WHO IS SIKA FIBERMESH

OUR BUSINESS IS BUILDING SOLUTIONS

MORE THAN 100 YEARS OF EXPERTISE

Our reputation for quality and reliability is illustrated through a comprehensive portfolio of technologies and solutions. Whether we are waterproofing your basement or your roof, sealing your skyscraper or your car, or solving problems with you on your house or your multi-story building, you will see why we are renowned for Building Trust.

SIKA AT A GLANCE

24,000+	EMPLOYEES
100+	COUNTRIES
300+	PLANTS WORLDWIDE
7	NEW PLANTS IN 2019
93	NEW PATENTS IN 2019
5	ACQUISITIONS IN 2019
$8.109 BN	NET SALES IN 2019

BUILDING TRUST

OUR SUSTAINABILITY COMMITMENT

BUILDING TRUST

SUSTAINABLE STRATEGY

TARGET 2023
All new product developments with "Sustainable Solutions".

TARGET 2023
15% reduction of CO_2-emissions per ton sold.

TARGET 2023
10,000 working days of volunteering work
50% more projects
50% more direct beneficiaries

SUSTAINABLE SOLUTIONS

We are leading the industry by pioneering a comprehensive portfolio of customer focused solutions, combining both higher performance and improved sustainability.

CLIMATE PERFORMANCE

We run our business in a responsible way and mitigate climate change and its impacts.

COMMUNITY ENGAGEMENT

We build trust and create value – with customers, communities, and with society.

MORE VALUE

LESS IMPACT

ENERGY

We manage resources and costs carefully.

WASTE / WATER

We increase material and water efficiency.

OCCUPATIONAL SAFETY

Sika employees leave the workplace healthy.

TARGET 2023
15% less energy consumption per ton sold
50% renewable electricity rate

TARGET 2023
50% less accidents
0 fatalities

TARGET 2023
15% less waste generation per ton sold
25% higher recycling rate of total waste
15% less water consumption per ton sold

A COMPREHENSIVE APPROACH

CONCRETE

WATERPROOFING

ROOFING

BUILDING FINISHING

FLOORING & COATING

SEALING & BONDING

REFURBISHMENT

INDUSTRY

WHEN AN ENTIRE VALLEY CAN RELY ON THE STRENGTH OF THE CONCRETE.

Sika develops and markets a complete range of admixtures and additives for use in concrete, cement and mortar production. These products enhance specific properties of the fresh or hardened concrete, such as workability, watertightness, durability, load-bearing capacity, or early and final strength.

Sika® ViscoCrete®
Sikament®
Sika® Plastiment®
SikaPlast®
Sika® Plastocrete®
Sika® Sigunit®
Sika® ViscoFlow®
SikaRapid®
SikaFiber®
SikaControl®

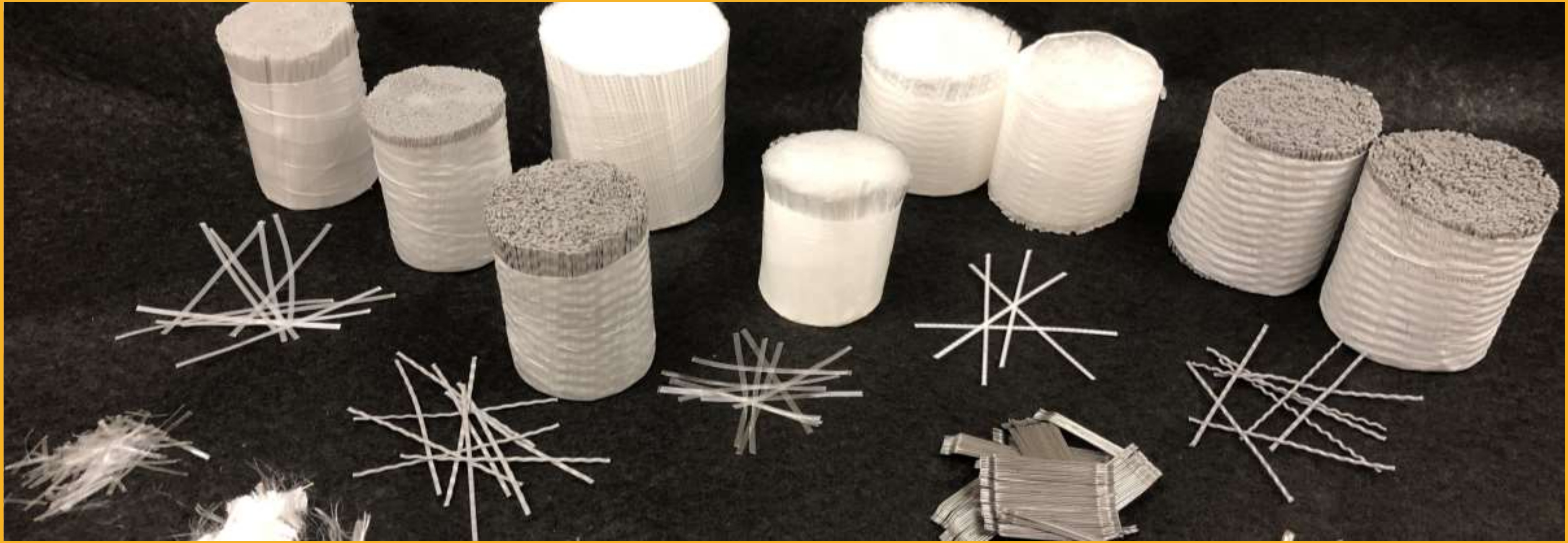
- Ready Mix Concrete
- Infrastructure Projects
- Precast Concrete
- Dry Mortar
- Shotcrete
- Tunneling
- Mining
- Slab on Ground Solutions

WHO IS SIKA FIBERMESH

- Manufacturing Fibermesh® Since 1983 in Chattanooga, TN
- Purchased by Sika 2018
- Average tenure 12+ years
- Lean Manufacturing Practices
- Safety Behavior Based Facility
- Certified ISO Facility
- Seven Extrusion Lines
- Eight Cutting Lines

WHO IS SIKA FIBERMESH

Advanced Processing and Chemistry



FIBER REINFORCED CONCRETE

6/10/20, PAUL LASKEY

SIKA CORPORATION / SIKAFIBER

BUILDING TRUST

Sika Corporation
J492

Fiber Reinforced Concrete
SIK308

Speaker Name/s
Name - date

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Questions related to specific products and services may be addressed at the conclusion of this presentation.

Course Description

Further your knowledge of fiber reinforced concrete by understanding the differences and applications for micro and macro fibers usage. Learn about the different fiber types in each category in relationship to fiber performance. Gain knowledge on fiber applications including; slab on ground, composite metal deck, overlays, precast and explosive spalling of concrete.

Course / Learning Objectives

- Understand what are Micro fibers and applications
- Understand what are Macro fibers (steel, synthetic and blends)
- Explore the aspects of Macro fibers that determine performance
- Recognize typical applications for fiber reinforced concrete

FIBER REINFORCED CONCRETE

HISTORY

HISTORY

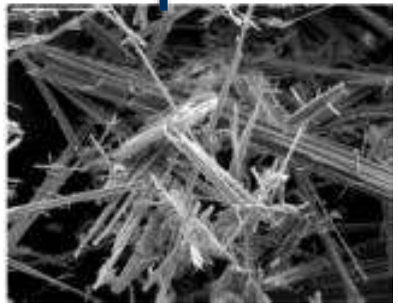
4500 years ago: Sun baked bricks in Mesopotamia used rice husk or straw

1847 French engineer Joseph Lambot used continuous reinforcement

1968 Micro Synthetic fiber used in shotcrete

1990 Macro Synthetic fiber

San Francisco de Assisi Mission Church, constructed of adobe 1772

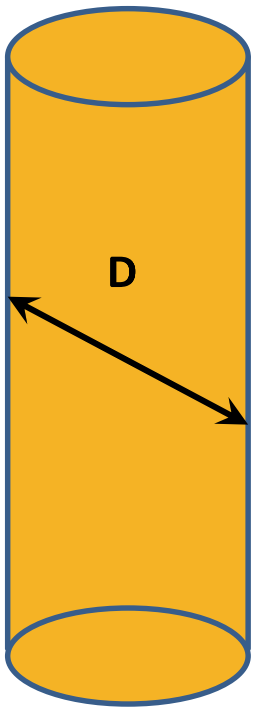


Asbestos fibers for concrete in 1900

1971 first steel fiber project in North America

1973 first steel fiber shotcrete – Ririe Dam

HISTORY



MICRO FIBERS: diameter or equivalent diameters less than 0.012 in (0.3mm)

MACRO FIBERS: diameter or equivalent diameters greater than or equal to 0.012 in

FIBER REINFORCED CONCRETE

MICRO

MICRO FIBERS

Short Term

- Plastic Shrinkage
- Settlement
- Reduce Bleed Water
- Create Uniform Bleed

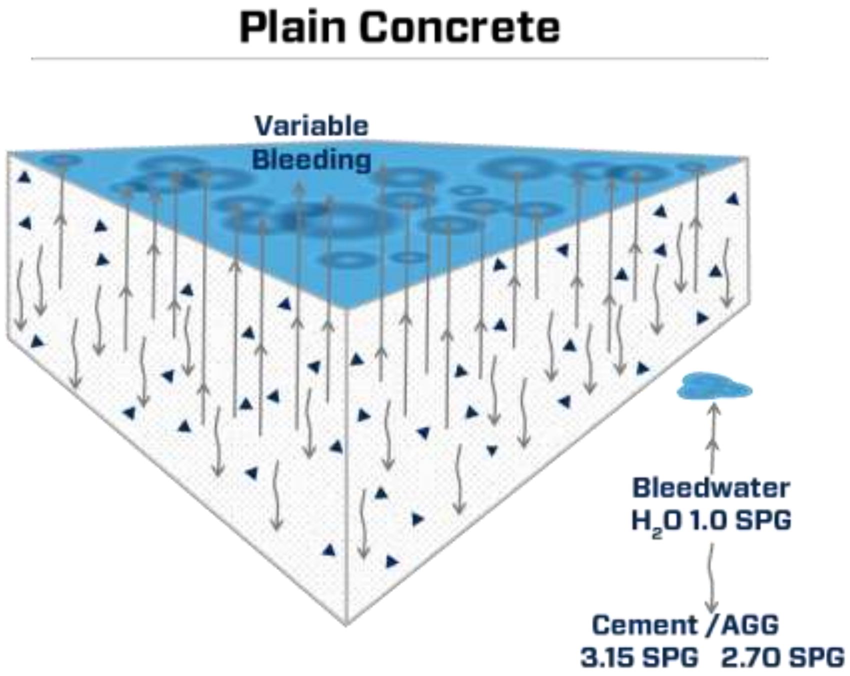
Long Term

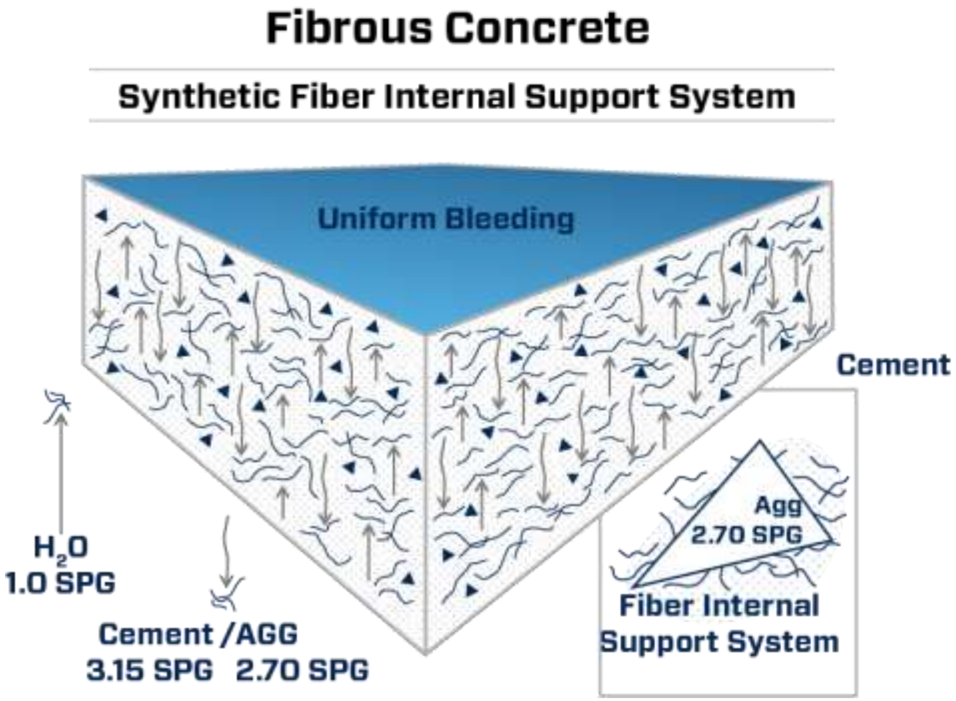
- Reduce Permeability
- Impact
- Abrasion
- Shatter Resistance
- Explosive Spalling

Applications for Micro Fibers

- Everyday concrete
- Sidewalks
- Driveways
- Tunnel segments
- Outdoor placements

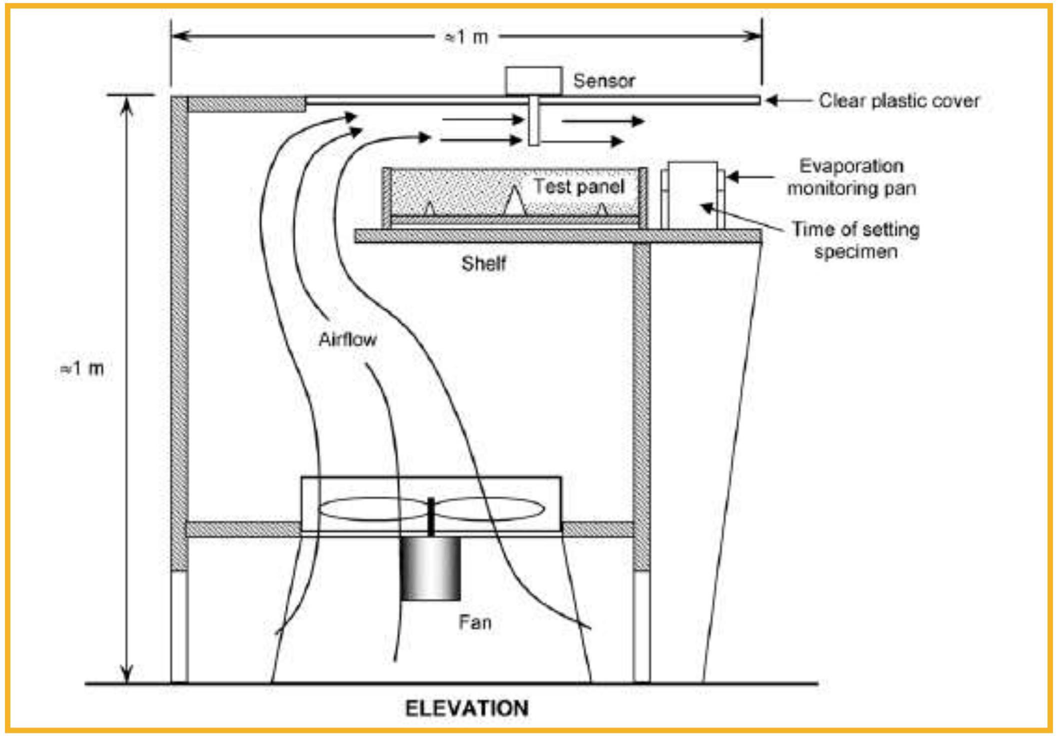
MICRO FIBERS





Uniform Bleeding & Internal Support

MICRO FIBERS

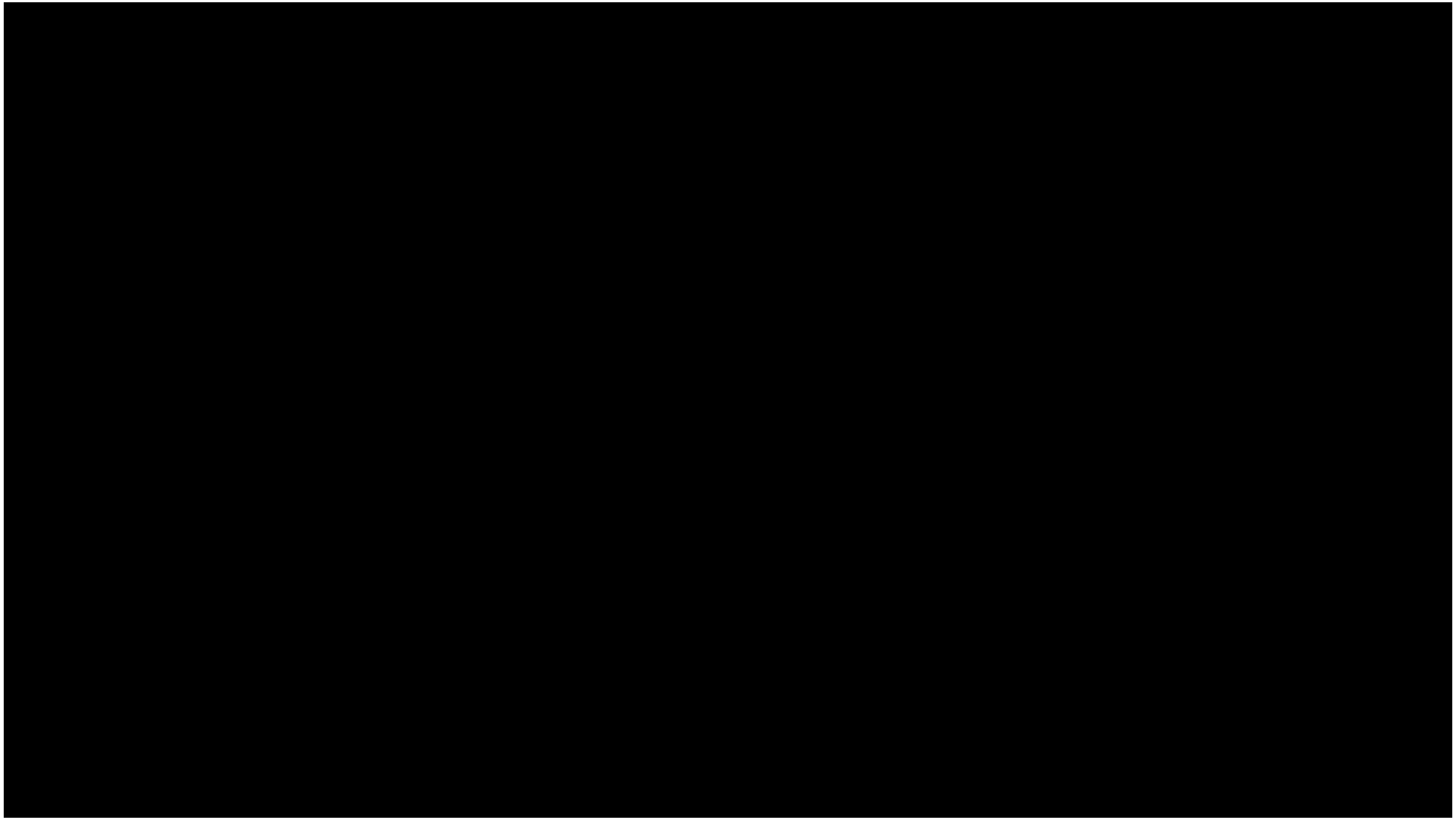


ASTM C1579 - Standard Test Method for Evaluating Plastic Shrinkage Cracking of Restrained Fiber Reinforced concrete

MICRO FIBERS

Explosive Spalling

MICRO FIBERS

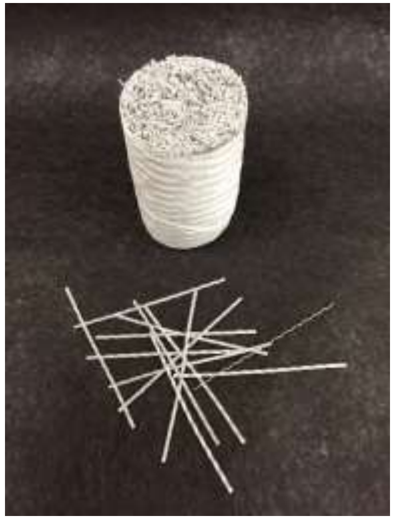


Explosive Spalling

FIBER REINFORCED CONCRETE

MACRO - PERFORMANCE

MACRO FIBERS - PERFORMANCE



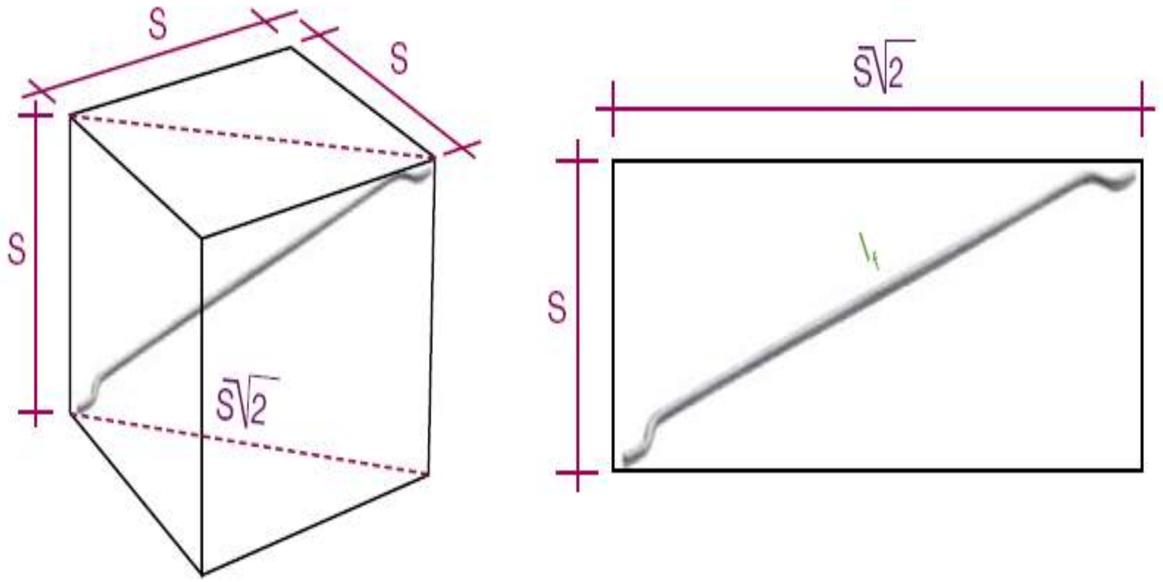
Macro Synthetic

Steel

Blend

- Steel with Micro
- Synthetic with Micro

MACRO FIBERS - PERFORMANCE



McKee Spacing Theory:

- In one unit volume of concrete there are a number of cubes with a dimension of S which is equal to the number of fibers in total volume.
- Fibers are random though-out the mix (not placed into location)
- If the size of the cube is reduced to be smaller than the volume containing one fiber, overlap is provided.

MACRO FIBERS - PERFORMANCE

McKee Spacing Theory:

$$S = \sqrt[3]{\frac{\pi d^2 L}{4\sigma}} \quad \Rightarrow \quad D = \frac{V M_v}{(O_f L)^3}$$

Volume of one Fiber (V)= $\pi d^2 L/4$

Where d = Diameter

L = Length

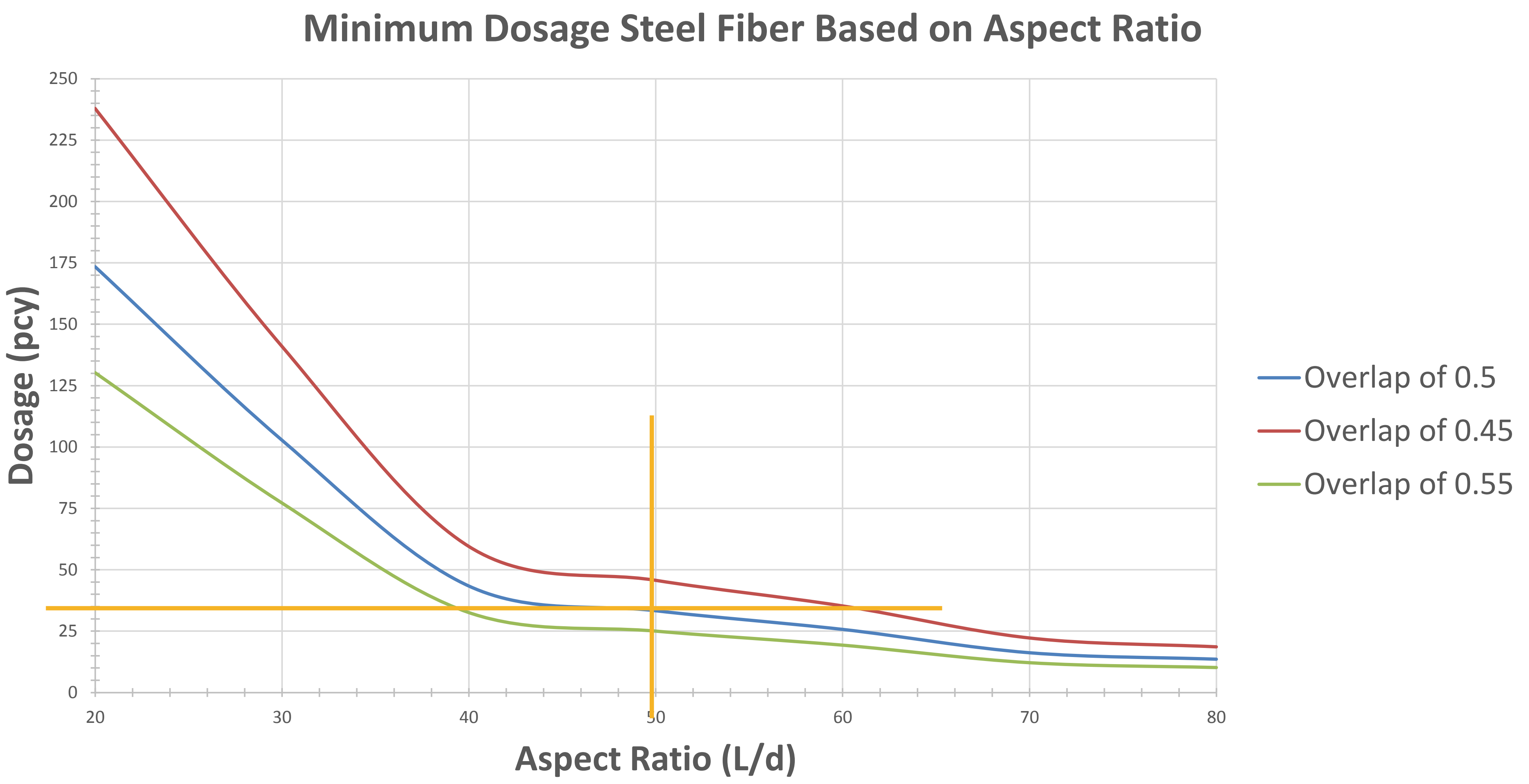
Fiber Volume Fraction (σ) = Dosage (D) / Mass per Volume (M_v)

Spacing (S) = Overlap factor (O_f) * L

Should never be 1 since fibers are random. Typical factor 0.45

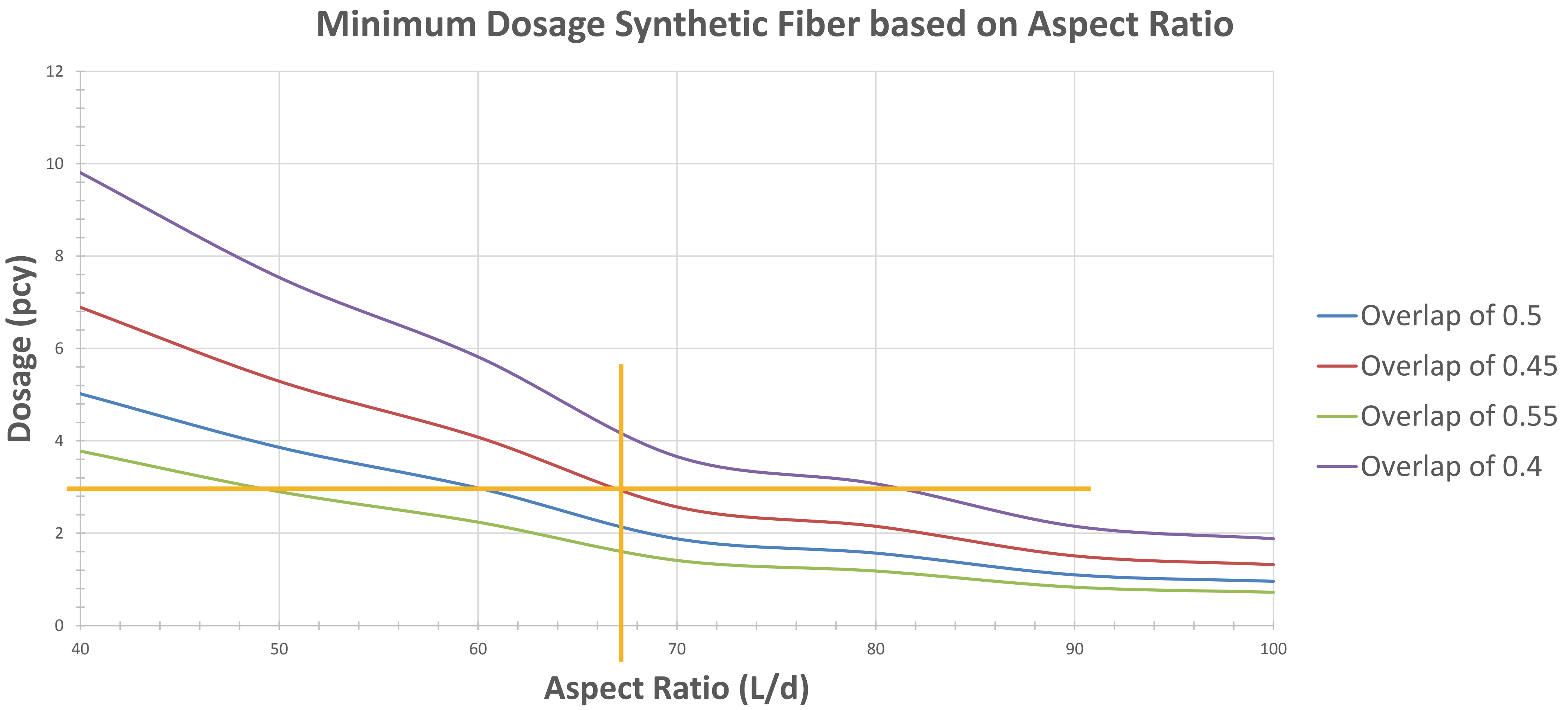
MACRO FIBERS - PERFORMANCE

McKee Spacing Theory:



MACRO FIBERS - PERFORMANCE

McKee Spacing Theory:

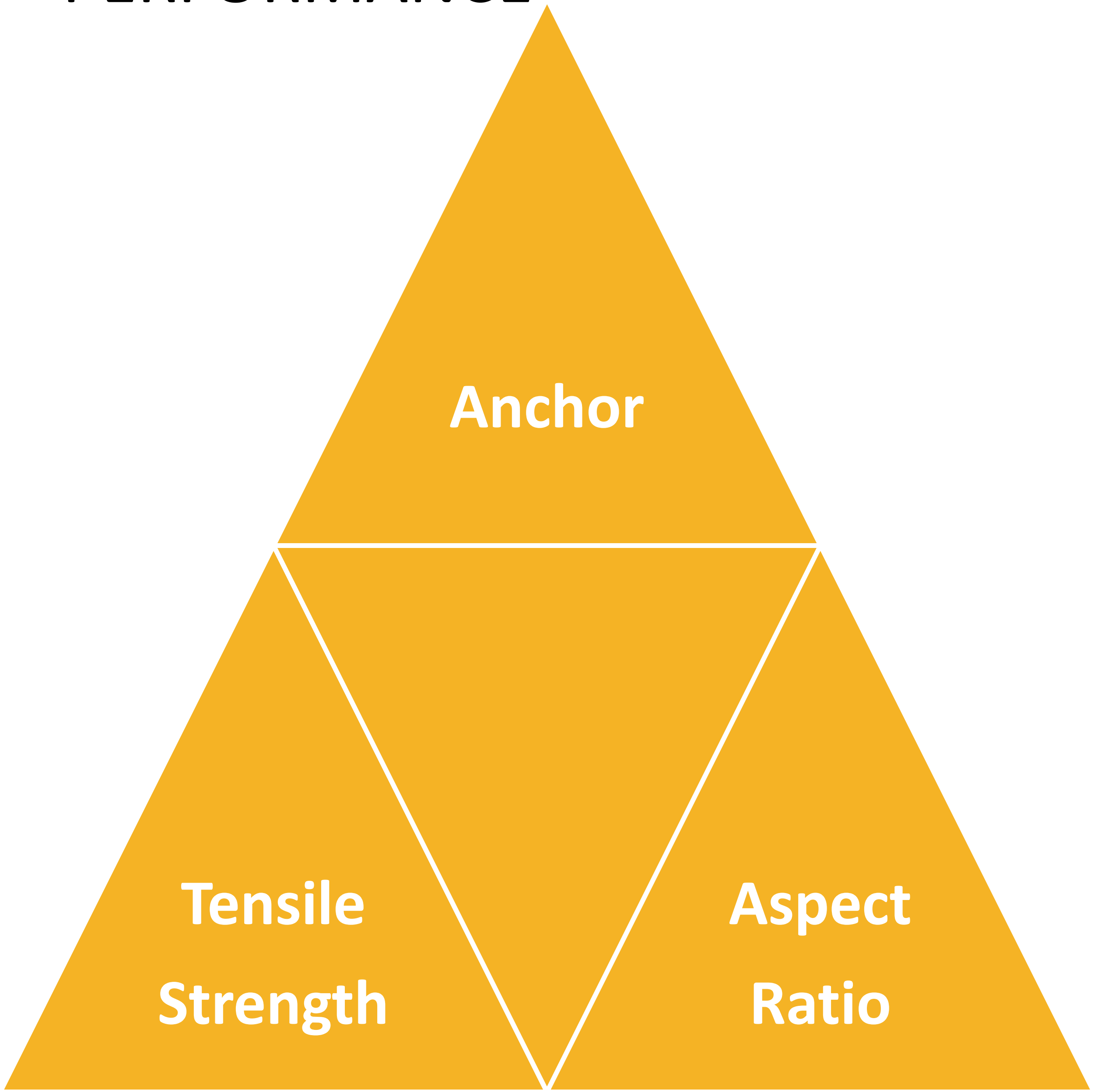


MACRO FIBERS - PERFORMANCE

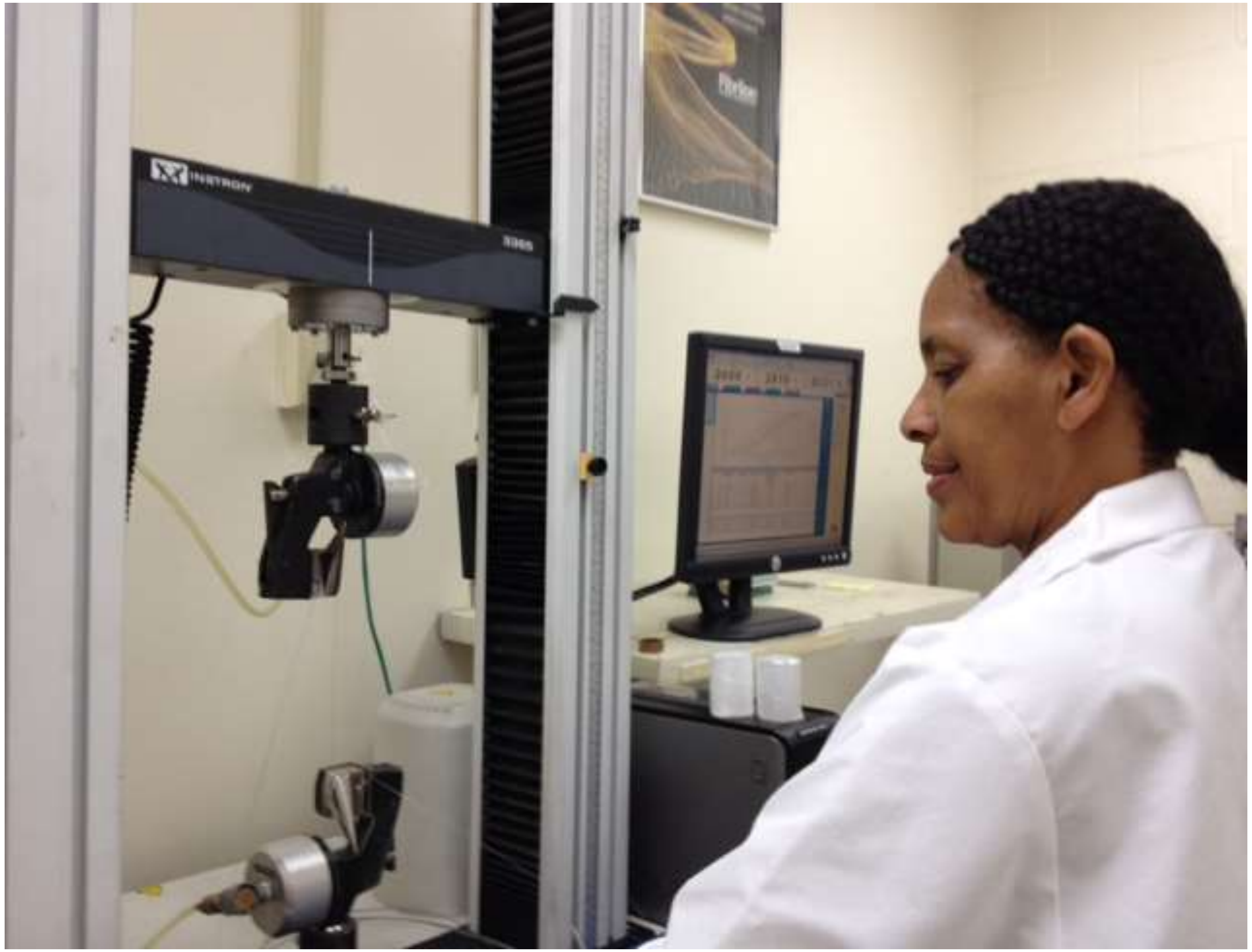
?
=

Is there a difference? Aren’t they all the same?

MACRO FIBERS - PERFORMANCE



MACRO FIBERS - PERFORMANCE



TENSILE STRENGTH

Higher the tensile strength the better the reinforcing

MACRO FIBERS - PERFORMANCE

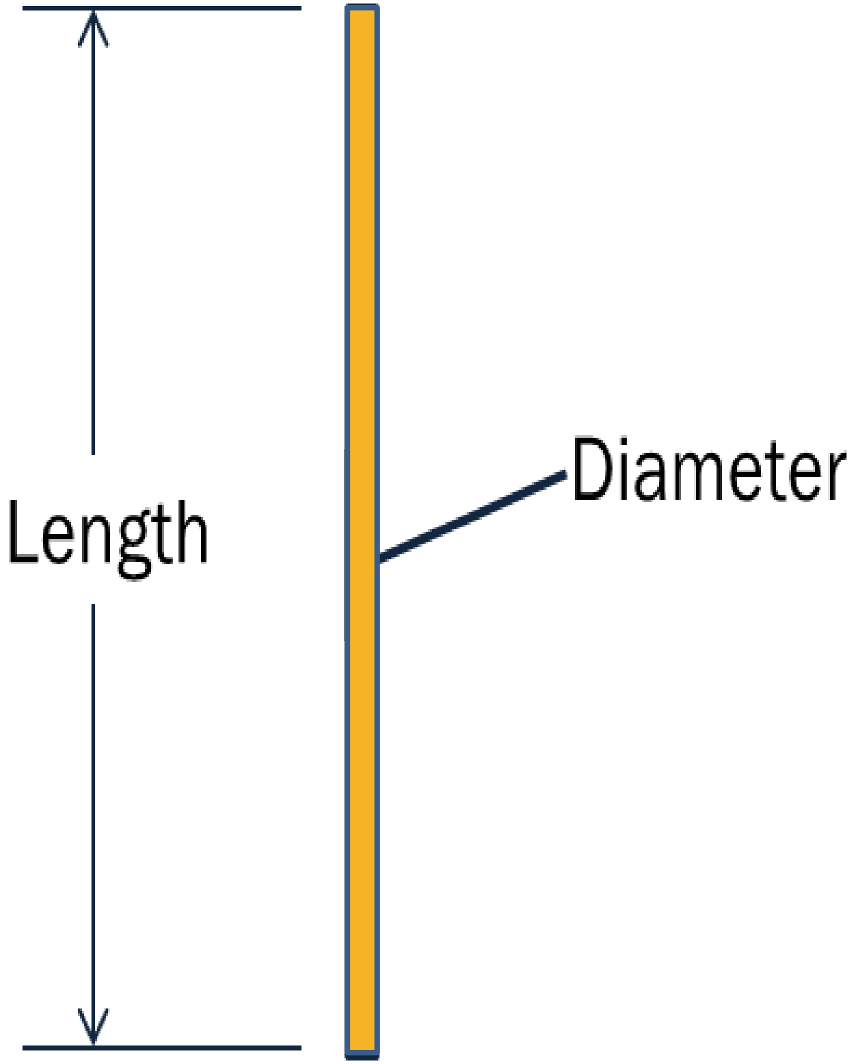
ANCHORAGE TYPES

- Hooked end
- Crimped
- Embossing
- Fibrillation

CONTROLLED PULL-OUT

- Due to deformation of the crack
- Controlled crack
- Ductility

MACRO FIBERS - PERFORMANCE



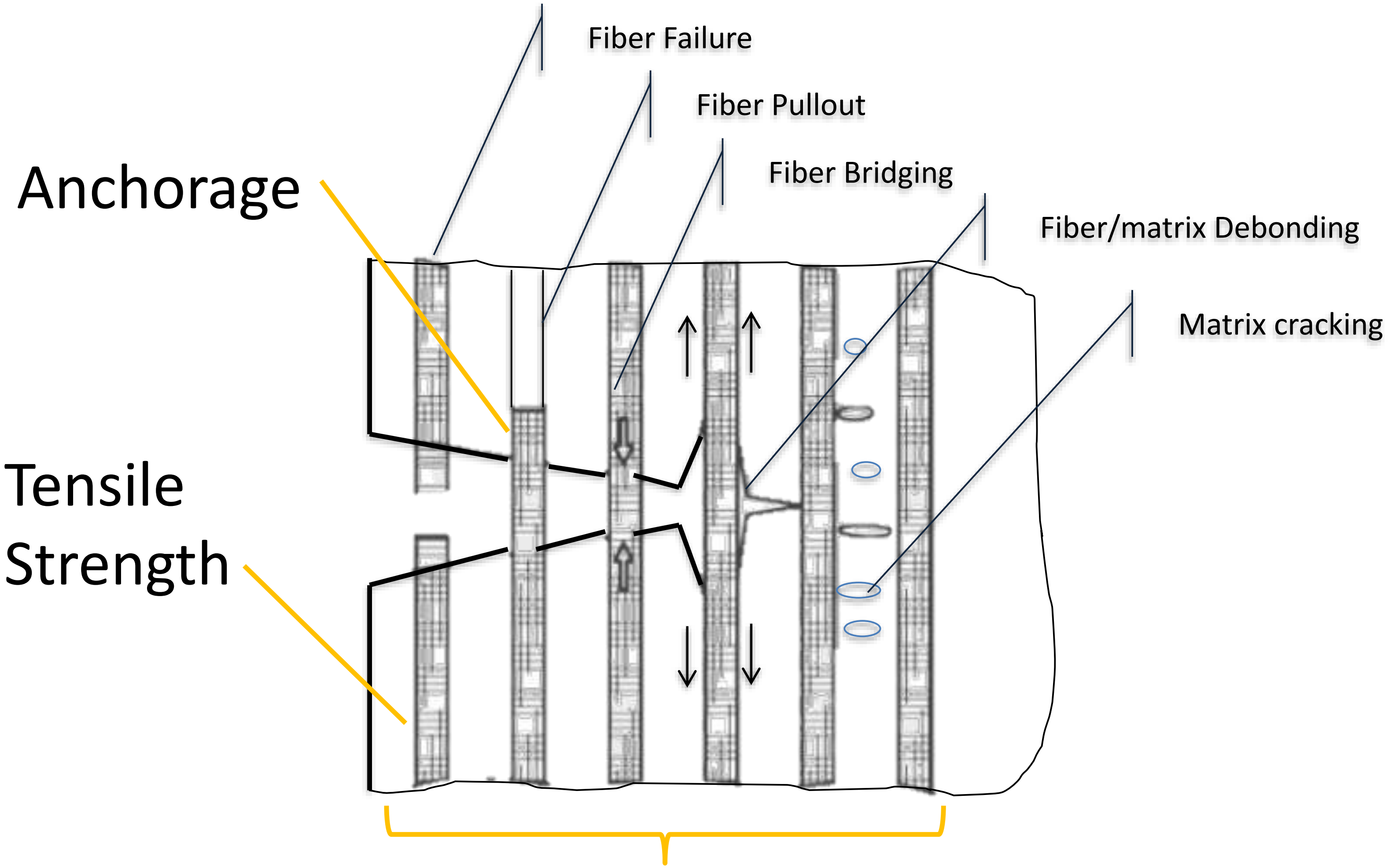
ASPECT RATIO

The length/diameter.

The higher the Aspect Ratio the better the performing the fiber:

- Better embedment
- More fibers per pound

MACRO FIBERS - PERFORMANCE



Aspect ratio (number of fibers & length of bond)

FIBER REINFORCED CONCRETE

MACRO – PERFORMANCE TESTING

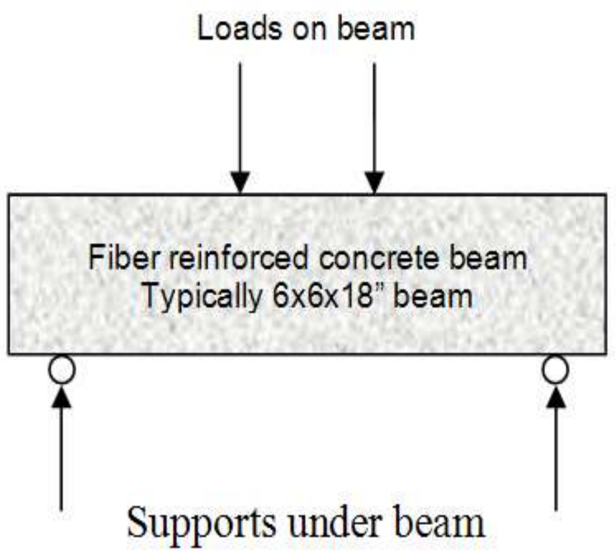
MACRO FIBER – PERFORMANCE TESTING

BEAM TESTS

- Used in calculations
- ASTM C1609 – Flexural Performance of Fiber-Reinforced Concrete
- ASTM C1399 - Obtaining Average Residual –Strength of Fiber-Reinforced Concrete

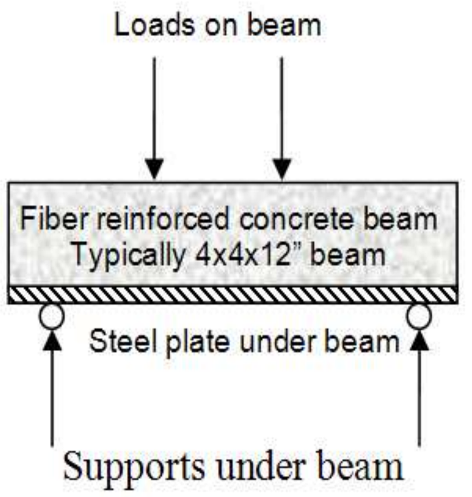
THIRD PARTY LAB

MACRO FIBER – PERFORMANCE TESTING



ASTM C1609

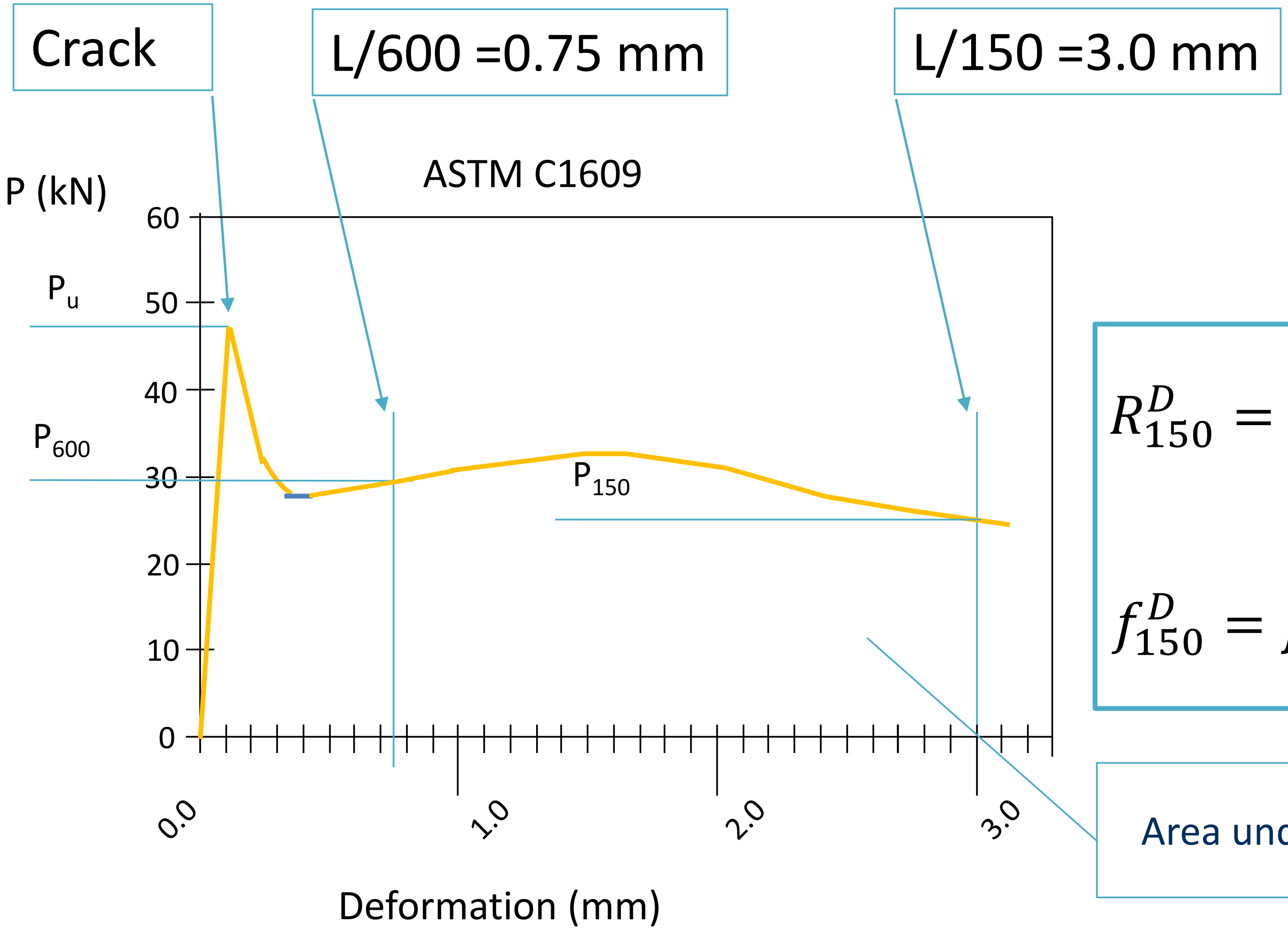
- Three dimensional orientation of fibers due to beam size
- Fiber reinforced beam and load
- More conservative results.
- ACI and More industry standards utilizing this standard



ASTM C1399

- Smaller beam size can lead to favorable fiber orientation
- Steel plate under the beam until after first crack
- Energy release of crack absorbed by steel plate
- 10 to 20% higher results than ASTM C1609
- Higher Standard Deviation

MACRO FIBER – PERFORMANCE TESTING



Performance testing done at variety of dosage and results used in calculation

$$R_{150}^{D} = \boldsymbol{R_{e3}} = \frac{150T_{150}^{D}}{f_1 bd^2} x100\% = \%$$

$$f_{150}^{D} = \boldsymbol{f_{e3}} = \frac{150T_{150}^{D}}{bd^2} x100\% = \boldsymbol{PSI}$$

Area under the curve is T^{D}_{150}

MACRO FIBER – PERFORMANCE TESTING

ICC
(International Code Council)

AC383 – Acceptance Criteria for Synthetic Macro Fibers for Use in Concrete

ESR – Engineering Service Report for each fiber

FIBER REINFORCED CONCRETE

MACRO – APPLICATION SLAB ON GROUND

SLAB ON GROUND

Simple and Quick

No Placing of WWF

Eliminates Pumping

Less Labor

Fewer Accidents

WHY USE MACRO FIBERS – CONSTRUCTION

SLAB ON GROUND

Full Depth Reinforcing

Reinforcing in the correct location

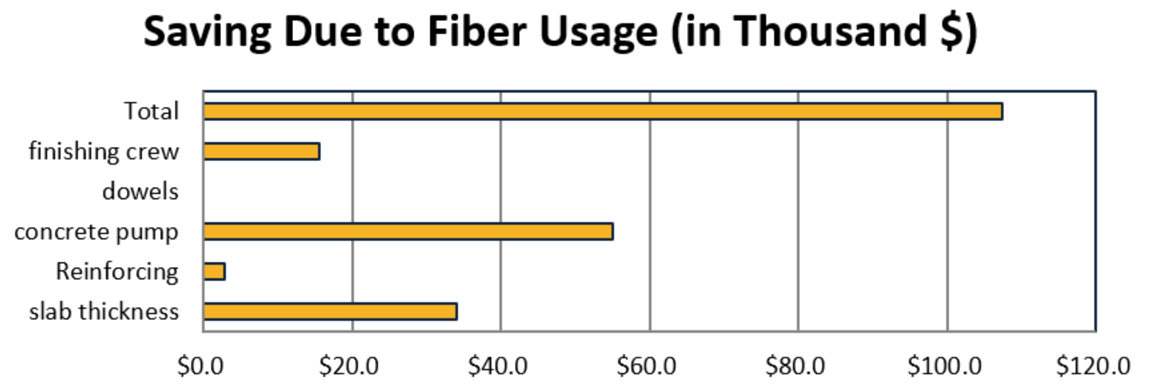
Excellent Crack Control

No Corrosion or Spalling

Improved Impact Resistance

WHY MACRO FIBERS - TECHNICAL

SLAB ON GROUND



	slab thickness	Reinforcing	concrete pump	dowels	finishing crew	Total
Traditional-Fiber	$34.0	$2.8	$55.0	$0.0	$15.6	$107.4

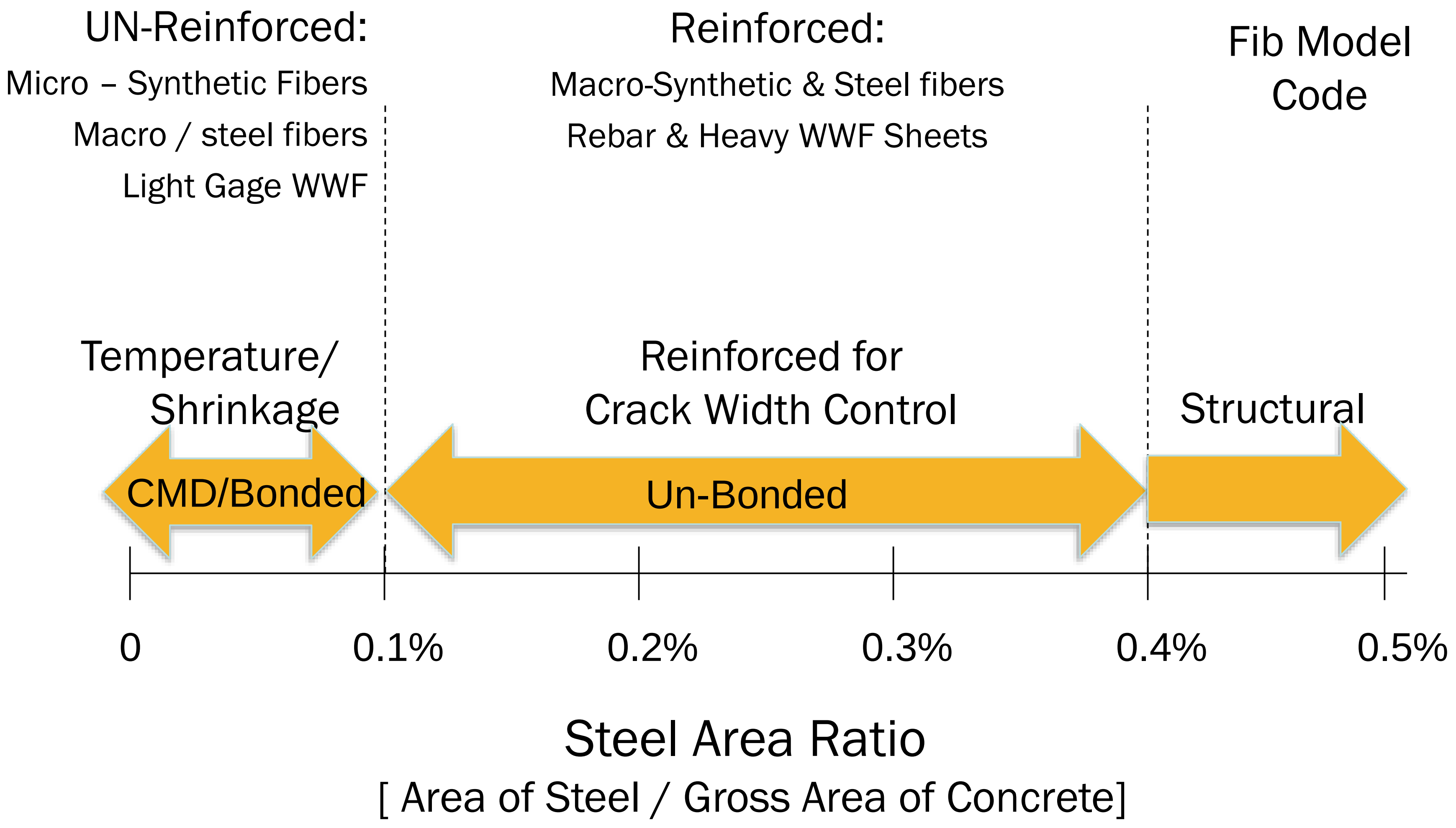
A percent cost savings of 27.7%

Traditional Reinforcing Costs						
concrete	110	$/cy			$	203,720
plasticizer	1	$/cy			$	1,852
steel	800	$/ton			$	17,248
Chairs & spacers	0.23	$/ea	@ 3.0	sq ft	$	7,667
steel installation	250	$/ton			$	5,390
concrete pump	5000	$/day			$	55,000
dowels	3.18	$/ft			$	40,386
finishing crew	5200	$/day			$	57,200
					$	**388,463**

Fiber Reinforced Concrete Cost				
concrete	110	$/cy	$	169,730
plasticizer	1	$/cy	$	1,543
Fibers	6	$/lb	$	27,774
concrete pump	0	$/day	$	-
dowels	3.18	$/ft	$	40,386
finishing crew	5200	$/day	$	41,600
			$	**281,033**

SLAB ON GROUND

Concrete Reinforcement Spectrum Slabs



SLAB ON GROUND

ACI 360 – CALCULATIONS (11.3.3)

Formulate Equivalency:

- PCA Method – Unreinforced concrete method
- WRI Method – From computer model
- COE Method – Design charts
- Elastic Method
- NonLinear Finite Element – Using springs

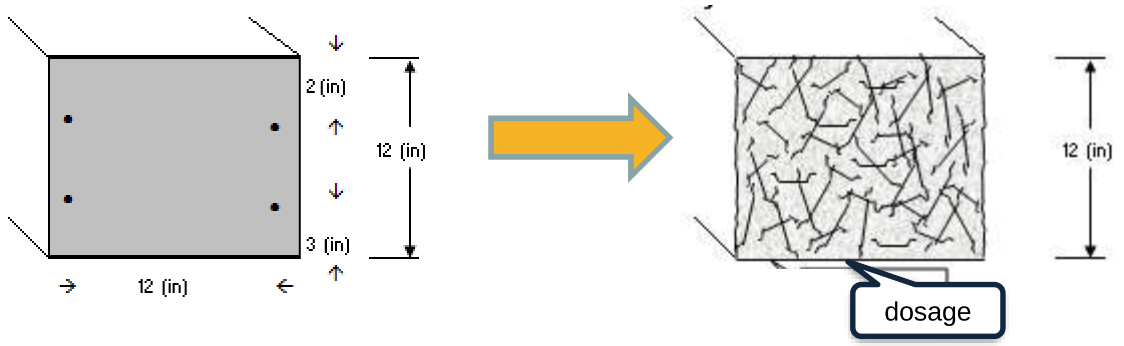
Load Based:

- Yield Line – Calculations from Lösberg and Meyerhof

- Combined FRC & bar reinforcement

SLAB ON GROUND

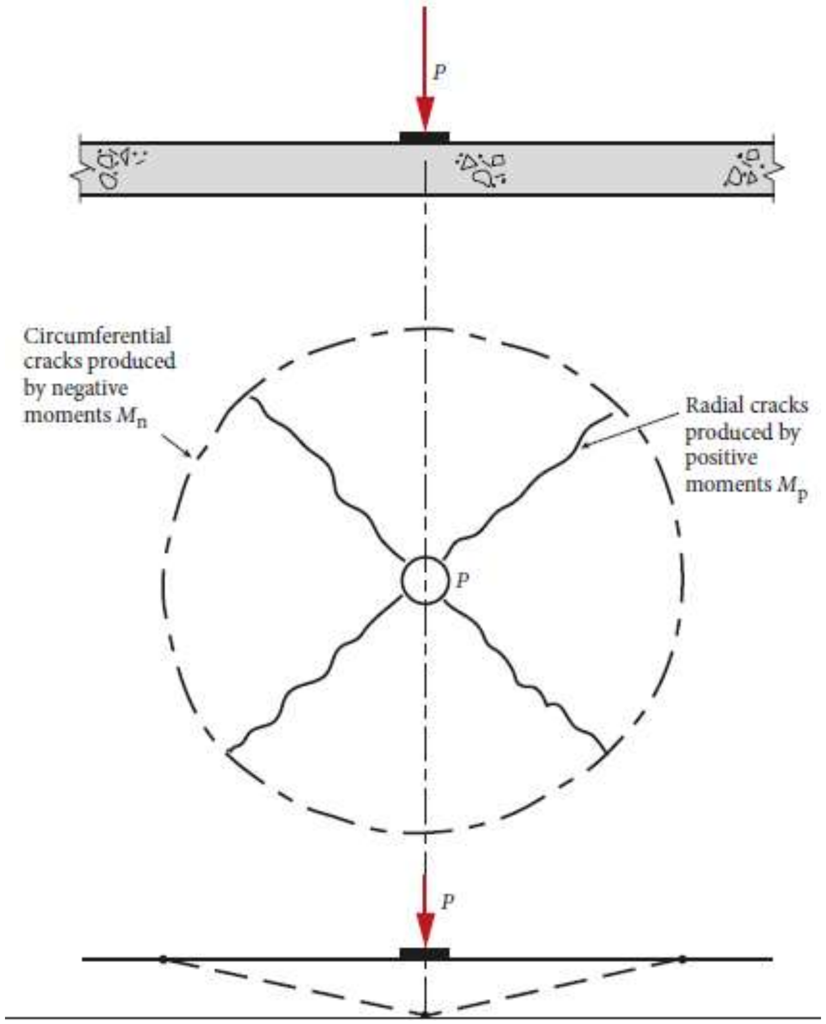
Equivalent Moment Capacity or Equivalent Shrinkage



The 3 items needed

1. slab/shotcrete thickness,
2. concrete/shotcrete psi
3. size/spacing of the steel – including the number of layers

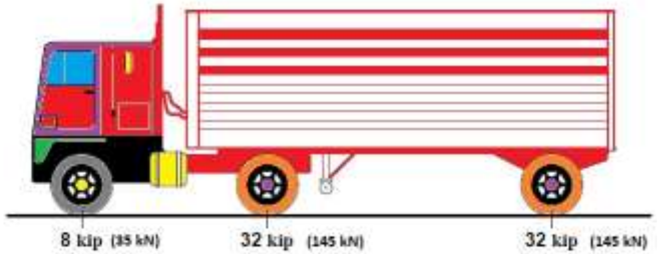
SLAB ON GROUND



YIELD LINE

- Ultimate Limit State Calculation
- Determines where the slab will crack (Yield)
- Applies safety factors to ensure the slab does not crack
- Slab on ground online programs are available

SLAB ON GROUND

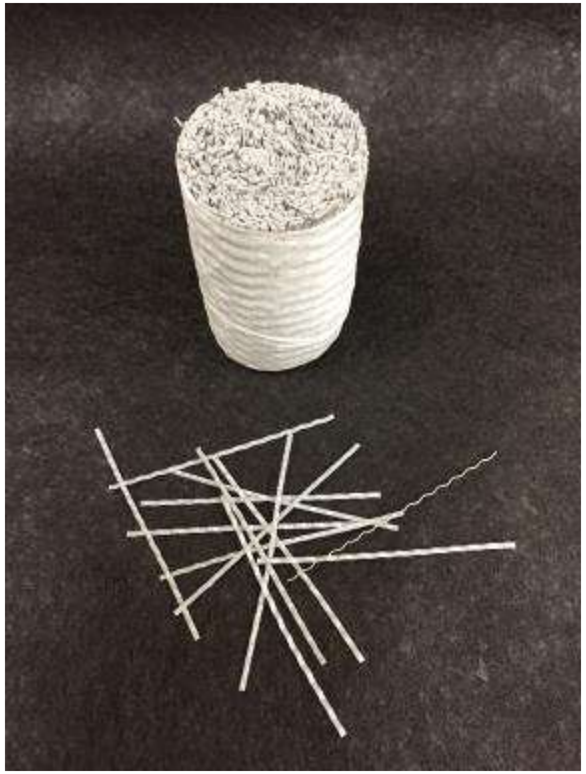


SLAB ON GROUND

STEEL FIBERS

- Collated for easy batching
- Fibers should not be first item in mix
- Ribbon feed steel fibers into mix
- Mixing time 5 min. or 70 revolutions

SLAB ON GROUND



SYNTHETIC MACRO FIBERS

- Pucked for easy batching
- Do not remove from bags
- Mix sequence
  - Dry mix (Ready Mix Truck) - Fibers should be last item in the mix
  - Central Batch – Fibers should be first to middle item in the mix
- Mixing time 5 min. or 70 revolutions

SLAB ON GROUND

Finishing Tips:

- Timing is Everything
- Follow ACI 302 Guide to Concrete Floor and Slab Construction
  - 10.3.9 Power Floating

FIBER REINFORCED CONCRETE

MACRO – APPLICATION
COMPOSITE METAL DECK (CMD)

CMD

TRADITIONAL CMD

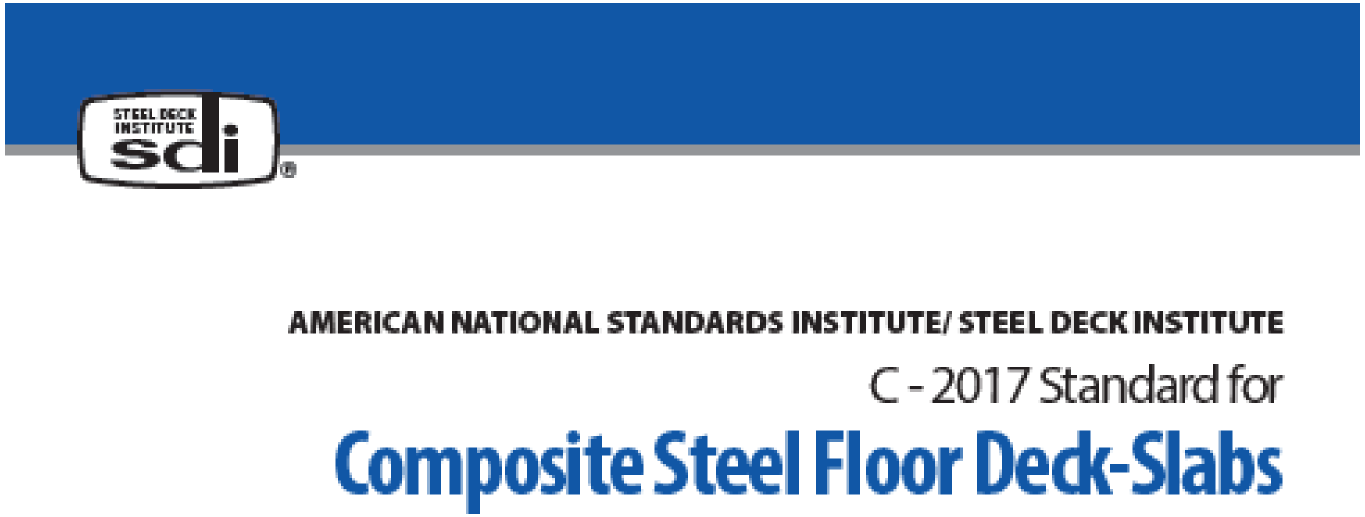
- Steel to be placed in top 1/3 of slab
- Tripping hazards
- Need crane time for steel (critical path)
- Negative steel above beam is rebar

CMD

FIBER REINFORCED CMD

- Three dimensional reinforcing
- Can be pumped (no crane time)
- No tripping hazard
- Negative steel above beam is rebar

CMD



Allows for the usage of:

- Steel fibers at minimum dosage 25 pcy
- Synthetic fibers at a minimum dosage of 4 pcy

CMD

ONLINE CERTIFICATIONS DIRECTORY

CBXQ.R14701
Fiber Reinforcement and Concrete Additives

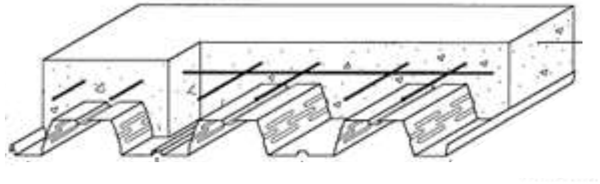
Page Bottom

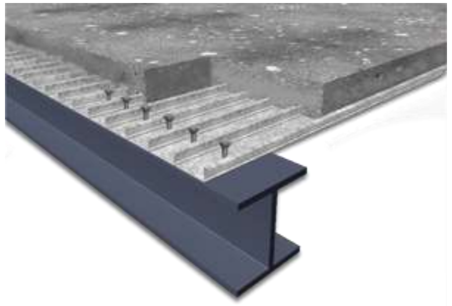
Fiber Reinforcement and Concrete Additives

See General Information for Fiber Reinforcement and Concrete Additives

UL FIRE TEST CERTIFICATION
type of deck and fire exposure hours is required for composite metal decks.

CMD





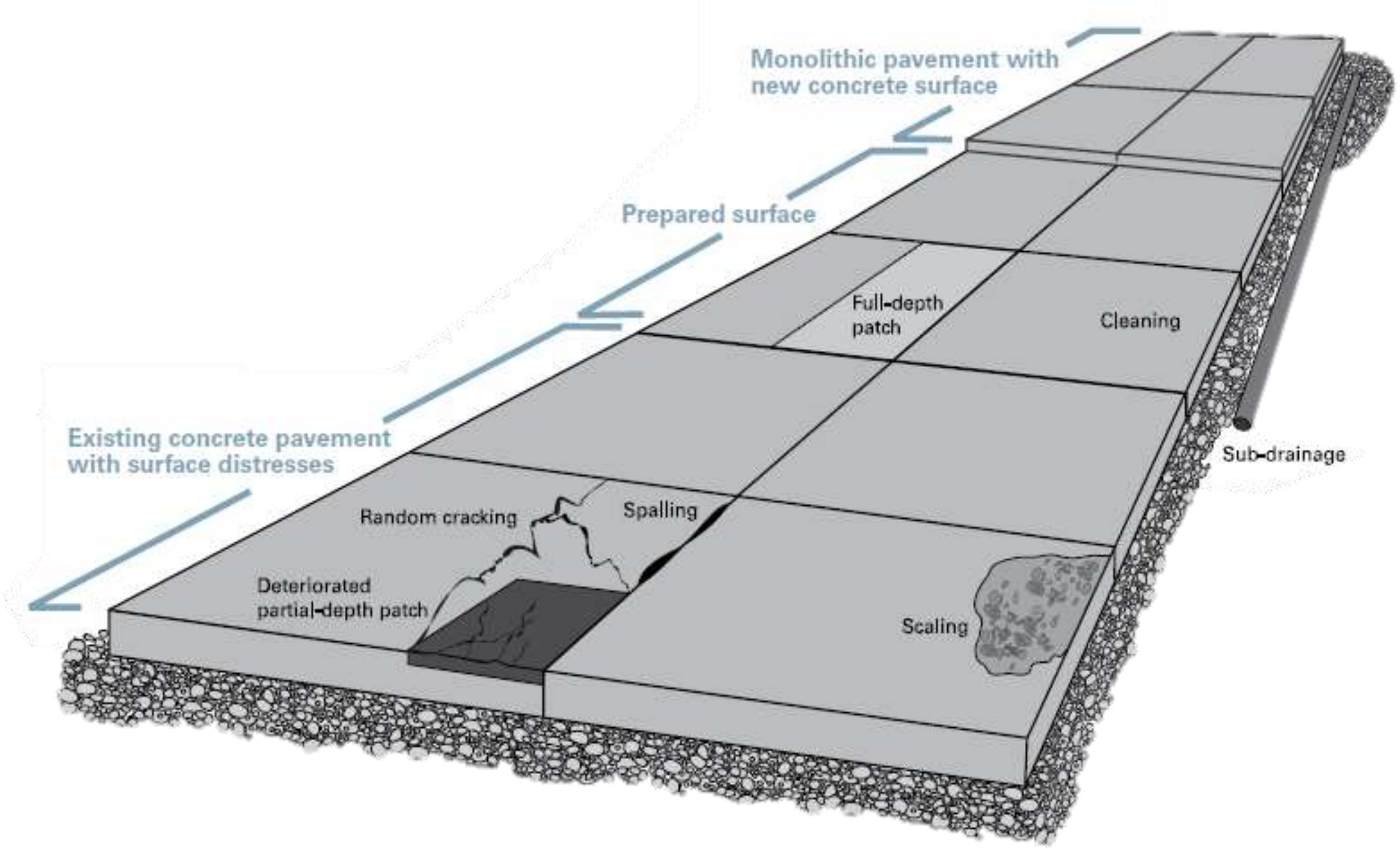
Traditional reinforced concrete tensile restraining capacity	=	Fiber reinforced concrete tensile restraining capacity

$$f_s \times A_s \quad = \quad 0.67 \times f_r \times R_{e3} \times w \times t$$

FIBER REINFORCED CONCRETE

MACRO – APPLICATION OVERLAYS

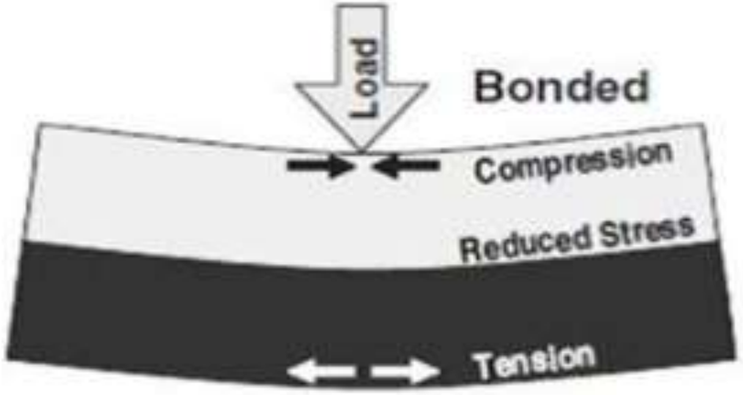
OVERLAY - BONDED

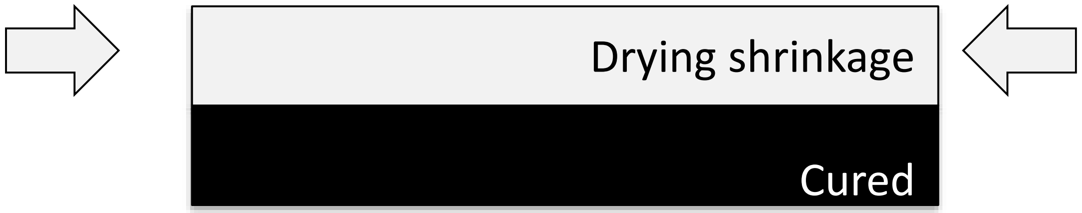


BONDED

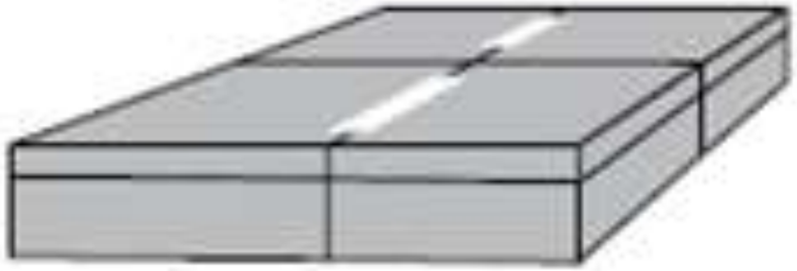
- Thin Layer bonded to Surface distressed slab / pavement below
- Typically, 1 to 3 inches in thickness
- Encounters plastic shrinkage forces Plus light flexural.

OVERLAY - BONDED



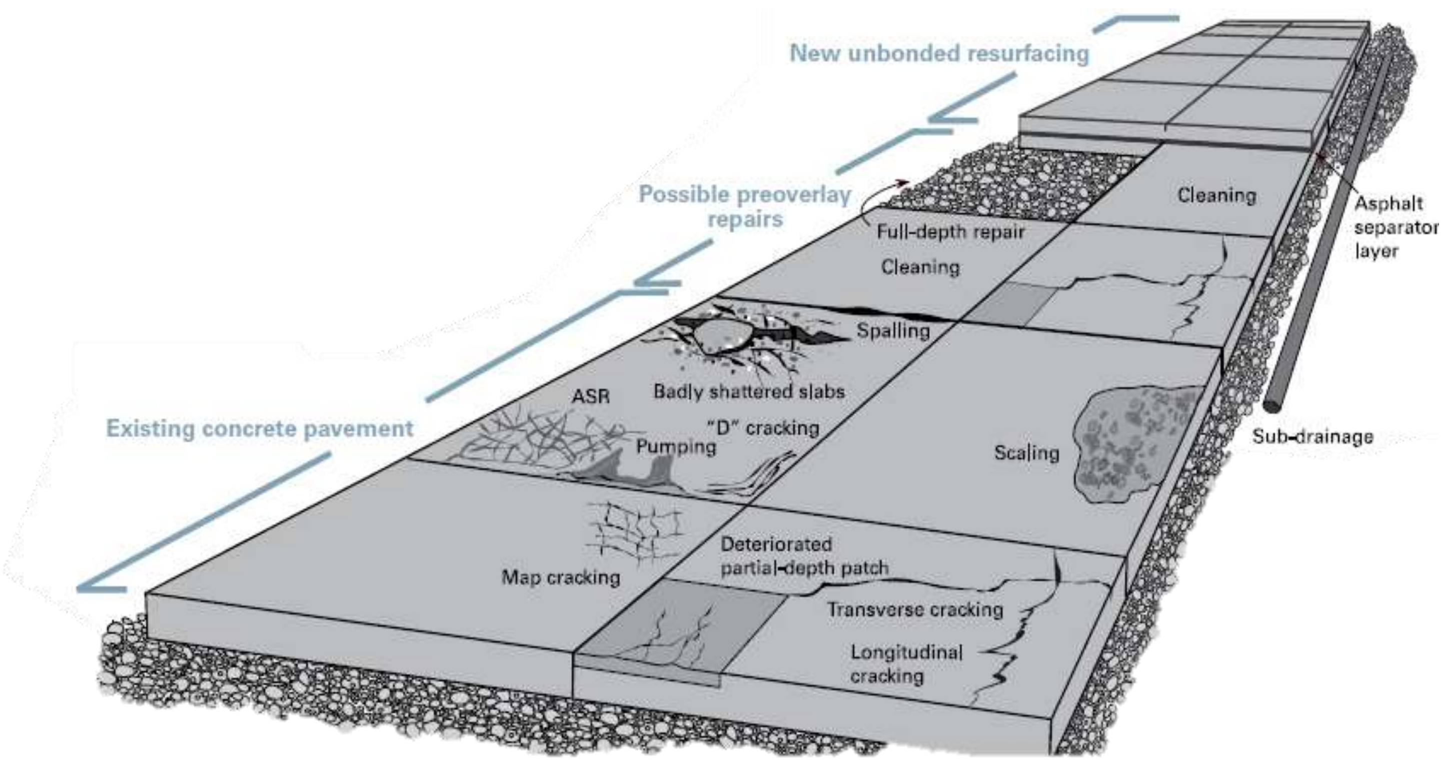


OVERLAY - BONDED



Traditional reinforced concrete tensile restraining capacity	=	Fiber reinforced concrete tensile restraining capacity
$f_s \times A_s$	=	$0.67 \times f_r \times R_{e3} \times w \times t$

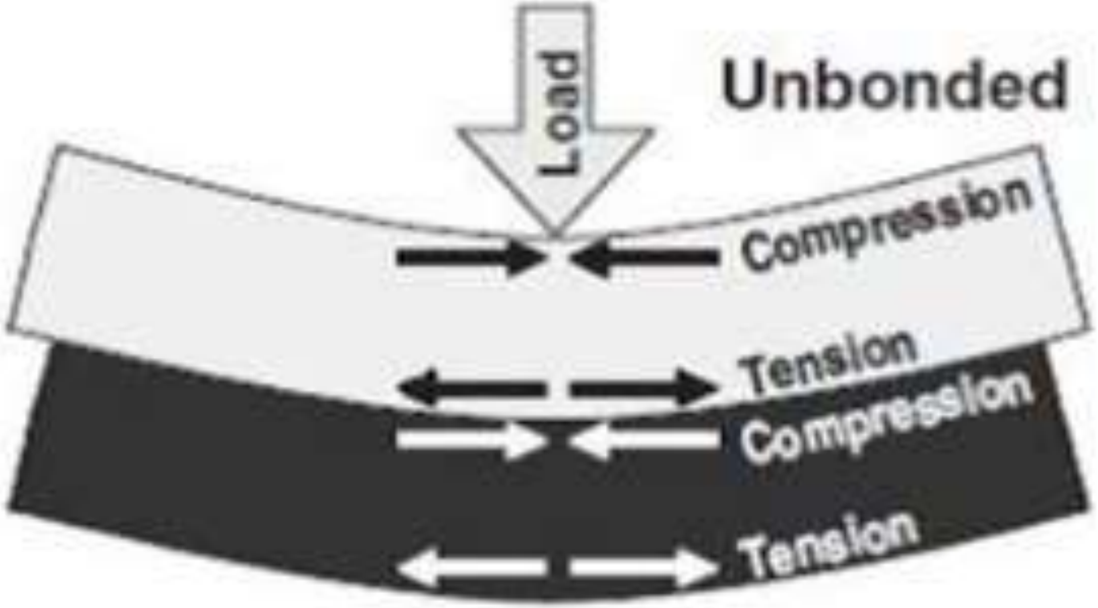
OVERLAY - UNBONDED



UNBONDED

- Thick Layer unbonded to Surface structurally deficient slab / pavement below
- Typically, 4 inches and up
- Encounters vertical loads
- Top slab in designed as an independent slab

OVERLAY - UNBONDED



SLAB CALCULATIONS

- Moment comparison
  - Thickness
  - Concrete Strength
  - Steel size and spacing
- Yield Line
  - Load Based
  - Utilize a high soil modulus (k)

OTHER – PRECAST / TRANSPORTATION

PRECAST

- Replacement of light gage wire mesh with Macro Fibers.
  - Creates a larger production area
  - Improved safety
  - Reduces waste
  - Save time
  - No rust marks
  - Leads to unique shapes
- Addition of Micro Fibers
  - Prevents plastic shrinkage cracks

PRECAST

CAGE REMOVAL ADVANTAGES

- Construction of the cage is time consuming and labor intensive
- Sufficient space and special equipment required for fabrication and storage of cages
- Positioning of the cage in the mold determines the quality of the precast product
- Remove time for cage increases productivity in the precast operation

PRECAST

ADVANTAGES:

- Decrease in manpower
- No increase in batch mixing time
- More durable against long term corrosion
- Spalling is minimized during construction and moving
- Cracking is common in the corners during shipping – fibers help minimize cracks

PRECAST

COMMON QUESTIONS

- Slump Loss? - Additional plasticizer may be required to compensate for the slump loss caused by the fibers.
- Self Compacting or Zero Slump Concrete? - Proven to be successful.
- Mixing time? Not changed from fibers in pan mixers
- Conductivity? Discrete reinforcing
- Fiber exposure? Yes along form base.   Exposed fibers can be removed with a stone

TRANSPORTATION

TRANSPORATION

- Tunnel Segments
- Shotcrete
- Concrete Roads
- Bridge Decks
- White toppings

COURSE EVALUATIONS

In order to maintain high-quality learning experiences, please feel free complete and return the course evaluation form found in the back of the room on the registration table.

This concludes The American Institute of Architects Continuing Education Systems Course

Contact Information:

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Heidi Helmink

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Email: Helmink.heidi@us.sika.com

MICRO FIBERS

Fibermesh 150

Multifilament, plastic concrete crack reduction, excellent finish-ability

Fibermesh 300

Fibrillated, plastic concrete crack reduction, moderate toughness

MACRO FIBERS

Macro	Steel	Blend
Fibermesh	Novocon	Novomesh
Enduro		
SikaFiber		

BUILDING TRUST

THANK YOU FOR YOUR ATTENTION

BUILDING TRUST