INFORME TÉCNICO DIAGNOSTICO FASE I CONTRATO COP-635-2025

Contrato de obra COP-635-2025 que tiene por objeto **"REALIZAR EL RECONOCIMIENTO TÉCNICO Y EJECUCIÓN DE LAS ACTIVIDADES DE MEJORAMIENTO, MANTENIMIENTO Y DOTACIÓN CON PRECIOS UNITARIOS FIJOS INCLUYENDO FÓRMULA DE REAJUSTE PARA LA CANCHA DEPORTIVA DE LA VEREDA RÍOS EN LA LOCALIDAD DE SUMAPAZ."**

Introducción

El presente informe técnico se elabora en el marco del Contrato de Obra COP-635-2025, cuyo objeto corresponde al mejoramiento, mantenimiento y dotación de la cancha deportiva ubicada en la vereda Ríos, en la localidad de Sumapaz.

Este documento tiene como finalidad presentar el análisis técnico, constructivo y financiero derivado del proceso de diagnóstico realizado en la fase inicial del proyecto, así como sustentar la necesidad de realizar ajustes en las especificaciones técnicas inicialmente previstas, garantizando la calidad, durabilidad y adecuado comportamiento estructural de las obras a ejecutar.

Ubicación del Proyecto

El sitio de intervención se ubica en la cancha deportiva de la vereda Los Ríos, en la cuenca de Rio Blanco, (4°09'38.6"N 74°08'51.5"W) en la localidad No. 20 Sumapaz. En este lugar de entorno rural que presenta condiciones particulares de terreno, clima y accesibilidad, las cuales inciden directamente en las decisiones técnicas adoptadas durante la etapa de diagnóstico y diseño constructivo.

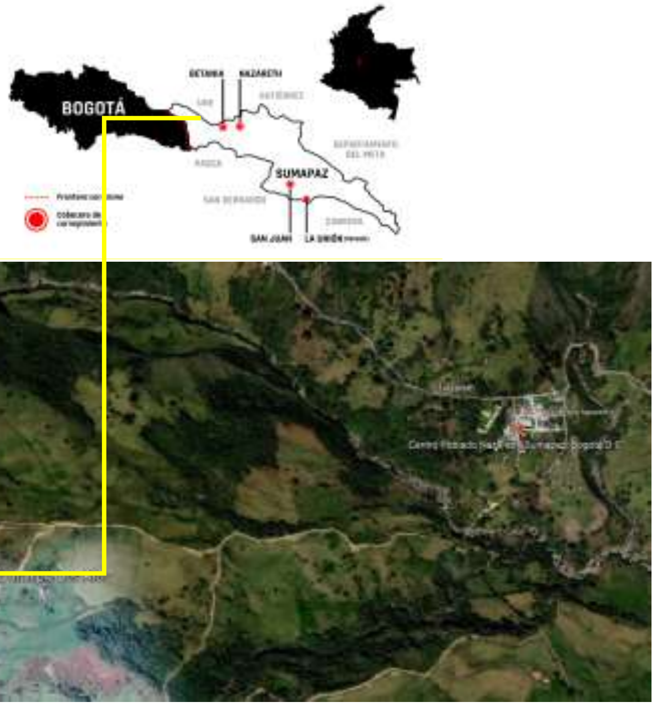


Ilustración 1. Localización Cancha múltiple Los Ríos, cuenca Río Blanco – Fuente: Google Earth

Alcance del informe

El alcance del informe comprende:

- Reconocimiento técnico del área de intervención.
- Replanteo general de la cancha conforme a los diseños.
- Nivelación topográfica y ajuste de cotas de diseño.
- Verificación de dimensiones reglamentarias según lineamientos del IDRD.
- Implementación de soluciones constructivas para la losa deportiva.
- Sustitución y optimización de especificaciones técnicas del sistema estructural de la losa.

Es importante precisar que el alcance funcional del proyecto se mantiene inalterado, presentándose únicamente ajustes en las especificaciones técnicas de los materiales y sistema constructivo.

Visitas de Obra

Como parte del proceso de diagnóstico técnico realizado en el marco de la FASE I del proyecto, se efectuaron visitas técnicas al área de intervención con el fin de verificar las condiciones reales del terreno y del estado de la superficie existente.

4/02/2026, 11:21:22 a.m. Bogotá Colombia Los Ríos Área Técnica	Bogotá Colombia Los Ríos Área Técnica
	

A partir de este reconocimiento se elaboró el diagnóstico técnico del área de intervención y la verificación de las cantidades de obra inicialmente previstas. Dicho diagnóstico sustenta la necesidad de ajustar algunas especificaciones técnicas del sistema constructivo originalmente previsto.

Se realizó reconocimiento del área de intervención, verificando condiciones existentes del terreno y elementos construidos.

- Se efectuó el replanteo general del proyecto, tomando como base los planos de diseño.
- Se llevó a cabo la ubicación y materialización de ejes principales de la cancha mediante estacado y referencias físicas en campo.

- Se ejecutó el replanteo de niveles, mediante nivelación topográfica, estableciendo cotas de diseño para la superficie de la cancha.

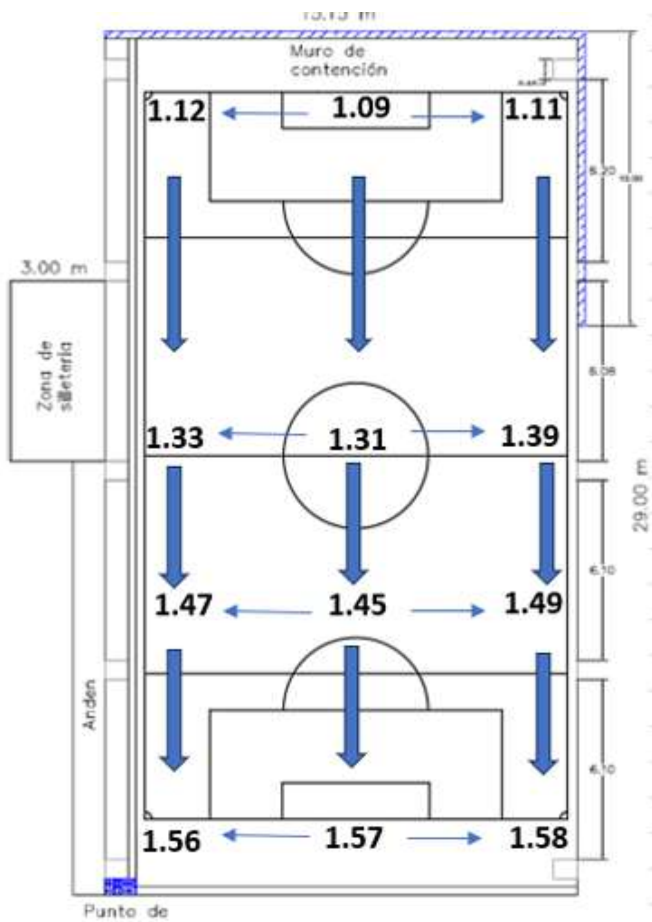


Ilustración 2. Niveles actuales cancha deportiva de la vereda Los Rios

- Se verificaron y ajustaron las pendientes longitudinales y transversales, garantizando el adecuado drenaje superficial.
- Se realizó la ubicación de cunetas y elementos de drenaje, conforme a las especificaciones del proyecto.
- Se llevó a cabo la verificación de dimensiones reglamentarias de la cancha, conforme a las guías del IDRD.

Análisis de Riesgos Técnicos

Durante las visitas de reconocimiento técnico se identificaron condiciones particulares del terreno y de la superficie existente que hacían necesario ajustar las especificaciones del sistema constructivo, con el fin de garantizar un adecuado comportamiento estructural y una mayor durabilidad del elemento proyectado. Entre dichas condiciones se evidenciaron irregularidades en la superficie, presencia de fisuras, fracturas y agentes asociados a humedad, los cuales podrían incidir negativamente en el desempeño de la nueva losa si no se adoptaban medidas técnicas adecuadas.

Durante la auscultación visual se evidenció que las fracturas e irregularidades presentes en la placa corresponden principalmente a fisuración típica del concreto, asociada a procesos de fraguado, retracción y posibles deficiencias en la compactación. Estas condiciones, sumadas a una inadecuada o insuficiente capacidad de refuerzo a tracción, favorecen la aparición de grietas en la superficie.

Adicionalmente, la exposición continua a la humedad y a las lluvias propias de la zona contribuye a la propagación de dichas fisuras, permitiendo la infiltración de agua. Este fenómeno puede generar procesos de corrosión en el acero de refuerzo y, con el tiempo, derivar en pérdida de adherencia y capacidad estructural. Asimismo, la filtración persistente puede ocasionar socavaciones en la subbase, afectando la estabilidad de las losas, situación que se evidenció con mayor intensidad en las áreas más expuestas a la acción directa de las lluvias.

En este orden de ideas, solicitamos la incorporación de fibra sintética estructural como solución a esta problemática. Estas fibras permiten mitigar estos riesgos al proporcionar un refuerzo tridimensional distribuido, mejorando el control de fisuración y reduciendo la propagación de grietas. Asimismo, el uso de concreto de mayor resistencia contribuye a disminuir la permeabilidad y aumentar la durabilidad frente a agentes ambientales.

En este sentido, se determinó la conveniencia de optimizar el sistema mediante el uso de un concreto de mayor resistencia y un refuerzo más eficiente en el control de fisuración, con el propósito de mitigar la posible transmisión de patologías existentes, mejorar la distribución de esfuerzos y garantizar un comportamiento más estable y durable de la estructura bajo condiciones reales de servicio.

Se tuvieron en cuenta las condiciones de carga asociadas al uso de la cancha, principalmente de tipo peatonal y recreativo, así como las condiciones propias del entorno rural, tales como presencia de humedad y variaciones térmicas.

La propuesta consiste en subir la resistencia del concreto de 2.500 psi a 3.000 psi. Aunque reducimos el espesor de la losa de 12 cm a 10 cm, este cambio se compensa con creces gracias al aumento del 20% en la capacidad de compresión y un mejor sistema de refuerzo. Al final, no solo mantenemos la capacidad de carga, sino que ganamos en durabilidad y rigidez.

Adicionalmente, el uso de concreto de mayor resistencia conlleva beneficios como:

- Mayor módulo de elasticidad, reduciendo deformaciones ante cargas de servicio.
- Mejor comportamiento frente a fisuración, especialmente en combinación con refuerzo distribuido.
- Mayor resistencia a la abrasión, relevante para superficies deportivas.

- Menor permeabilidad, lo que incrementa la durabilidad frente a agentes ambientales.

Desde el punto de vista estructural, la reducción del espesor es compensada por el aumento en la resistencia del material, dado que la capacidad de la losa está directamente relacionada con la resistencia del concreto y la distribución de esfuerzos. En este sentido, la solución adoptada garantiza condiciones equivalentes o superiores de capacidad estructural, estabilidad y vida útil, respecto a la especificación originalmente prevista.

Como soporte técnico al análisis presentado, se presenta la platilla de cálculo desarrollada con base en la herramienta suministrada por Toxement, las cuales permiten determinar la dosificación de la fibra sintética estructural en función de los parámetros del diseño original de la losa.

El producto empleado, correspondiente a fibra sintética estructural tipo TUF-STRAND SF, cumple con estándares y certificaciones internacionales ampliamente reconocidos, entre los cuales se destacan:

- ASTM C1116 (Especificación para concreto reforzado con fibras)
- ASTM D7508 (Especificación para fibras sintéticas macroestructurales)
- IBC 2015 (International Building Code)
- SDI/ANSI-C1.0
- ICC AC383 (ESR-4072)
- UL/ULC (CBXQ.R13773)

El cumplimiento de estas normas garantiza que el material utilizado ha sido evaluado bajo criterios técnicos exigentes en cuanto a desempeño estructural, control de fisuración, durabilidad y comportamiento post-fisuración, asegurando su idoneidad para aplicaciones en losas sobre terreno y superficies sometidas a cargas de servicio.

Como referencia técnica adicional, se dispone del siguiente enlace del fabricante, donde se describe la metodología de diseño por temperatura y retracción, así como los fundamentos para la equivalencia estructural entre refuerzo tradicional y fibras: https://www.tufstrand.com/temperature-and-shrinkage/

Dicho análisis se realizó tomando como base los parámetros correspondientes a la losa contemplada en los diseños iniciales, considerando sus condiciones geométricas, resistencia del concreto y configuración de refuerzo originalmente especificada.

The Euclid Chemical Company

Fiber Reinforced Concrete

TUF-STRAND SF

EUCLID CHEMICAL

Temperature and Shrinkage Calculation and Design

Project Name: Temp-Shrinkage_02-13-26

This report calculates the tensile capacity provided by steel mesh/bar and finds the TUF-STRAND SF dosage for equivalent performance.

Bar diameter	4.95	mm
Bar spacing	150	mm
Section thickness, t (or h)	120	mm
Concrete compressive strength, f'_c	21	MPa
Steel yield strength, f_y	420	MPa
Depth to reinforcement, d	60	mm
Unit width of measure, b	1000	mm
Area of steel provided, A_s	128.295	mm²/m
Reinforcement ratio, ρ	0.11	%
Residual strength ratio, R_{e3}	18	%

Minimum ratio of reinforcing steel (ACI 318)	0.1	%
Q. is the steel ratio provided greater than the minimum?	Yes	
Required A_s based on minimum steel ratio	120	mm²/m
Tensile capacity provided by minimum steel	0	MPa
Tensile capacity provided by actual steel, F_{ts}	0	MPa
Working stress provided by steel F_{ws}=0.667*F_{ts}	0	MPa
FRC flexural residual strength F_{e3}=F_{ws}/0.37	1	MPa

Required dosage for TUF-STRAND SF: 1.8 kg/m3 (based on ASTM C1609 data)

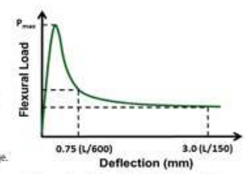
Estimated GWP emissions value: 5.4 kg CO2eq/m3 — GWP Value calculated on Environmental Product Declaration NRMCAEPD:20080 at 3.08 kg CO_2eq/kg fiber

Price of TUF-STRAND SF: $/kg

Cost of TUF-STRAND SF: $/m²

Notes:

- Be sure that all manual entries are in the correct units and values as this will have a significant impact on the final dosage and cost.
- The value of the TUF-STRAND SF dosage may be increased if necessary (depending upon the mixing, safety and performance requirements).
- This spreadsheet is only valid to calculated dosages up to 7 kg/m³. High dosages may require adjustments to the mix design.
- This minimum recommended fiber dosage is 1.8 kg/m³, even if the required dosage is lower.
- R_{e3} is calculated for a typical concrete mix with flexural strength (f_r) in the range of 4.4±0.4 MPa. Higher fr can result in a higher fiber dosage.



Schematics of a typical C1609 test result

Calculations:

- The performance of FRC is measured according to ASTM C1609.
- The value of residual strength (fe3) or its ratio (Re3) is used to calculate the moment capacity of FRC.

$$A_s = \frac{\pi d^2}{4} \qquad F_{ws} = 0.667\ F_{ts}$$

$$\rho = \frac{A_s}{b.h} \times 100 \qquad f_{e3} = \frac{F_{ws}}{0.37}$$

$$F_{ts} = \frac{0.9 A_s . F_y}{b.h} \qquad R_{e3} = \frac{f_{e3}}{f_r} \times 100$$

Note: R_{e3} is also known as $R^T_{D,150}$

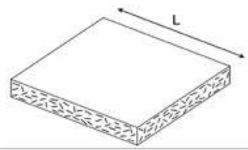


Ilustración 3. Análisis de dosificación de fibra TUF-STRAND SF para reemplazo de malla electrosoldada (Toxement)

Lo anterior permite establecer la equivalencia estructural entre ambos sistemas de refuerzo, así como definir la dosificación adecuada de la fibra, garantizando el cumplimiento de los requerimientos técnicos en términos de capacidad mecánica, control de fisuración y desempeño estructural.

En este orden de ideas, se remite junto con este informe general un informe específico sobre la adopción de la fibra sintética *(ver anexo 1)* en el cual se evalúa su comportamiento frente a la sustitución de la malla electrosoldada.

Invariabilidad del Alcance Contractual y Funcional

El ajuste propuesto no constituye una modificación sustancial del objeto contractual. Se mantiene la integridad funcional del sistema, conservando la ruta crítica de ejecución. La variación se limita estrictamente a la especificación técnica de los materiales y su geometría, sin alterar los hitos de entrega ni los componentes operativos del proyecto.

Parámetro	Diseño original (2500 psi)	Diseño propuesto (3000 psi)	Evaluación técnica
Resistencia a compresión (f'c)	2.500 psi	3.000 psi	Se evidencia un incremento aproximado del 20% en la capacidad a compresión del material, lo cual mejora directamente el comportamiento mecánico del concreto, incrementando su resistencia frente a cargas de servicio y reduciendo la probabilidad de fallas por aplastamiento.
Módulo de rotura (fr)	31 psi	34 psi	El aumento cercano al 9.5% en la resistencia a flexión permite una mayor capacidad del concreto para resistir esfuerzos de tracción antes de fisurarse, lo cual resulta determinante en losas sobre terreno donde el control de fisuración es crítico.
Módulo de elasticidad (E)	2.85×10^6 psi	3.12×10^6 psi	El incremento en el módulo de elasticidad mejora la rigidez del material, reduciendo deformaciones bajo carga y favoreciendo una mejor distribución de esfuerzos en la losa.
Control de fisuración	Malla electrosoldada (acción localizada)	Fibra estructural distribuida	La fibra sintética proporciona un refuerzo tridimensional distribuido en toda la masa del concreto, mejorando significativamente el control de fisuración temprana y reduciendo la propagación de grietas en comparación con la malla, que actúa de forma puntual.
Distribución del refuerzo	Bidimensional	Tridimensional	La distribución tridimensional del refuerzo permite un comportamiento más uniforme del concreto frente a esfuerzos, mejorando la capacidad de disipación de energía y aumentando la estabilidad del sistema estructural.
Resistencia a la abrasión	Media	Alta	El uso de concreto de mayor resistencia incrementa la resistencia superficial al desgaste, lo cual es fundamental en superficies deportivas sometidas a uso continuo.
Permeabilidad	Mayor	Menor	El concreto de mayor resistencia presenta una matriz más densa, reduciendo la permeabilidad y mejorando la durabilidad frente a agentes ambientales como humedad

			y ciclos térmicos.
Vida útil esperada	Estándar	Superior	La combinación de mayor resistencia, mejor control de fisuración y menor permeabilidad se traduce en una mayor durabilidad del elemento y una extensión de su vida útil.
Comportamiento post-fisuración	Limitado	Mejorado (fibra estructural)	La fibra permite que el concreto mantenga capacidad de carga después de la aparición de fisuras, evitando fallas frágiles y mejorando el comportamiento estructural global del sistema.

Análisis financiero

Se está presentando la información correspondiente a la comparación entre los ítems contractuales originalmente establecidos y los tres ítems no previstos (NP) propuestos, con el fin de evidenciar las variaciones técnicas y económicas derivadas de la modificación. Este análisis permite identificar la sustitución de los ítems iniciales por las nuevas alternativas planteadas, garantizando la trazabilidad y coherencia entre las condiciones contractuales y la solución adoptada.

NP1 – PLACA DE NIVELACIÓN DE CONCRETO E=0.10 3000 PSI

	Diseño original (2500 PSI)	**Diseño propuesto (3000 PSI)**	**Variación**
Materiales	$ 90,751.56	$ 85,722.10	↓ $ 5,029.46
Equipo	$ 9,759.79	$ 9,759.79	$ 0.00
Mano de obra	$ 36,354.84	$ 36,354.84	$ 0.00
Transporte	$ 0.00	$ 0.00	$ 0.00
Costo total unidad	**$ 136,866.19**	**$ 131,836.73**	**$ 5,029.46**

NP2 - CUNETAS REVESTIDAS EN CONCRETO DE 21 MPA (3000 PSI) SIN REFUERZO (INCLUYE SELLO DE JUNTAS)

	Diseño original (2500 PSI)	**Diseño propuesto (3000 PSI)**	**Variación**
Materiales	$ 547,020.65	$ 597,497.30	↑ $ 50,476.65
Equipo	$ 9,759.79	$ 9,759.79	$ 0.00
Mano de obra	$ 36,354.84	$ 36,354.84	$ 0.00
Transporte	$ 0.00	$ 0.00	$ 0.00
Costo total unidad	**$ 593,135.28**	**$ 643,611.93**	**↑ $ 50,476.65**

NP3 - FIBRA SINTÉTICA TUF-STRAND SF

	REFUERZO MALLA ELECTROSOLDADA	FIBRA SINTETICA TUF-STRAND SF	Variación
Total Materiales	**$ 8,018,347.44**	**$ 7,568,027.85**	**↓ $450,319.59**

Es importante precisar que, si bien que al realizar la sumatoria total de los ítems involucrados en la modificación, el valor global del contrato **no** presenta variación. En este sentido, la modificación propuesta corresponde a una redistribución interna de los costos, sin generar incremento en el valor total contractual, manteniéndose así el equilibrio económico del contrato y la coherencia con las condiciones inicialmente establecidas.

ITEM	DESCRIPCIÓN	UN	CANTIDAD	Vr. Unitario (INCLUYE AIU)
1	1. PRELIMINARES			
1.1	REPLANTEO GENERAL	M2	467.93	$ 1,321.05
1.2	DEMOLICION DE CUNETA EN CONCRETO	ML	42.75	$ 12,500.56
1.3	PREPARACION DE SUPERFICIE DE CONCRETO ESTRUCTURAL, CON MEDIOS MANUALES O MECÁNICOS E=20MM	M2	399.94	$ 45,792.45
2	2. PISOS Y CUNETAS			
2.1	PLACA DE NIVELACIÓN E=0.12 2.500 psi	M2		$ 181,716.18
2.2	CUNETAS REVESTIDAS EN CONCRETO DE 21 MPA (2.500 PSI) SIN REFUERZO (INCLUYE SELLO DE JUNTAS)	M3		$ 787,501.09
2.3	REFUERZO MALLA ELECTROSOLDADA	KG		$ 14,216.93
2.4	MEDIA CAÑA 10X10 IMPERMEABILIZADA	ML	24.90	$ 76,215.80
3	3. CARPINTERIA METÁLICA			
3.1	MANTENIMIENTO DE PORTERIA DE MICROFUTBOL (DESINSATALACIÓN, LIJAR , PINTAR, REINSTALAR)	UND	2.00	$ 787,135.71
3.2	SUMINISTRO E INSTALACION DE PUERTA EN TUBO GALVANIZADO DE 1 1/2 CAL 14 CON CANTÓN EN MALLA DE CERRAMIENTO GALVANIZADA CAL 14 Y ANGULO 1X1/8 (INCLUYE BISAGRAS DE PISTON DE 1/2", PASADOR, ANTICORROSIVO Y PUNTURA A DOS MANOS)	M2	7.70	$ 321,634.66
4	4. CUBIERTA			
4.1	MANTENIMIENTO GENERAL DE CUBIERTA DEPORTIVA (INCLUYE LIMPIEZA, TORNILLOS Y DEMAS ACCESORIOS PARA SU OPTIMO MANTENIMIENTO)	M2	240.00	$ 27,287.64
5	5. PINTURA			
5.1	DEMARCACION CON PINTURA TIPO TRAFICO E=0.10	ML	396.26	$ 5,983.91
6	6. DOTACION			
6.1	SOPORTE MALLA VOLEIBOL CON TENSOR (INCLUYE OBRA)	UND	1.00	$ 2,834,916.27
6.2	MALLA NYLON PETROLIZADA VOLEIBOL (NYLON #5)	UND	1.00	$ 155,657.31
6.3	MALLA PORTERIA (NYLON #5)	UND	2.00	$ 214,532.40
6.4	SUMINISTRO E INSTALACION DE MALLA BALONCESTO (NYLON)	UND	2.00	$ 146,166.87
7	7. TRANSPORTE RURALIDAD			
7.1	TRANSPORTE DE MATERIALES PETREOS (Valor transporte de insumos - CUENCA RIO BLANCO CON UN PROMEDIO DE 55 KM Y UNA VOLQUETA DE 14 M3).	M3/KM	11,361.01	$ 2,389.85
7.3	TRASIEGO A LOMO DE MULA (HASTA 60 KG/CARGA HASTA 1KM)	GLOBAL	1.00	$ 19,915,383.00
8	8. ASEO GENERAL DE OBRA			
8.1	ASEO GENERAL	M2	467.93	$ 7,079.75
9	NO PREVISTOS			
NP1	PLACA DE NIVELACIÓN DE CONCRETO E=0.10 3000 psi	M2	399.00	$ 182,712.53
NP2	CUNETAS REVESTIDAS EN CONCRETO DE 21 MPA (3000 PSI) SIN REFUERZO (INCLUYE SELLO DE JUNTAS)	M3	2.14	$ 891,981.78
NP3	FIBRA SINTETICA TUF-STRAND SF	KG	78.61	$ 96,271.20
	TOTAL COSTOS DIRECTOS (CD) INCLUYEN AIU			
	TOTAL DEL PROYECTO + AIU (REDONDEADO AL PESO)			

A = TOTAL COSTOS DIRECTOS (CD) - VALOR DE COSTO DIRECTO SI	$ 123,245,579.05
B = TOTAL COSTOS INDIRECTOS (CI) (B = 1 + 2 +3)	
1.- ADMINISTRACION (A)= 32,59%	$ 40,165,734.21
2.- IMPREVISTOS (I)= 1%	$ 1,232,455.79
3. - UTILIDAD (U)= 5%	$ 6,162,278.95
C = TOTAL DEL PROYECTO + AIU (REDONDEADO AL PESO) C = A	$ 170,806,048.00

Nota: Se aclara que los ítems NP1, NP2 y NP3 no corresponden a actividades nuevas, sino que sustituyen técnicamente los ítems contractuales 2.1, 2.2 y 2.3 respectivamente. En consecuencia, los ítems originalmente previstos no serán ejecutados, al ser reemplazados por los ítems NP propuestos en la presente modificación. En este sentido, la modificación propuesta obedece a un ajuste en las especificaciones técnicas de las actividades inicialmente previstas, manteniéndose el alcance general del contrato y garantizando la adecuada ejecución de las obras conforme a las condiciones técnicas requeridas.

Conclusión Técnica

- La modificación se tipifica como un ajuste técnico no sustancial. Se preserva la tipología estructural y la funcionalidad, garantizando que el factor de seguridad y la vida útil de la infraestructura sean iguales o superiores a los del diseño original, cumpliendo con la normativa técnica vigente (NSR-10 o equivalente).

- Dentro del informe técnico de la fibra se anexan los cálculos correspondientes a la dosificación, los cuales se desarrollan teniendo en cuenta los parámetros del diseño original de la losa, específicamente un espesor de 12 cm, concreto de 2500 psi y refuerzo mediante malla electrosoldada de 6 mm con espaciamiento 15x15. Estos cálculos fueron realizados con base en los lineamientos técnicos adquiridos durante la capacitación brindada por Toxement, empleando la hoja de cálculo suministrada por el fabricante, la cual permite establecer la dosificación adecuada de la fibra en función de las condiciones de diseño y desempeño requeridas.

  A partir de este análisis se obtiene la dosificación de fibra implementada en el proyecto, la cual garantiza una equivalencia estructural en términos de control de fisuración y comportamiento mecánico respecto al sistema originalmente previsto. No obstante, es importante resaltar que el uso de fibra sintética estructural no solo reproduce el comportamiento de la malla electrosoldada, sino que lo supera técnicamente, al proporcionar un refuerzo tridimensional distribuido en toda la masa del concreto.

Por lo anterior, se solicita la aprobación del NP del ítem, con el fin de implementar esta mejora en beneficio de la calidad, durabilidad y eficiencia del proyecto.

ANEXOS

1. **INFORME TECNICO FIBRA**

Elaboró:

Víctor Hugo Pedraza Guzmán

Representante Legal

Consorcio HDCIVILNET

Revisó Y Aprobó:

Ing. Sebastian Molina
Apoyo a la Supervisión
FDRS

INFORME TÉCNICO: SUSTITUCIÓN DE REFUERZO METÁLICO POR MICROFIBRA SINTÉTICA

PROYECTO: Losa de Concreto 3000 psi

ÁREA: 399 m^2

ESPESOR: 0.10 m

1. OBJETO

Justificar técnicamente el cambio de malla electrosoldada por el uso de microfibra sintética como refuerzo secundario para el control de retracción y aumento de durabilidad en la losa de concreto.

2. VENTAJAS DEL CAMBIO PROPUESTO

- **Refuerzo Multidireccional:** A diferencia de la malla que solo refuerza en un plano, la fibra se distribuye en todo el espesor de los 10 cm, creando una red tridimensional que intercepta microfisuras antes de que se conviertan en grietas visibles.

Fuente: Toxement. (2022). Fibras sintéticas estructurales-Toxement

- **Resistencia a la Corrosión:** Al ser una losa de poco espesor (10 cm), el recubrimiento del acero suele ser insuficiente. La fibra sintética no se oxida, eliminando riesgos de desprendimientos o manchas por corrosión a futuro.

- **Control de Retracción Plástica:** La fibra actúa desde el estado fresco del concreto, momento crítico en losas de gran área donde la evaporación rápida del agua genera tensiones.

Fuente: Toxement. (2022). Fibras sintéticas estructurales-Toxement

- **Logística Simplificada:** Se facilita el transporte del material a la cancha, debido a que peso del material a subir a obra es significativamente menor.

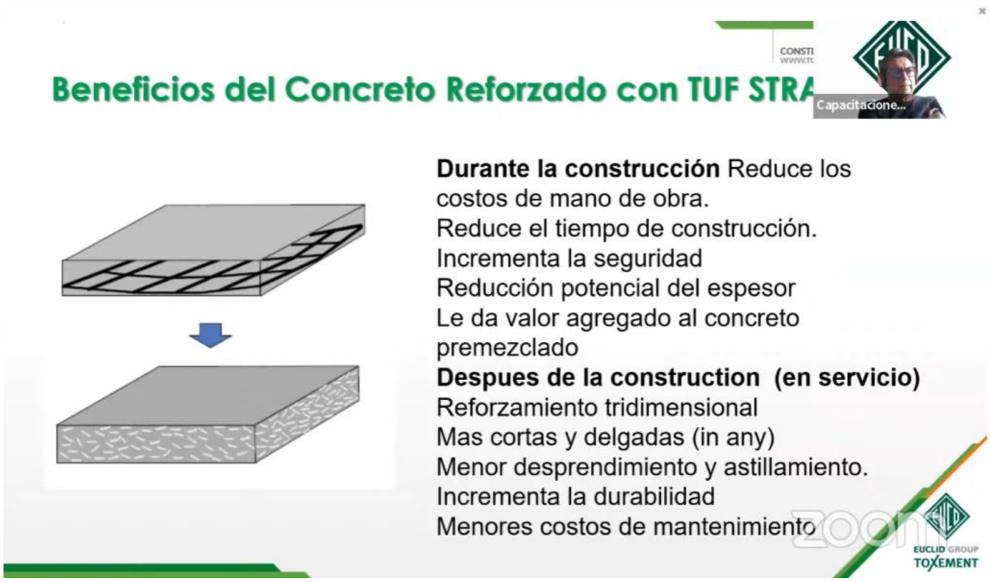
3. DOSIFICACIÓN Y CANTIDADES REQUERIDAS

Según la ficha técnica del producto seleccionado (dosis recomendada de **1.8 kg a 3.0 kg por m^3** para sustitución de malla estándar):

- **Dosis por m^3:** 1.8 kg (1 bolsa por cada metro cúbico).
- **Volumen de concreto a fundir:** 40 m^3.
- **Cemento:** 242 bulos de 50kg.
- **Mixto** 40 m^3.
- **Acelerante:** 19 Galones.
- **Cantidad de producto:** 35 bolsas de 2.27 kg.
- **Total, en kilogramos:** 78.61 kg de fibra sintética.

4. PROCEDIMIENTO DE MEZCLADO Y COLOCACIÓN

1. **Adición:** La fibra puede añadirse directamente en la canaleta del camión mixer o en la mezcladora de obra, en este caso se aplicará directamente al trompo en sitio.
2. **Tiempo de Mezclado:** Se debe garantizar un mezclado a alta velocidad por un periodo de **5 minutos** para asegurar que los filamentos se dispersen y no formen "bolas" o erizos.
3. **Acabado:** El producto permite acabados con llana metálica. Se recomienda realizar el pulido cuando el concreto haya empezado a fraguar para que la fibra quede embebida correctamente.
4. **Juntas:** Es imperativo realizar cortes de junta de dilatación cada 3 metros (máximo 4 metros) a una profundidad de 3 cm para dirigir la contracción natural del concreto.



Fuente: Toxement. (2022). Fibras sintéticas estructurales-Toxement

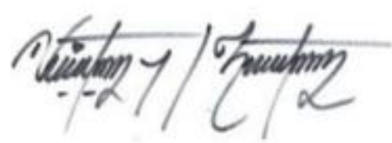
Conclusiónes:

- El cambio propuesto mejora la vida útil de la losa, reduce los tiempos de ejecución y garantiza un refuerzo homogéneo que la malla electrosoldada difícilmente logra en espesores delgados de 10 cm.
- Por las razones técnicas anteriormente expuestas, el contratista propone la sustitución de la malla electrosoldada por fibras sintéticas estructurales del fabricante Toxement, incorporadas directamente en la mezcla de concreto, con el fin de mejorar el control de fisuración, la durabilidad y la eficiencia constructiva del elemento.

- Adicionalmente, considerando que la diferencia de valor entre ambas alternativas es mínima, se presenta el ajuste presupuestal correspondiente y se solicita la aprobación de la entidad para ejecutar este ítem No Previsto, el cual será utilizado una vez se autorice formalmente la modificación.

Anexo 1. Cálculo y diseño de temperatura y contracción para diferentes diámetros de varilla en malla electrosoldada para determinar la dosificación adecuada de fibra sintética.

Elaboró:



Víctor Hugo Pedraza Guzmán

Representante Legal

Consorcio HDCIVILNET

EUCLID CHEMICAL

Fiber Reinforced Concrete

TUF-STRAND SF

Temperature and Shrinkage Calculation and Design

Project Name: Temp-Shrinkage_02-13-26

This report calculates the tensile capacity provided by steel mesh/bar and finds the TUF-STRAND SF dosage for equivalent performance.

Bar diameter	3.4	mm
Bar spacing	150	mm
Section thickness, t (or h)	120	mm
Concrete compressive strength, f'_c	21	MPa
Steel yield strength, f_y	420	MPa
Depth to reinforcement, d	60	mm
Unit width of measure, b	1000	mm
Area of steel provided, A_s	60.528	mm^2/m
Reinforcement ratio, ρ	0.05	%
Residual strength ratio, R_{e3}	9	%

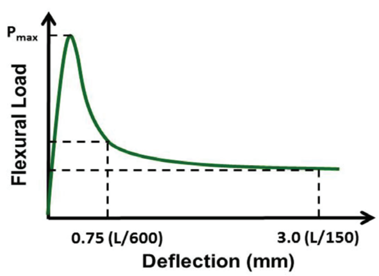
Minimum ratio of reinforcing steel (ACI 318)	0.1	%
Q. is the steel ratio provided greater than the minimum?	No	
Required A_s based on minimum steel ratio	120	mm^2/m
Tensile capacity provided by minimum steel	0	MPa
Tensile capacity provided by actual steel, F_{ts}	0	MPa
Working stress provided by steel $F_{ws}=0.667*F_{ts}$	0	MPa
FRC flexural residual strength $F_{e3}=F_{ws}/0.37$	0	MPa

Required dosage for TUF-STRAND SF: 1.8 kg/m3 (based on ASTM C1609 data)

Estimated GWP emissions value: 5.4 kg CO2eq/m3 — GWP Value calculated on Environmental Product Declaration NRMCAEPD:20080 at 3.08 kg CO_2eq/kg fiber

Price of TUF-STRAND SF: $/kg

Cost of TUF-STRAND SF: $/m²



Schematics of a typical C1609 test result

Notes:

- Be sure that all manual entries are in the correct units and values as this will have a significant impact on the final dosage and cost.
- The value of the TUF-STRAND SF dosage may be increased if necessary (depending upon the mixing, safety and performance requirements).
- This spreadsheet is only valid to calculated dosages up to 7 kg/m³. High dosages may require adjustments to the mix design.
- This minimum recommended fiber dosage is 1.8 kg/m³, even if the required dosage is lower.
- R_{e3} is calculated for a typical concrete mix with flexural strength (f_r) in the range of 4.4±0.4 MPa. Higher fr can result in a higher fiber dosage.

Calculations:

- The performance of FRC is measured according to ASTM C1609.
- The value of residual strength (fe3) or its ratio (Re3) is used to calculate the moment capacity of FRC.

$$A_s = \frac{\pi d^2}{4}$$

$$\rho = \frac{A_s}{b.h} \times 100$$

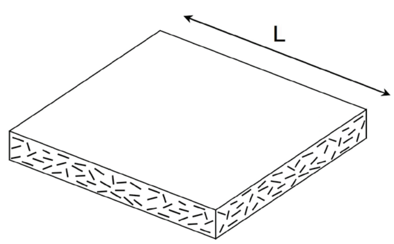
$$F_{st} = \frac{0.9 A_s . F_y}{b.h}$$

$$F_{ws} = 0.667\ F_{st}$$

$$f_{e3} = \frac{F_{ws}}{0.37}$$

$$R_{e3} = \frac{f_{e3}}{f_r} \times 100$$

$Note: R_{e3}\ is\ also\ known\ as\ R^T_{D,150}$



NOTE: The solutions provided are to be treated as a recommendation only.

For more information, please contact The Euclid Chemical Company at 1-800-321-7628 or info@euclidchemical.com

CONCRETE FIBERS

Master Format #: 03 24 00

TUF-STRAND™ SF

SYNTHETIC MACROFIBER

EUCLID CHEMICAL

PRODUCT INFORMATION

PACKAGING

3.0 lb (1.36 kg), 4.0 lb (1.81 kg), 5.0 lb (2.27 kg) and 7.5 lb (3.4 kg) water soluble bags

SHELF LIFE

3 years in original, unopened package

SPECIFICATIONS/COMPLIANCES

ASTM C1116

ASTM D7508

IBC 2015 SDI/ANSI-C1.0

ICC AC383 (ESR4072)

UL/ULC (CBXQ.R13773)

TECHNICAL INFORMATION

Material: Polypropylene/polyethylene

Specific Gravity: 0.92

Typical Dosage Rates:
3.0 to 20.0 lbs/yd³ (1.8 to 12.0 kg/m³)

Available Lengths: 2" (51 mm)

Aspect Ratio: 74

Tensile Strength:
87-94 ksi (600 to 650 MPa)

Modulus of Elasticity (EN 14889.2):
1380 ksi (9.5 GPa)

Melt Point: 320°F (160°C)

Electrical/Thermal Conductivity: Low

Water Absorption: Negligible

Acid and Alkali Resistance: Excellent

Color: White

GWP Value: 3.08 kg CO_2eq/kg

DESCRIPTION

TUF-STRAND SF is a patented polypropylene and polyethylene synthetic macrofiber successfully used to replace steel fibers, welded wire mesh and conventional reinforcing bars in a wide variety of applications. TUF-STRAND SF fibers comply with ASTM C1116, Standard Specification for Fiber Reinforced Concrete and Shotcrete, and are specifically designed to provide equivalent tensile and bending resistance to conventional reinforcement requirements. Concrete reinforced with TUF-STRAND SF will have three-dimensional reinforcing with enhanced flexural toughness, impact and abrasion resistance and will also help mitigate the formation of plastic shrinkage cracking in concrete. Dosage rates will vary depending upon the reinforcing requirements and can range from 3.0 to 20.0 lbs/yd³ (1.8 to 12.0 kg/m³). TUF-STRAND SF synthetic macrofibers comply with the International Code Council (ICC) Acceptance Criteria AC383 for synthetic fibers, are UL certified for composite metal deck construction and are recognized within ACI 360 and IBC 2015 as an alternative reinforcement.

PRODUCT CHARACTERISTICS

FEATURES & BENEFITS

- Equivalent strengths to WWM and rebar provided by engineering calculations
- Controls and mitigates plastic shrinkage cracking and reduces segregation and bleed-water
- Provides three-dimensional reinforcement against micro and macro-cracking
- Reduces equipment wear, fiber rebound and increases build-up thickness compared to steel fibers for shotcrete applications
- Increases overall concrete durability, fatigue resistance and flexural toughness
- Reduction of in-place cost versus wire mesh
- Easily added to concrete mixture at any time prior to placement
- Applicable for design by ACI 332, ACI 360 and ACI 544
- Tested in accordance with ASTM C1609, ASTM C1550 and EN 14651
- Certified for use by UL/ULC for D900 and F900 Series metal deck assemblies as alternate to WWM (CBXQ.R13773)
- Reduction of carbon footprint (CO_{2eq}) compared to conventional reinforcement

PRIMARY APPLICATIONS

- Slabs-on-Ground: Parking lots, sidewalks, distribution centers, warehouses, industries, decorative concrete
- High performance floors with extended joint spacing
- Thin walled precast (septic tanks, vaults, walls, etc.)
- Shotcrete for tunnel linings, pool construction and slope stabilization
- Whitetoppings, bridge decks and concrete pavements
- Residential poured and ICF walls
- Elevated construction, composite metal decks

PRECAUTIONS/LIMITATIONS

- Use of fibers may cause an apparent loss in measured slump of concrete. This may be offset with the use of a water reducing admixture if necessary.
- Fibers should never be added to a "zero-slump" concrete. Ensure a minimum concrete slump of 3" (80 mm) prior to addition of any fiber material. Fibers may also be added in loose form to aggregate charging devices.
- In all cases, consult the Safety Data Sheet before use.

DIRECTIONS FOR USE

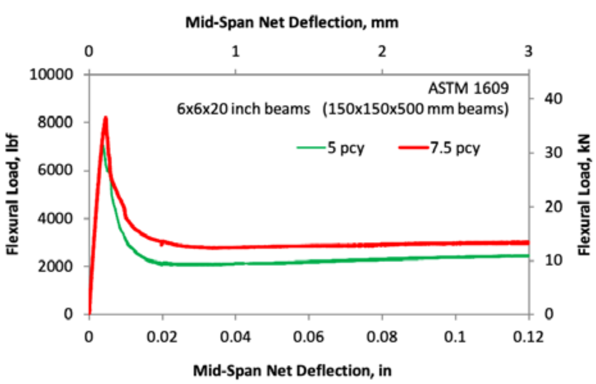
TUF-STRAND SF fibers can be added to the concrete mixture at any time prior to placement of the concrete. It is generally recommended to add any fiber material at the ready-mix concrete plant during batching. Fibers must be mixed with concrete for a minimum of three (3) to five (5) minutes at maximum mixing speed, depending on the mixer type, to ensure complete dispersion and uniformity. When adding up to 5.0 lbs/yd³ (3.0 kg/m³), a slump loss of up to 2" (50 mm) can be expected for a typical ready-mix concrete design. For higher dosages, increased loss in slump can be expected depending upon the mixture design. The use of water reducers and/or superplasticizers, such as the Eucon series or the Plastol series of admixtures may be necessary to maintain desired workability.

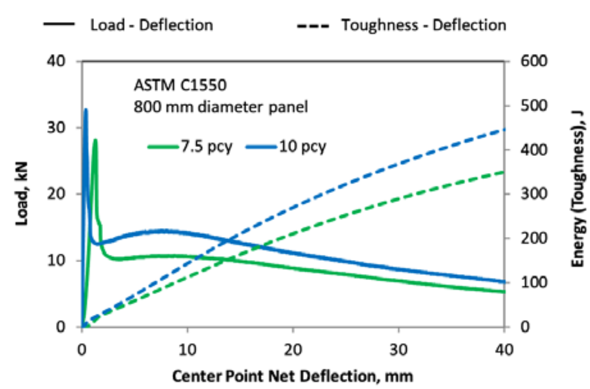
Add other admixtures independently from fiber addition. TUF-STRAND SF is compatible with all Euclid Chemical admixtures. When used properly, and placed in a concrete mix of sufficient workability, the fibers will not adversely alter the compressive or flexural strength of concrete or shotcrete.

For further recommendations please consult Euclid Chemical Technical Bulletins at www.euclidchemical.com.

PERFORMANCE

Fiber-reinforced concrete (FRC) is characterized by standard test methods such as ASTM C1399, C1609, and C1550 or RILEM TC162 (EN14651). The flexural residual strength of FRC is measured using these beam tests and is used for design purposes with proper conversion factors. Typical test results for ASTM C1609 and EN14651 (FRC beams) and C1550 (FRC round panels) are shown for TUF-STRAND SF macro synthetic fiber tested at different dosage rates. These test results could vary with mix design and curing conditions. For additional or specific test results in concrete, please contact Euclid Chemical.





ASTM C1609	A_3		f_r		f_3		fe_3		Re_3
Dosage	lbf-in	N-m	psi	MPa	psi	MPa	psi	MPa	%
5 lb/yd³ (3 kg/m³)	298	33.6	588	4.0	206	1.4	207	1.4	35
7.5 lb/yd³ (4.4 kg/m³)	375	42.4	684	4.7	250	1.7	260	1.6	38

ASTM C1550	Corrected Energy Absorption, W Joules (J) at given deflection, mm				
Dosage	5	10	20	30	40
7.5 lb/yd³ (4.4 kg/m³)	60	115	215	295	356
10 lb/yd³ (5.9 kg/m³)	73	147	276	376	454

CLEAN UP

Loose fiber material may be disposed in proper receptacles for refuse. Finishing equipment with fibers embedded in concrete should be thoroughly cleaned.

Rev. 03.23

EUCLID CHEMICAL

Fiber Reinforced Concrete

TUF-STRAND SF

Temperature and Shrinkage Calculation and Design

Project Name: Temp-Shrinkage_02-13-26

This report calculates the tensile capacity provided by steel mesh/bar and finds the TUF-STRAND SF dosage for equivalent performance.

Bar diameter	5.74	mm
Bar spacing	150	mm
Section thickness, t (or h)	120	mm
Concrete compressive strength, f'_c	21	MPa
Steel yield strength, f_y	420	MPa
Depth to reinforcement, d	60	mm
Unit width of measure, b	1000	mm
Area of steel provided, A_s	172.513	mm^2/m
Reinforcement ratio, ρ	0.14	%
Residual strength ratio, R_{e3}	24	%

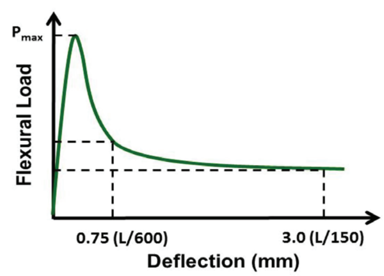
Minimum ratio of reinforcing steel (ACI 318)	0.1	%
Q. is the steel ratio provided greater than the minimum?	Yes	
Required A_s based on minimum steel ratio	120	mm^2/m
Tensile capacity provided by minimum steel	0	MPa
Tensile capacity provided by actual steel, F_{ts}	1	MPa
Working stress provided by steel $F_{ws}=0.667*F_{ts}$	0	MPa
FRC flexural residual strength $F_{e3}=F_{ws}/0.37$	1	MPa

Required dosage for TUF-STRAND SF: 1.9 kg/m3 (based on ASTM C1609 data)

Estimated GWP emissions value: 5.7 kg CO2eq/m3 — GWP Value calculated on Environmental Product Declaration NRMCAEPD:20080 at 3.08 kg CO_2eq/kg fiber

Price of TUF-STRAND SF: $/kg

Cost of TUF-STRAND SF: $/$m^2$



Schematics of a typical C1609 test result

Notes:

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- R_{e3} is calculated for a typical concrete mix with flexural strength (f_r) in the range of 4.4±0.4 MPa. Higher fr can result in a higher fiber dosage.

Calculations:

- The performance of FRC is measured according to ASTM C1609.
- The value of residual strength (fe3) or its ratio (Re3) is used to calculate the moment capacity of FRC.

$$A_s = \frac{\pi d^2}{4}$$

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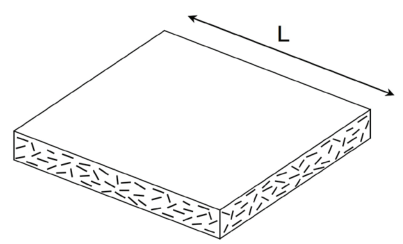
$$F_{st} = \frac{0.9 A_s . F_y}{b.h}$$

$$F_{ws} = 0.667 \ F_{st}$$

$$f_{e3} = \frac{F_{ws}}{0.37}$$

$$R_{e3} = \frac{f_{e3}}{f_r} \times 100$$

Note : R_{e3} *is also known as* $R^T_{D,150}$



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Master Format #: 03 24 00

TUF-STRAND™ SF

SYNTHETIC MACROFIBER

EUCLID CHEMICAL

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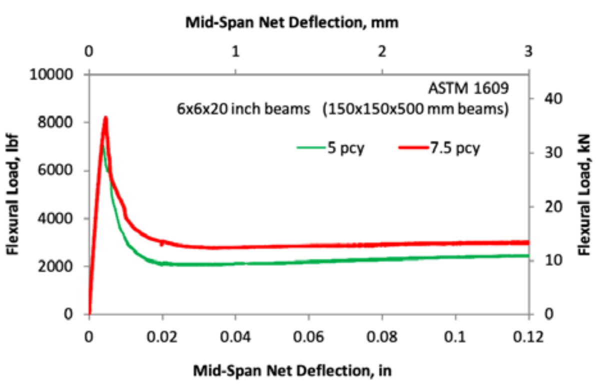

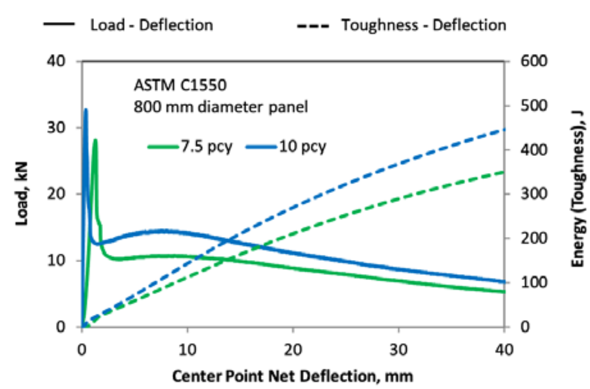

ASTM C1609	A_3		f_r		f_3		fe_3		Re_3
Dosage	lbf-in	N-m	psi	MPa	psi	MPa	psi	MPa	%
5 lb/yd³ (3 kg/m³)	298	33.6	588	4.0	206	1.4	207	1.4	35
7.5 lb/yd³ (4.4 kg/m³)	375	42.4	684	4.7	250	1.7	260	1.6	38

ASTM C1550	Corrected Energy Absorption, W Joules (J) at given deflection, mm				
Dosage	5	10	20	30	40
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Rev. 03.23

EUCLID CHEMICAL

Fiber Reinforced Concrete

TUF-STRAND SF

Temperature and Shrinkage Calculation and Design

Project Name: Temp-Shrinkage_02-13-26

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Bar diameter	4.95	mm
Bar spacing	150	mm
Section thickness, t (or h)	120	mm
Concrete compressive strength, f'_c	21	MPa
Steel yield strength, f_y	420	MPa
Depth to reinforcement, d	60	mm
Unit width of measure, b	1000	mm
Area of steel provided, A_s	128.295	mm^2/m
Reinforcement ratio, ρ	0.11	%
Residual strength ratio, R_{e3}	18	%

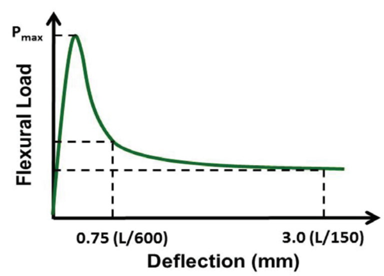
Minimum ratio of reinforcing steel (ACI 318)	0.1	%
Q. is the steel ratio provided greater than the minimum?	Yes	
Required A_s based on minimum steel ratio	120	mm^2/m
Tensile capacity provided by minimum steel	0	MPa
Tensile capacity provided by actual steel, F_{ts}	0	MPa
Working stress provided by steel $F_{ws}=0.667*F_{ts}$	0	MPa
FRC flexural residual strength $F_{e3}=F_{ws}/0.37$	1	MPa

Required dosage for TUF-STRAND SF: 1.8 kg/m3 (based on ASTM C1609 data)

Estimated GWP emissions value: 5.4 kg CO2eq/m3 — GWP Value calculated on Environmental Product Declaration NRMCAEPD:20080 at 3.08 kg CO_2eq/kg fiber

Price of TUF-STRAND SF: $/kg

Cost of TUF-STRAND SF: $/$m^2$



Schematics of a typical C1609 test result

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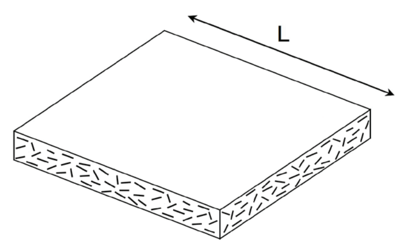
$$F_{st} = \frac{0.9 A_s . F_y}{b.h}$$

$$F_{ws} = 0.667\ F_{st}$$

$$f_{e3} = \frac{F_{ws}}{0.37}$$

$$R_{e3} = \frac{f_{e3}}{f_r} \times 100$$

Note : R_{e3} *is also known as* $R^T_{D,150}$



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CONCRETE FIBERS

Master Format #: 03 24 00

TUF-STRAND™ SF

SYNTHETIC MACROFIBER

EUCLID CHEMICAL

PRODUCT INFORMATION

PACKAGING

3.0 lb (1.36 kg), 4.0 lb (1.81 kg), 5.0 lb (2.27 kg) and 7.5 lb (3.4 kg) water soluble bags

SHELF LIFE

3 years in original, unopened package

SPECIFICATIONS/COMPLIANCES

ASTM C1116

ASTM D7508

IBC 2015 SDI/ANSI-C1.0

ICC AC383 (ESR4072)

UL/ULC (CBXQ.R13773)

TECHNICAL INFORMATION

Material: Polypropylene/polyethylene

Specific Gravity: 0.92

Typical Dosage Rates:
3.0 to 20.0 lbs/yd³ (1.8 to 12.0 kg/m³)

Available Lengths: 2" (51 mm)

Aspect Ratio: 74

Tensile Strength:
87-94 ksi (600 to 650 MPa)

Modulus of Elasticity (EN 14889.2):
1380 ksi (9.5 GPa)

Melt Point: 320°F (160°C)

Electrical/Thermal Conductivity: Low

Water Absorption: Negligible

Acid and Alkali Resistance: Excellent

Color: White

GWP Value: 3.08 kg CO_2eq/kg

DESCRIPTION

TUF-STRAND SF is a patented polypropylene and polyethylene synthetic macrofiber successfully used to replace steel fibers, welded wire mesh and conventional reinforcing bars in a wide variety of applications. TUF-STRAND SF fibers comply with ASTM C1116, Standard Specification for Fiber Reinforced Concrete and Shotcrete, and are specifically designed to provide equivalent tensile and bending resistance to conventional reinforcement requirements. Concrete reinforced with TUF-STRAND SF will have three-dimensional reinforcing with enhanced flexural toughness, impact and abrasion resistance and will also help mitigate the formation of plastic shrinkage cracking in concrete. Dosage rates will vary depending upon the reinforcing requirements and can range from 3.0 to 20.0 lbs/yd³ (1.8 to 12.0 kg/m³). TUF-STRAND SF synthetic macrofibers comply with the International Code Council (ICC) Acceptance Criteria AC383 for synthetic fibers, are UL certified for composite metal deck construction and are recognized within ACI 360 and IBC 2015 as an alternative reinforcement.

PRODUCT CHARACTERISTICS

FEATURES & BENEFITS

- Equivalent strengths to WWM and rebar provided by engineering calculations
- Controls and mitigates plastic shrinkage cracking and reduces segregation and bleed-water
- Provides three-dimensional reinforcement against micro and macro-cracking
- Reduces equipment wear, fiber rebound and increases build-up thickness compared to steel fibers for shotcrete applications
- Increases overall concrete durability, fatigue resistance and flexural toughness
- Reduction of in-place cost versus wire mesh
- Easily added to concrete mixture at any time prior to placement
- Applicable for design by ACI 332, ACI 360 and ACI 544
- Tested in accordance with ASTM C1609, ASTM C1550 and EN 14651
- Certified for use by UL/ULC for D900 and F900 Series metal deck assemblies as alternate to WWM (CBXQ.R13773)
- Reduction of carbon footprint (CO_{2eq}) compared to conventional reinforcement

PRIMARY APPLICATIONS

- Slabs-on-Ground: Parking lots, sidewalks, distribution centers, warehouses, industries, decorative concrete
- High performance floors with extended joint spacing
- Thin walled precast (septic tanks, vaults, walls, etc.)
- Shotcrete for tunnel linings, pool construction and slope stabilization
- Whitetoppings, bridge decks and concrete pavements
- Residential poured and ICF walls
- Elevated construction, composite metal decks

PRECAUTIONS/LIMITATIONS

- Use of fibers may cause an apparent loss in measured slump of concrete. This may be offset with the use of a water reducing admixture if necessary.
- Fibers should never be added to a "zero-slump" concrete. Ensure a minimum concrete slump of 3" (80 mm) prior to addition of any fiber material. Fibers may also be added in loose form to aggregate charging devices.
- In all cases, consult the Safety Data Sheet before use.

DIRECTIONS FOR USE

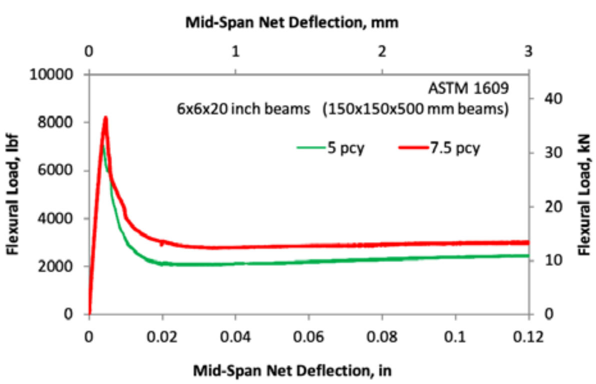
TUF-STRAND SF fibers can be added to the concrete mixture at any time prior to placement of the concrete. It is generally recommended to add any fiber material at the ready-mix concrete plant during batching. Fibers must be mixed with concrete for a minimum of three (3) to five (5) minutes at maximum mixing speed, depending on the mixer type, to ensure complete dispersion and uniformity. When adding up to 5.0 lbs/yd³ (3.0 kg/m³), a slump loss of up to 2" (50 mm) can be expected for a typical ready-mix concrete design. For higher dosages, increased loss in slump can be expected depending upon the mixture design. The use of water reducers and/or superplasticizers, such as the Eucon series or the Plastol series of admixtures may be necessary to maintain desired workability.

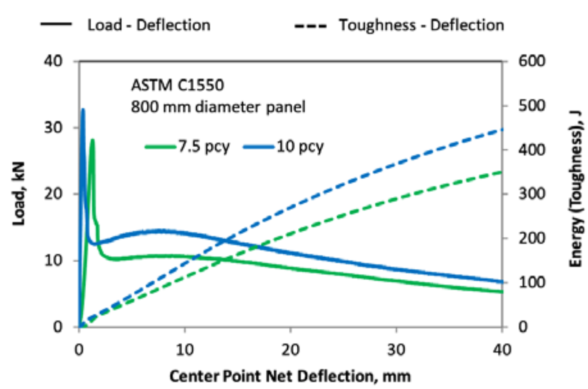
Add other admixtures independently from fiber addition. TUF-STRAND SF is compatible with all Euclid Chemical admixtures. When used properly, and placed in a concrete mix of sufficient workability, the fibers will not adversely alter the compressive or flexural strength of concrete or shotcrete.

For further recommendations please consult Euclid Chemical Technical Bulletins at www.euclidchemical.com.

PERFORMANCE

Fiber-reinforced concrete (FRC) is characterized by standard test methods such as ASTM C1399, C1609, and C1550 or RILEM TC162 (EN14651). The flexural residual strength of FRC is measured using these beam tests and is used for design purposes with proper conversion factors. Typical test results for ASTM C1609 and EN14651 (FRC beams) and C1550 (FRC round panels) are shown for TUF-STRAND SF macro synthetic fiber tested at different dosage rates. These test results could vary with mix design and curing conditions. For additional or specific test results in concrete, please contact Euclid Chemical.





ASTM C1609	A_3		f_r		f_3		fe_3		Re_3
Dosage	lbf-in	N-m	psi	MPa	psi	MPa	psi	MPa	%
5 lb/yd³ (3 kg/m³)	298	33.6	588	4.0	206	1.4	207	1.4	35
7.5 lb/yd³ (4.4 kg/m³)	375	42.4	684	4.7	250	1.7	260	1.6	38

ASTM C1550	Corrected Energy Absorption, W Joules (J) at given deflection, mm				
Dosage	5	10	20	30	40
7.5 lb/yd³ (4.4 kg/m³)	60	115	215	295	356
10 lb/yd³ (5.9 kg/m³)	73	147	276	376	454

CLEAN UP

Loose fiber material may be disposed in proper receptacles for refuse. Finishing equipment with fibers embedded in concrete should be thoroughly cleaned.

Rev. 03.23

EUCLID CHEMICAL

Fiber Reinforced Concrete

TUF-STRAND SF

Temperature and Shrinkage Calculation and Design

Project Name: Temp-Shrinkage_02-13-26

This report calculates the tensile capacity provided by steel mesh/bar and finds the TUF-STRAND SF dosage for equivalent performance.

Bar diameter	3.8	mm
Bar spacing	150	mm
Section thickness, t (or h)	120	mm
Concrete compressive strength, f'_c	21	MPa
Steel yield strength, f_y	420	MPa
Depth to reinforcement, d	60	mm
Unit width of measure, b	1000	mm
Area of steel provided, A_s	75.608	mm²/m
Reinforcement ratio, ρ	0.06	%
Residual strength ratio, R_{e3}	11	%

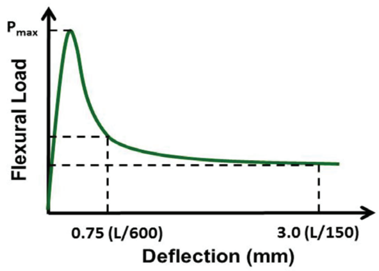
Minimum ratio of reinforcing steel (ACI 318)	0.1	%
Q. is the steel ratio provided greater than the minimum?	No	
Required A_s based on minimum steel ratio	120	mm²/m
Tensile capacity provided by minimum steel	0	MPa
Tensile capacity provided by actual steel, F_{ts}	0	MPa
Working stress provided by steel F_{ws}=0.667*F_{ts}	0	MPa
FRC flexural residual strength F_{e3}=F_{ws}/0.37	0	MPa

Required dosage for TUF-STRAND SF: 1.8 kg/m3 (based on ASTM C1609 data)

Estimated GWP emissions value: 5.4 kg CO2eq/m3 — GWP Value calculated on Environmental Product Declaration NRMCAEPD:20080 at 3.08 kg CO_2eq/kg fiber

Price of TUF-STRAND SF: $/kg

Cost of TUF-STRAND SF: $/m²



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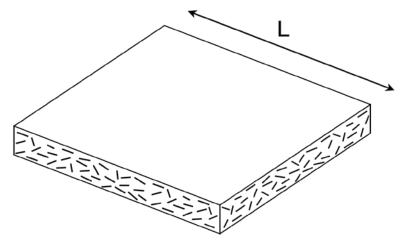

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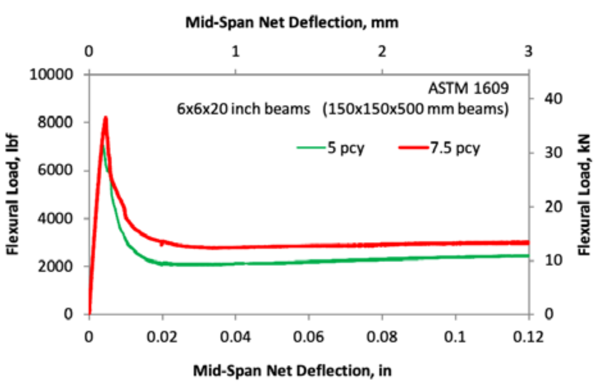

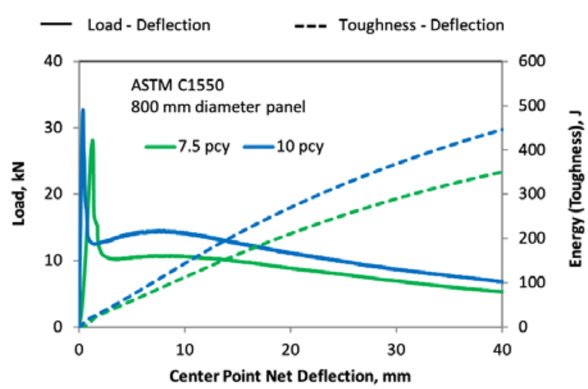

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