtures is slightly reduced, while that of lean mixtures is slightly increased. However, the increase in the durability of concrete pavement against alterations of freezing and thawing where such an agent is present has led to its wide use, and it has also often been used for less exposed structures because of the favorable effect on the workability and texture of the concrete.

Accelerators. Calcium chloride is the most widely used accelerator. When used in the ratio of about 2 per cent of the weight of the cement, it increases the early strength of the concrete and provides a certain protection against freezing temperatures. If larger amounts are used, the ultimate strength of the concrete is substantially reduced.

Hydrated Lime. The use of hydrated lime in quantities up to 15 per cent of the weight of the cement has been advocated by various authorities on the theory that it improved the workability of the concrete or increased its strength and watertightness. In lean mixtures it is true that the addition of hydrated lime does have a marked effect in producing a more plastic and better working concrete. In the richer mixes this effect is less pronounced. Some tests have shown a slight increase in strength with the use of a small percentage of hydrated lime. It appears that if the hydrated lime is added without decreasing the amount of cement or increasing the amount of water, such an increase usually occurs, but if some of the cement is replaced by hydrated lime, a reduction in strength can be expected.

Water-repelling Agents. Various waterproofing compounds in powdered or liquid form are sometimes used to make a more impervious concrete. They are either added to the mixing water, mixed with the cement on the job, or added to the cement during its manufacture. Their function is to fill the voids or pores of the concrete with a more or less soapy, insoluble filler, and thus prevent the percolation of water through the concrete. The results obtained are varied. Some practically impervious concrete has been produced, while on other work the waterproofing has not been successful. Practically all the compounds in use detract from the compressive strength of the concrete. Fully as impervious concrete can generally be obtained by using a slightly richer

mix, well-graded fine aggregate, as stiff a consistency as possible, and thoroughly puddling the concrete as it is placed.

PROPERTIES OF CONCRETE

1.19. Compressive Strength. The ultimate strength of a concrete normally increases with age. This increase proceeds very rapidly for the first few days after the concrete is placed, but becomes more gradual as time goes on, though continuing at a more reduced rate for an indefinite period. The compressive strength of concrete at the age of 28 days, as determined by test specimens made and cured in accordance with ASTM C 192-49, is generally used as a measure of the quality of the concrete. This assumes proper mixing and placing and suitable curing conditions. The ultimate compressive strength expressed in pounds per square inch is used as a basis for determining the unit stresses to be used in design, for it has been found that practically all the other structural properties of a concrete are proportional to the compressive strength.

1.20. Tensile Strength. The tensile strength of concrete is a property of little importance, because it is so low in comparison with the compressive strength that it is usually neglected altogether in the design of reinforced concrete structures. It may roughly be estimated as having a value of about 10 per cent of the compressive strength.

1.21. Transverse Strength. The transverse, or flexural, strength of concrete is low as compared with its compressive strength, but much greater than the strength in pure tension. The transverse strength is measured by the stress developed in beam action. In a reinforced concrete member this strength is usually disregarded, and steel reinforcement is placed in the member to develop the flexural stresses on the tension side. Load tests, however, on reinforced concrete structures have shown that the transverse strength of the concrete contributes to a marked degree in increasing the capacity of the structure. Tests made by Duff A. Abrams¹ indicate that, at 28 days, the transverse strength varies from 26 per cent of the compressive strength for a 1000-psi concrete to 15 per cent for a 4000-psi concrete.

1.22. Shearing Strength. The shearing strength of concrete is important in that failure by shear on a diagonal plane often occurs in short compression specimens. The direct shear must not be confused with the combination of shear and diagonal tension that occurs in the web of a beam. The resistance of concrete to direct shear is difficult to determine, as it is almost impossible to eliminate the effect of bearing, diagonal tension, and other stresses, so that different series of tests show quite a variation from one another. For most concrete the shearing

¹ See Lewis Inst. Structural Materials Research Lab. Bull. 11.

CONCRETE

ENGINEERS' HANDBOOK

DATA FOR

THE DESIGN AND CONSTRUCTION OF PLAIN
AND REINFORCED CONCRETE STRUCTURES

BY

GEORGE A. HOOL, S. B.
CONSULTING ENGINEER

AND

NATHAN C. JOHNSON, M. M. E.
CONSULTING CONCRETE ENGINEER, NEW YORK CITY

ASSISTED BY

S. C. HOLLISTER, B. S.
CONSULTING ENGINEER, PHILADELPHIA, PA.

WITH CHAPTERS BY

HARVEY WHIPPLE, ADELBERT P. MILLS,

WALTER S. EDGE, A. G. HILLBERG

AND LESLIE H. ALLEN

FIRST EDITION
TWENTIETH IMPRESSION

2178

McGRAW-HILL BOOK COMPANY, INC.

NEW YORK AND LONDON

1918

Section 1. Materials

xi

CONTENTS

ART.	PAGE	ART.	PAGE
b. General laws.....	25	58. Modulus of elasticity.....	37
c. Effect of moisture on voids in sand and screenings.....	26	59. Steel specifications.....	37
d. Percentage of voids determined by weight.....	26	a. For bars rolled from billets.....	37
35. Tests of aggregates.....	27	b. For rolled bars.....	40
36. Notes on the selection and testing of aggregates.....	30	60. Factors affecting cost of reinforcing bars.....	42
37. Specifications for aggregates.....	30	61. Deformed bars.....	42
WATER			
38. General requirements.....	31	a. Diamond bar.....	42
39. Examination of water.....	31	b. Corrugated bars.....	43
40. Functions of water.....	31	c. Havermeier bars.....	43
41. Influence of quantity of water on strength of concrete.....	32	d. Rib bar.....	44
42. Influence of quantity of water on fluxing of cement.....	32	e. Inland bar.....	44
43. Influence of quantity of water on lubrication of concrete mixture.....	33	f. American bars.....	44
44. Influence of quantity of water on space occupied in resulting concrete.....	33	62. Wire fabric.....	45
45. Harmful effects of voids caused by excess water.....	34	a. Welded wire fabric.....	46
46. Excess water the cause of "day's work planes".....	34	b. Triangle-mesh wire fabric.....	47
47. Excess water the cause of large laitance deposits.....	34	c. Unit wire fabric.....	48
48. Excess water and waterproof concrete.....	35	d. Lock-woven steel fabric.....	49
49. Excess water causes unsatisfactory concrete floor surfaces.....	35	e. Wisco reinforcing mesh.....	50
50. Excess water prevents bonding new concrete to old.....	35	63. Expanded metal.....	50
51. Excess water and concreting in cold weather.....	35	a. Steelcrete.....	51
52. Suggested procedures to guard against use of excess water.....	36	b. Kahn mesh.....	52
REINFORCEMENT			
53. Types of reinforcement.....	36	c. Corr-X-metal.....	52
54. Surface of reinforcement.....	37	d. Econo.....	53
55. Quality of steel.....	37	e. G. F. expanded metal.....	53
56. Working stresses.....	37	64. Rib metal.....	55
57. Coefficient of expansion.....	37	65. Self-centering fabrics.....	56
		a. Hy-rib.....	56
		b. Corr-mesh.....	56
		c. Self-centering.....	56
		d. Chancelath.....	56
		e. Ribplex.....	57
		f. Dovetailed corrugated sheets.....	57
		66. Reinforcing systems for beams, girders and columns.....	57
		a. Kahn system.....	57
		b. Cummings system.....	58
		c. Unit system.....	58
		d. Corr system.....	60
		e. Hennebique system.....	60
		f. Pin-connected system.....	60
		g. Luten truss.....	60
		h. Xpantruss system.....	60
		i. Shop fabricated reinforcement system.....	60
Section 2. General Methods of Construction			
PROPORTIONING CONCRETE			
1. Properties of concrete, dependent upon properties and relative proportions of constituent materials.....	63	2. Theory of proportioning.....	63
		3. The strength elements of concrete.....	64
		4. Proportioning for high strength concretes.....	64

CONTENTS.

[illegible]

ART.	PAGE	MANUFACTURE AND USE OF CONCRETE	ART.	PAGE	STONE, BLOCK AND BRICK
54.	93	Addition of colors to concrete.....	74.	146	Development of the industry.....
55.	93	Use of white cement.....	75.	147	Two main lines of work.....
56.	93	Plaster finishes.....	76.	147	Methods of manufacture.....
57.	93	Surfacing concrete floors.....	a.	147	Dry tamp method.....
58.	93	Specification for the production of a rubbed surface.....	b.	148	Pressure method.....
			c.	148	Wet-cast method.....
			77.	148	Consistency.....
			78.	149	Commercial molds.....
59.	93	General requirements.....	79.	150	Operation of machines.....
60.	94	Economical considerations.....	a.	150	Tamping.....
61.	94	Lumber for forms.....	80.	151	Gang molds for wet-cast products.....
62.	95	Removal of forms.....	81.	151	Materials.....
63.	96	Number of sets of forms in building work.....	a.	151	Cement (storage and conveying).....
64.	96	Examples of form design.....	b.	152	Aggregates (kind and quality).....
a.	96	Column forms.....	82.	152	Mixing.....
b.	103	Beam and girder forms.....	a.	153	Mixers (general type).....
c.	104	Slab forms.....	b.	153	Mixing dry and mixing wet.....
d.	108	Column heads.....	c.	153	Agitation subsequent to mixing in wet-cast work.....
e.	111	Wall and pier forms.....	d.	153	Mixing facing materials.....
65.	120	Design of forms.....	83.	154	Placing.....
a.	121	Values to use in design.....	a.	154	Buckets and hoppers.....
b.	123	Drafting room methods.....	b.	155	Wheelbarrows.....
66.	124	Tables and diagrams for designing forms.....	c.	155	Pallets.....
a.	124	Notation.....	d.	156	Bankers.....
b.	124	Fiber stresses allowed.....	c.	156	Curing.....
c.	125	Formulas used.....	a.	157	Natural curing.....
67.	131	Systematizing form work for buildings.....	b.	159	Steam curing.....
a.	131	Saw mill and yard.....	85.	159	Special molds.....
b.	131	Shop procedure.....	a.	159	Wood molds.....
c.	134	Cleat spacing.....	b.	159	Plaster molds.....
d.	134	Planning of field work.....	c.	160	Glue molds.....
e.	134	Stripping of forms.....	d.	161	Combination molds.....
68.	135	Steel forms.....	e.	161	Waste molds.....
69.	138	Construction notes.....	86.	161	Sand molds and casting in sand.....
			87.	162	Surfaces.....
			a.	162	Face design in standard units.....
			b.	163	Facing materials.....
			c.	163	Colors.....
			d.	164	Spraying.....
			e.	165	Brushing.....
			f.	166	Rubbing.....
			g.	166	Tooling.....
			h.	167	Mosaics.....
			i.	167	Efflorescence.....
			j.	167	Air bubbles.....
			k.	167	Crazing.....
			88.	167	Specifications of the American Concrete Institute.....
				168	

BENDING AND PLACING REINFORCEMENT

70.	139	Checking, assorting and storing steel
71.	139	Bending of reinforcement.....
a.	139	Types of bends.....
b.	139	Hand devices.....
c.	141	Power-operated benders.....
d.	141	Care to be exercised in bending.....
e.	142	Bending of slab reinforcement.....
72.	142	Placing of reinforcement.....
73.	143	Devices for supporting reinforcing bars.....

Section 3. Construction Plant

ART.	PAGE	PREPARATION OF CONCRETE AGGREGATES	ART.	PAGE	CONSTRUCTION PLANT
1.	171	Preparation of crushed-stone aggregate.....	c.	181	Cost of operation.....
a.	171	Preparation of site for quarrying.....	d.	181	Cost of maintenance.....
b.	171	Quarrying.....	e.	181	Cost of removal.....
c.	171	Drills.....	f.	181	Salvage.....
d.	172	Stone crushers.....	19.	181	Balancing the plant.....
e.	172	Screening and grading of crushed stone.....	20.	181	Typical plants.....
f.	172	Washing crushed stone.....	21.	186	Machine vs. hand mixing.....
g.	172	Crushed limestone.....	22.	187	Types of mixers.....
2.	172	Screening of sand and gravel.....	a.	187	Drum mixers.....
3.	173	Washing of sand and gravel.....	b.	187	Trough mixers.....
			c.	188	Gravity mixers.....
			d.	188	Pneumatic mixers.....
			23.	189	Machine mixing.....
			a.	189	Time of mixer operations.....
			b.	189	Time of mixing.....
			c.	190	Drum speeds.....
			d.	190	Loading the mixer.....
				190	Charging hoppers.....
				191	Power loaders.....
				191	Low charging mixers.....
			e.	192	Measuring materials.....
			f.	192	Discharge of the mixer.....
			24.	193	Transporting and placing concrete.....
			a.	193	Barrows.....
			b.	193	Concrete carts.....
			c.	194	Buckets.....
			d.	195	Cableways and buckets.....
			e.	195	Spouts or chutes.....
			f.	196	Sections used in spouting.....
			g.	200	Hoists.....
			25.	203	Spouting plants.....
			a.	203	Boom plants.....
			b.	203	Guy line plants.....
			c.	203	Tower plants.....
			d.	203	Combinations of spouting systems.....
			e.	203	Regulating flow of concrete in spouting plants.....

Section 4. Concrete Floors and Floor Surfaces, Sidewalks, and Roadways

CONCRETE FLOORS AND FLOOR SURFACES

1.	205	The concrete floor problem.....	c.	207	Finish produced by removal of water from surface.....
2.	206	"Dusting" of concrete floors.....	d.	207	Integral hardeners and surface compounds.....
3.	206	Making good concrete floors and floor surfaces.....	5.	207	Causes of common defects in concrete floors.....
4.	206	Special surface finishes.....	6.	209	Remedial measures.....
a.	206	Surface grinding.....	a.	209	Retopping.....
b.	206	Integral pigments.....	b.	210	Chemical hardeners.....

ART.	PAGE	ART.	PAGE
b. Turneure and Maurer's method	305	43. Beams of any complex or irregular section	314
29. Slabs	306	a. Analytical method	314
a. Moments in continuous slabs	306	b. Graphical method	316
b. Provision for negative moment in continuous slabs	306	SHEAR AND MOMENT IN RESTRAINED AND CONTINUOUS BEAMS	
c. Floor slabs supported along four sides	307	44. Span length for beams and slabs	318
d. Cross reinforcement in slabs	307	45. Recommendations of Joint Committee as to positive and negative moments	318
T-BEAMS		46. Theorem of three moments	318
30. T-beams in floor construction	307	47. Uniform load over all spans	323
31. Tests of T-beams	307	48. Fixed and moving concentrated loads	324
32. Flange width	308	a. Influence lines	324
33. Bonding of web and flange	308	49. Moving uniform loads	329
34. Flexure formulas	308	50. Maximum moments from uniform loads	330
a. Formulas for determining dimensions and steel ratio for given working stresses	309	51. Beam concentrations	331
35. Designing for shear	310	52. Negative moment at the ends of continuous beams	334
36. General proportions of T-beams	310	53. Bending up of bars and provision for negative moment	335
37. Economical considerations	310	54. Continuous beams with varying moment of inertia	339
38. Conditions met with in design of T-beams	310	DESIGNING TABLES AND DIAGRAMS FOR BEAMS AND SLABS	
39. Design of a continuous T-beam at the supports	311	55. Illustrative problems (12 in all)	341
40. T-beams with steel in top and bottom	313	56. Leffler's comprehensive beam chart	348
a. Formulas for determining percentages of steel in double-reinforced T-beams	313	57. Beard and Schuler's comprehensive charts	350
41. Deflection of T-beams	313	SPECIAL BEAMS	
42. Wedge-shaped beams	314	Section 8. Columns	
1. Column types	371	6. Working stresses	372
2. Plain concrete columns or piers	371	7. Recommendations of the Joint Committee	373
3. Columns with longitudinal reinforcement	371	8. Tables and diagrams	374
4. Columns with hooped and longitudinal reinforcement	372	9. Reduction formula for long columns	381
5. Columns reinforced with structural steel shapes	372	10. Columns supporting bracket loads	381
Section 9. Bending and Direct Stress			
1. Theory in general	385	c. Case III.—Tension over part of section—steel in tension face only	403
2. Analytical determination of stresses in rectangular sections	387	3. Graphical determination of stresses	406
a. Case I.—Compression over the whole section—steel top and bottom	387	a. Rectangular sections	406
b. Case II.—Tension over part of section—steel top and bottom	394	b. Hollow-circular sections	407
		c. Solid circular and other sections	409

Section 10. Moments in Rigid Building Frames

PAGE	ART.	PAGE	ART.
1. Importance of the subject	411	h. Point of inflection at center of upper columns. Lower columns fixed. Outer girders with constant moment	419
2. Method of analysis	411	i. Point of inflection at center of upper columns. Lower columns fixed. Outer girders hinged	419
3. Application of method of analysis to simple cases	414	j. Point of inflection at center of upper columns. Lower columns fixed. Outer girders fixed	420
4. Conception of rigidity of building frames	415	6. Moments at exterior columns in beam-and-girder construction	420
5. Moments at interior columns in beam-and-girder construction	416	a. Inner end of girder hinged	425
a. All terminals hinged	416	b. Inner end of girder fixed	425
b. All terminals fixed	417	7. Moments in columns in flat-slab construction	425
c. Columns hinged. Outer girders with constant moment	418	8. Criteria for maximum combined stresses in columns	426
d. Columns fixed. Outer girders with constant moment	418	a. Interior columns	426
e. Point of inflection at center of columns. Outer girders hinged	418	b. Exterior columns	426
f. Point of inflection at center of columns. Outer girders fixed	418	9. Wind stresses in building frames	427
g. Point of inflection at center of columns. Outer girders with constant moment	419	10. Roof frames	428
Section 11. Buildings		11. L-frames	429
FLOORS—GENERAL DATA		15. Classes of buildings to which adapted	458
1. General types of concrete floors	431	16. Remarks regarding design	459
2. Floor loads	431	17. Systems	461
3. Economic considerations	432	a. Barton Spider Web system	461
4. Floor surfaces	432	b. Cantilever Flat-slab construction	463
5. Small floor openings	433	c. Simplex system	465
6. Provision for the attachment of shaft-hangers and sprinkler pipes	434	d. Mushroom system	465
7. Bedding machinery	437	e. Watson system	466
8. Waterproof floors	438	f. Akme system	467
9. Tests	438	g. Corr-plate floors	470
10. Basement floors	438	h. S-M-I system	471
MONOLITHIC BEAM AND GIRDER CONSTRUCTION		i. Three-way system	476
11. Ordinary type of beam and girder construction	439	18. Patents	479
12. Hollow tile construction	447	19. Loading tests	480
FLAT SLAB CONSTRUCTION		20. Methods of design and problems	487
13. General description	457	a. Computations for Akme system	488
14. Advantages over the beam-and-girder type	457	b. Computations for Corr-plate floors	489
		c. Computations based on Pittsburgh Ruling	492
		d. Computations based on Chicago Ruling	494
		e. Computations based on Ruling of American Concrete Institute	495

Section 16. Arches

ART.	GENERAL DATA	PAGE
1.	Definitions.....	651
2.	Curve of the intrados.....	651
3.	Three-centered curve.....	652
4.	Semi-ellipse.....	652
5.	Parabola.....	653
6.	Arrangement of spandrels.....	653
7.	Piers and abutments.....	653
8.	Depth of filling at crown.....	654
9.	Loads.....	654
10.	Empirical rules for thickness of arch ring.....	656
11.	Approximate formula for best shape of arch axis.....	658
12.	Proper thickness of arch ring in the haunch for given thicknesses at crown and springing.....	658
13.	Dead loads and their action lines.....	658
14.	Approximate method of testing trial arch.....	658
15.	Use of temporary hinges in arch erection.....	659
16.	Use of reinforcement in concrete arches.....	660
17.	Classification of arch rings.....	660
18.	ANALYSIS OF THE ARCH BY THE ELASTIC THEORY	
19.	Deflection of curved beams.....	660
20.	General procedure in arch analysis.....	661
21.	Notation.....	662
22.	Formulas for thrust, shear, and moment.....	663
23.	Division of arch ring for constant $\frac{s}{l}$	663
24.	Loadings to use in computations.....	664
25.	Use of influence lines.....	664
26.	Internal temperature investigations.....	664
27.	Shrinkage stresses.....	664
28.	Deflection at any point.....	664
29.	Method of procedure in arch-ring design.....	665
30.	Uncertainty as to fixedness of ends of arch.....	665
31.	Skew arches.....	665
32.	Unsymmetrical arches.....	665
33.	Accuracy of formulas and diagrams.....	669
34.	Difficulties and uncertainties involved in applying the elastic theory.....	669
35.	Best shape of arch axis.....	669
36.	Variation in thickness of arch ribs.....	670
37.	Influence-line diagrams.....	673
38.	Diagrams for moments, thrusts, and average stresses.....	681
39.	Approximate method of correcting maximum moments when actual arch axis deviates from assumed axis.....	686
40.	DETAILS OF ARCH BRIDGES	
41.	Spandrel details in earth-filled bridges.....	691
42.	Spandrel details in open-spandrel bridges.....	694
43.	Piers and abutments.....	702
44.	Railing and ornamental details.....	702
45.	CONSTRUCTION OF ARCHES	
46.	Arch-ring construction.....	702
47.	Centering.....	704
48.	Timber centers.....	704
49.	Steel centers.....	712
50.	THREE-HINGED ARCHES	
51.	General discussion.....	715
52.	Methods of analysis.....	715
53.	Common type of hinges.....	717
54.	Methods of construction.....	717
55.	Details of design.....	719

Section 17. Hydraulic Structures

ART.	DAMS	PAGE
1.	Preliminary studies.....	723
2.	Locating.....	723
3.	Geological investigations.....	723
4.	Selecting a suitable type of dam.....	724
5.	Height of structure.....	724
6.	Hydrographic investigations.....	725
7.	Capacity of reservoir.....	726
8.	Design of foundation.....	728
9.	Grouting.....	728
10.	Cut-off walls.....	728
11.	Caissons.....	728
12.	Pilings.....	728
13.	Sheet piling.....	728
14.	Design of dams of gravity section.....	729
15.	Hydrostatic pressure.....	729
16.	Profiles of dams.....	729
17.	Uplift.....	731
18.	Wind pressure.....	732
19.	Ice thrust.....	732
20.	Initial stress.....	732
21.	Temperature stresses.....	732
22.	Stresses in masonry and on foundation.....	733
23.	Shearing stresses.....	734
24.	Final calculation.....	734
25.	Design of arched dams.....	736
26.	Constant radius dams.....	736
27.	Constant angle dams.....	738
28.	Design of reinforced-concrete dams.....	739
29.	Cut-off walls.....	740
30.	Foundation mattress.....	740
31.	Buttresses.....	740
32.	Bracing.....	741
33.	Apron.....	741
34.	Multiple-arch dams.....	743
35.	Earthen dams with concrete core wall.....	745
36.	Passing the discharge.....	748
37.	Form of spillway.....	748
38.	Discharge capacity.....	749
39.	Profiles of spillways.....	749
40.	Overflow dams.....	753
41.	Sluices.....	754
42.	Siphonic spillways.....	755
43.	Movable dams.....	758
44.	Requiring operating machinery.....	759
45.	Operating under hydrostatic pressure differences.....	759
46.	RESERVOIRS	
47.	General types.....	760
48.	Quality of concrete for reservoir masonry.....	760
49.	Open basins with embankment walls.....	761
50.	Concrete floors for reservoirs.....	761
51.	Groined and flat floors.....	762
52.	Concrete walls for open reservoirs.....	763
53.	Partition and outside walls.....	764
54.	Provision for ice.....	764
55.	Covers or roofs for reservoirs and basins.....	764
56.	Groined arch construction.....	764
57.	Construction details of columns and roof.....	764
58.	STANDPIPES AND SMALL TANKS	
59.	Analysis of stresses in standpipes.....	765
60.	Restraint at base.....	765
61.	Shear at base.....	767
62.	Small tanks.....	768
63.	Construction details of tanks and standpipes.....	769
64.	Precautions in construction.....	771
65.	ELEVATED TANKS	
66.	Analysis of stresses.....	771
67.	Supporting tower.....	774
68.	CULVERTS	
69.	General considerations.....	775
70.	Factors in culvert design.....	776
71.	Culvert efficiency.....	776
72.	Waterway required.....	776
73.	Length of culverts.....	776
74.	Design of ends.....	777
75.	Pipe culverts.....	777
76.	Pressure in trenches.....	778
77.	Strength of pipe.....	781
78.	Circular culverts cast in place.....	782
79.	Box culverts.....	783
80.	Forms of box culverts.....	785

ART.	PAGE	ART.	PAGE
b. Loading.....	785	b. Forms.....	797
c. Design of cross-section.....	785	CONDUITS AND SEWERS	
Type I. The closed frame.....	787	34. Stresses due to internal pressure.....	799
Type II. Open frame with fixed walls.....	788	35. External earth pressure on circular pipe.....	799
Type III. Open frame hinged at the base.....	789	36. Large conduits and sewers not circular.....	799
Diagrams.....	794	37. Construction.....	802
d. Construction.....	794	38. Longitudinal reinforcement.....	802
33. Arch culverts.....	796	39. Examples of reinforced-concrete pipe.....	803
a. Design of cross-section.....	796	40. Forms for sewers.....	803

Section 18. Miscellaneous Structures

DEEP GRAIN BINS OR SILOS		8. Sloped sides—fill heaped to angle of repose (Case III).....	811
1. Action of grain in deep bins.....	805	9. Partly vertical sides—fill heaped (Case IV).....	812
2. Janssen's formulas for pressure in deep bins.....	805	10. Thrust due to P_4	812
3. Conclusions from tests.....	806	11. Data for bin design.....	812
4. Design of walls.....	808	12. Submerged storage for coal.....	813
a. Vertical load carried by walls.....	808	13. Dock pockets.....	815
b. Wind stresses on a horizontal section.....	808		
c. Thickness of walls.....	808	CHIMNEYS	
d. Horizontal reinforcement—circular sections.....	808	14. Dead load stresses.....	816
e. Rectangular sections.....	808	15. Stresses on annular sections in flexure.....	816
f. Hexagonal bins.....	809	16. Wind stresses in chimneys of reinforced concrete.....	818
5. Construction.....	809	17. Chimney with no vertical reinforcement.....	818
SHALLOW BINS		18. Longitudinal shear in chimneys.....	819
6. Sloped sides—level full (Case I).....	811	19. Temperature stresses in chimneys.....	819
7. Partly vertical sides—level full (Case II).....	811	20. Chimney construction.....	820
		21. Bases for chimneys.....	820

Section 19. Estimating

ESTIMATING UNIT COSTS		d. Summary.....	828
1. Division of the work.....	823	4. Estimating unit cost of steel reinforcement.....	828
2. Estimating unit cost of concrete.....	823	5. Estimating unit cost of surface finish.....	829
a. Materials.....	823	ESTIMATING QUANTITIES	
b. Labor.....	824	6. Systematic procedure advisable.....	830
c. Plant.....	825	7. Rules for measurement of concrete work.....	830
d. Summary.....	825	8. Estimating amount of form work.....	831
3. Estimating unit cost of forms.....	826	9. Estimating amount of steel.....	832
a. Considerations involved.....	826	10. Estimating amount of surface finish.....	832
b. Materials.....	827		
c. Labor.....	827		

PAGE	PAGE	PAGE
Appendix A	Final report of special committee of the American Society of Civil Engineers—part pertaining to flat-slab design.....	854
Standard specifications and tests for Portland cement.....	833	
Appendix B	Standard building regulations for the use of reinforced concrete. American Concrete Institute, 1917—part pertaining to flat-slab floors.....	858
Working stresses.....	845	
Appendix C	RULINGS PERTAINING TO FLAT-SLAB DESIGN	
Ruling on the design of cantilever flat-slab construction in the city of Pittsburgh.....	847	Appendix D
Ruling covering design of flat-slab construction in the city of Chicago.....	849	Standard notation.....
Chicago reinforced-concrete flat-slab ruling amended.....	851	Appendix E
INDEX.....	867	Concrete barges and ships—extract from report of the Joint Committee of the American Concrete Institute and Portland Cement Association.....

FORMULARIO ÚNICO DE CORRECCIONES Y MODIFICACIONES
2000-10

1) SOLICITUD DE:

☐ Corrección de error material

☒ Modificación a una solicitud

2) SOLICITANTE

Nombre: CEMEX TRADEMARKS
WORLDWIDE, LTD.

Dirección: Romerstrasse 13, 2555
Brugg, Suiza
Nacionalidad o Domicilio: Brugg,
Suiza

Lugar de Constitución: Suiza

Teléfono:

Fax:

E. Mail:

IDENTIFICACIÓN

C.C. ☐ NIT: ☐

C.E. ☐ OTRO ☐

NÚMERO _____

**3) REPRESENTANTE
O APODERADO**

Nombre: DILIA MARÍA
RODRÍGUEZ D'ALEMAN

Dirección: Carrera 11 N°. 86-53
Piso 6 Bogotá D.C.

Teléfono: 6181088 Fax: 6350824

E. Mail: info@clarkemodet.com.co

IDENTIFICACIÓN

C.C. ☒ NIT: ☐

C.E. ☐ OTRO ☐

NÚMERO: 41.654.882
TP: 20824 CSJ

4) NUMERO DE EXPEDIENTE: 03105202

5) DESCRIPCIÓN DE LA CORRECCIÓN O MODIFICACIÓN SOLICITADA:

Se presenta nuevo capítulo reivindicatorio

Nuevo título: MATERIAL DE CONSTRUCCION PREFABRICADO PARA
ACABADOS SELECCIONADO DEL GRUPO INTEGRADO POR PISO Y/O
RECUBRIMIENTO QUE TIENEN UNA ACTIVIDAD ANTIMICROBIANA
INMEDIATA.

**6) Comprobante de pago No. 06-99,820 DE DIC. 20, 2006 Y 07-1,266 ENERO 5
DE 2007**

7) Anexos:

☒ Comprobante de la tasa

☐ Poderes, si fuere el caso

☐ Certificado de Existencia y Representación legal, cuando el solicitante sea persona Jurídica

8)

Nombre: DILIA RODRÍGUEZ D'ALEMAN

Firma: _____

C.C.: 41.654.882 TP: 20824 CSJ