USE OF GEOSYNTHETICS IN FLEXIBLE PAVEMENT

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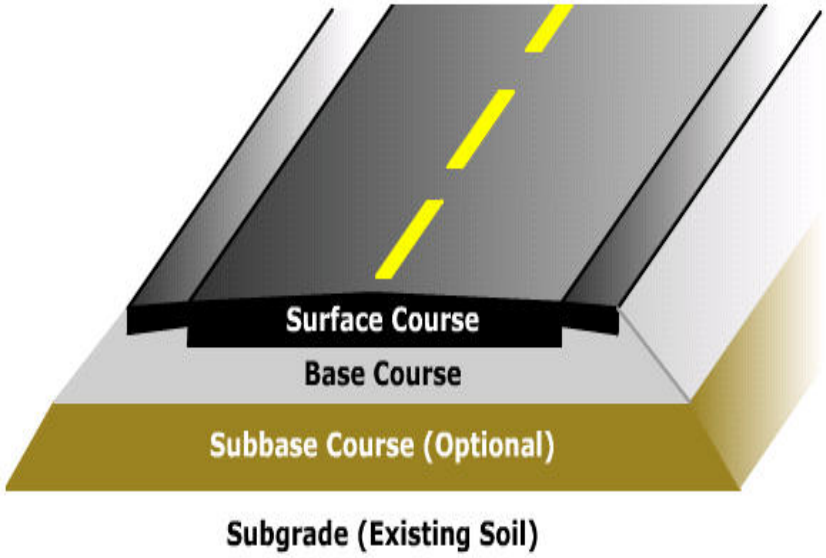
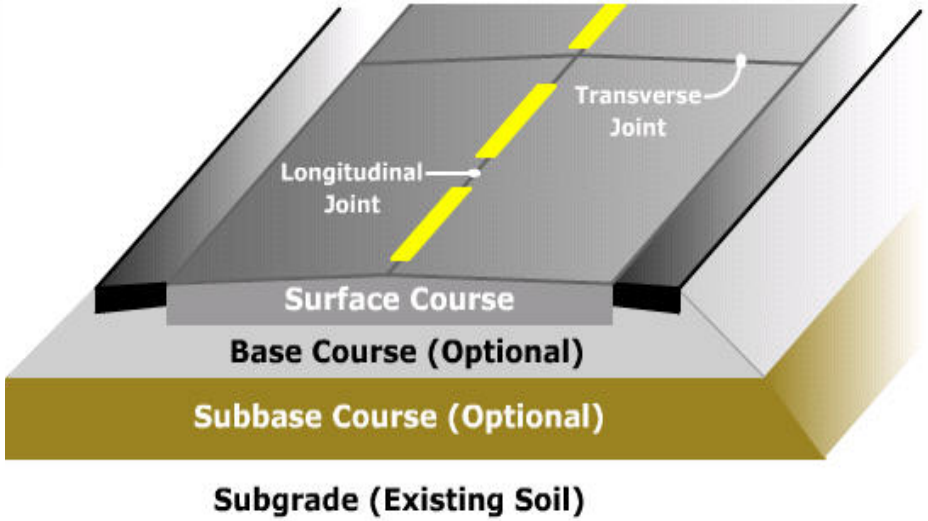
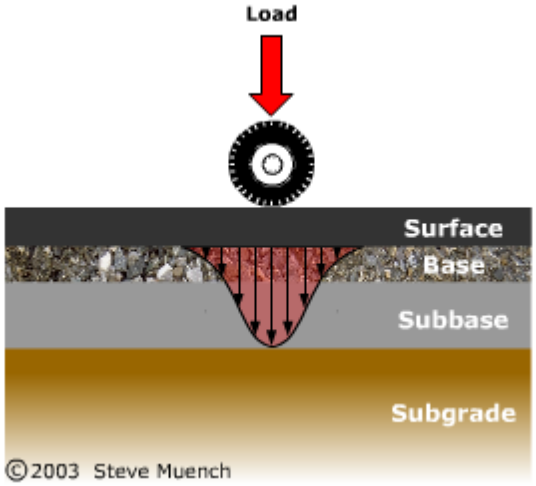
MACCAFERRI

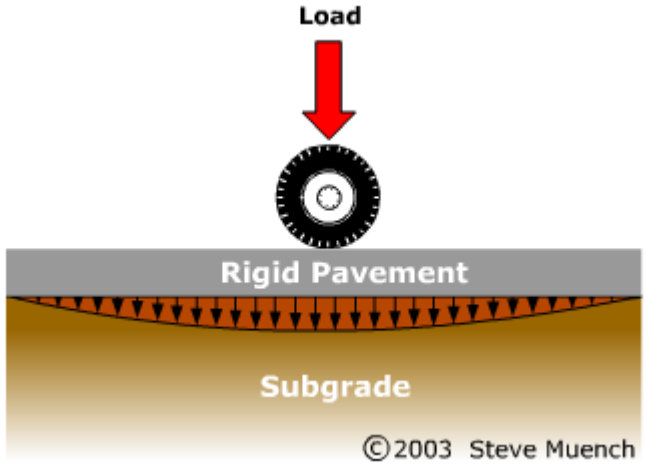
Engineering a better solution

FLEXIBLE AND RIGID PAVEMENT

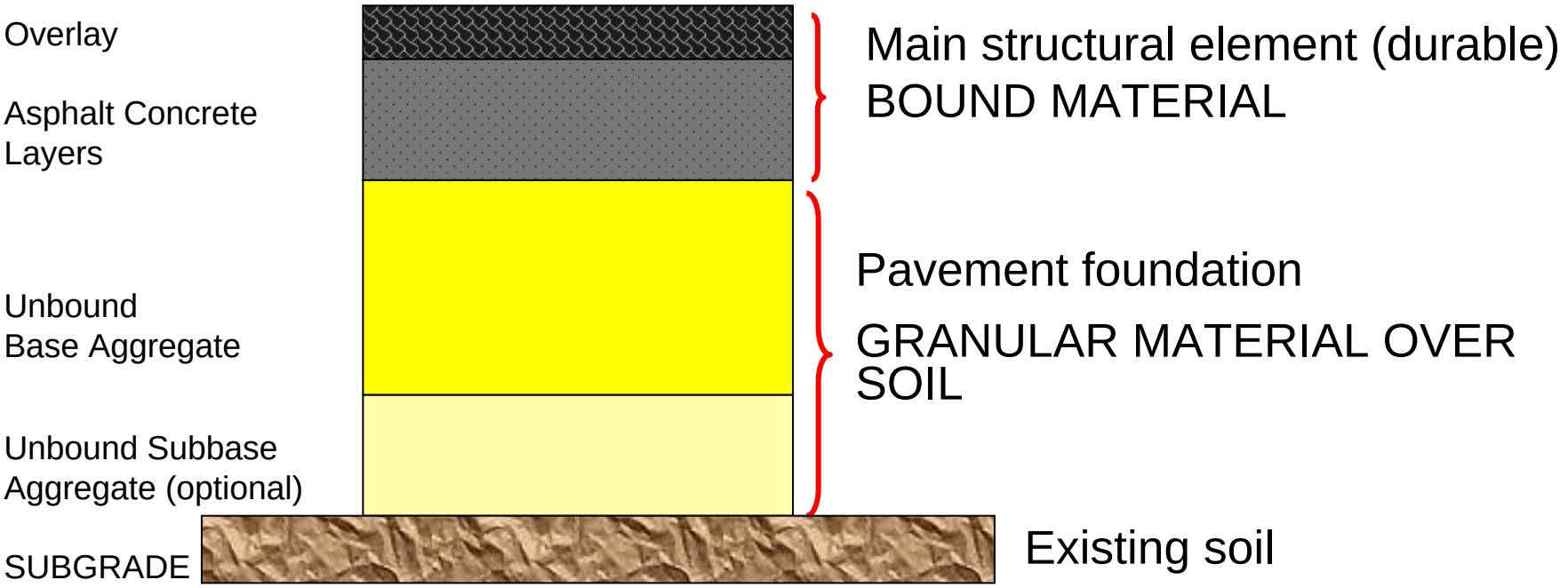








TYPICAL FLEXIBLE PAVEMENT SECTION AND TERMINOLOGY



GEOSYNTHETICS

- Geosynthetics is “a planar product manufactured from polymeric material used with soils and aggregate in variety of geotechnical engineering applications”.
- Geosynthetic usage has steadily increased in both public and private construction projects in last three decades.
- Geosynthetics is likely to increase in the future with stricter environmental regulations enforcement.

MAJOR GEOSYNTHETIC PRODUCTS

- Geotextiles
- Geogrids
- Geonets
- Geomembranes
- Geocomposites

GEOSYNTHETICS IN PAVEMENT

- The primary purpose of incorporating the use of Geosynthetics in the pavement design process is to reduce reflective cracking
- Geosynthetics resist moisture intrusion into the underlying pavement structure, stabilize roadways and their edges.
- It improve road quality, particularly when roads were built on unstable soil.

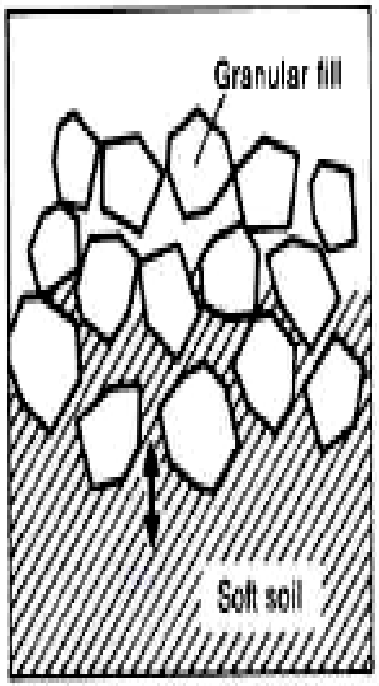
FUNCTIONS OF GEOSYNTHETICS

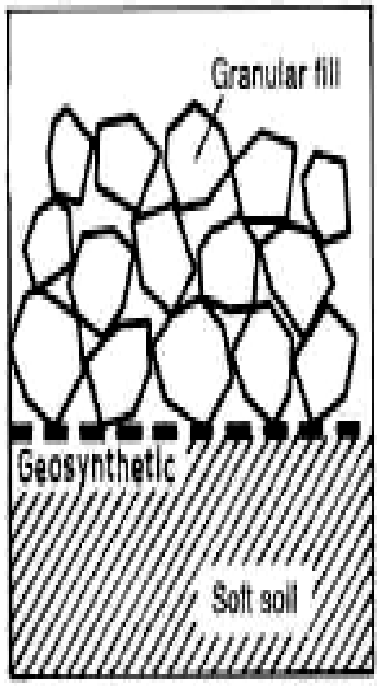
	Separation	Reinforcement	Filtration	Drainage	Moisture Barrier
geotextile	√	√	√	√	
geogrid	√	√			
geocomposite	√	√	√	√	√
geonet				√	
geomembrane					√

FUNCTIONS

SEPARATION

- Geosynthetics is sandwiched between aggregate base course and subgrade material.
- It prevents mixing of the two layers, aggregate loss and pumping.

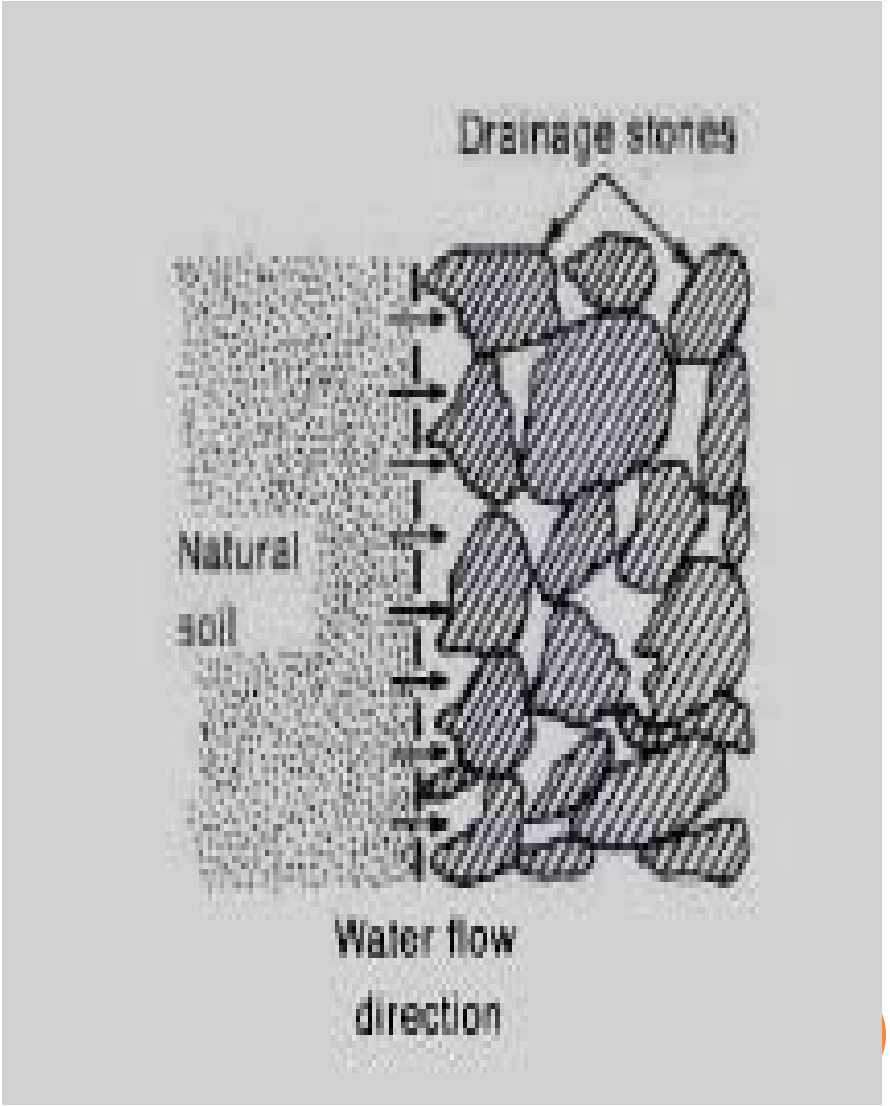




FUNCTIONS

FILTRATION

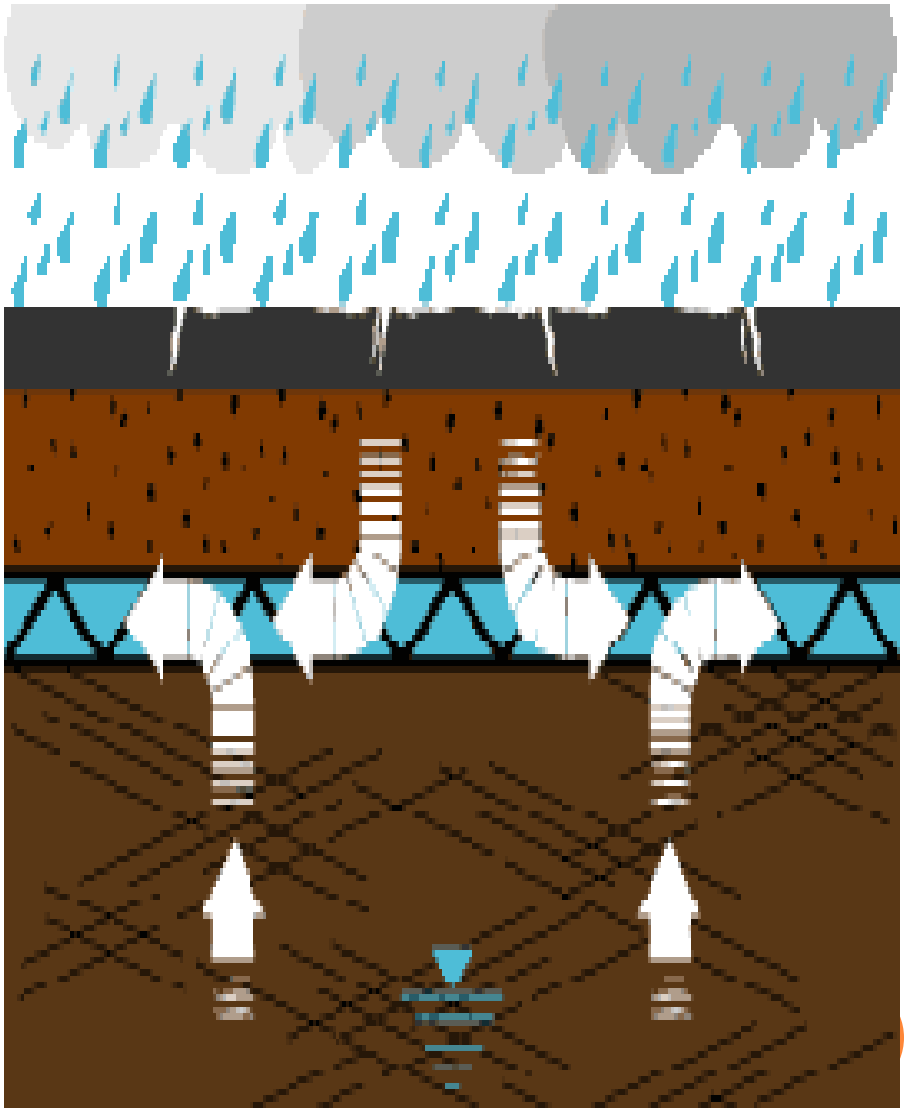
- Geosynthetic acts as a filter by preventing material from washing out while allowing the water to flow through.
- Allowing an increase in subgrade strength.



FUNCTIONS

DRAINAGE

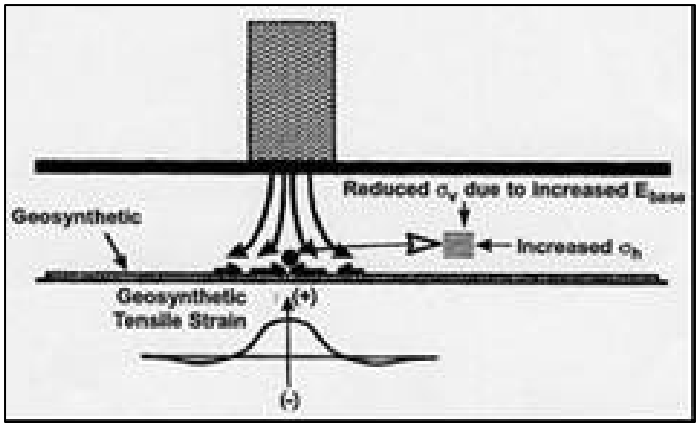
- Drainage applications refer to situations where the water flows within the plane of the geosynthetic product .
- Prevents water logging in the pavement structure.

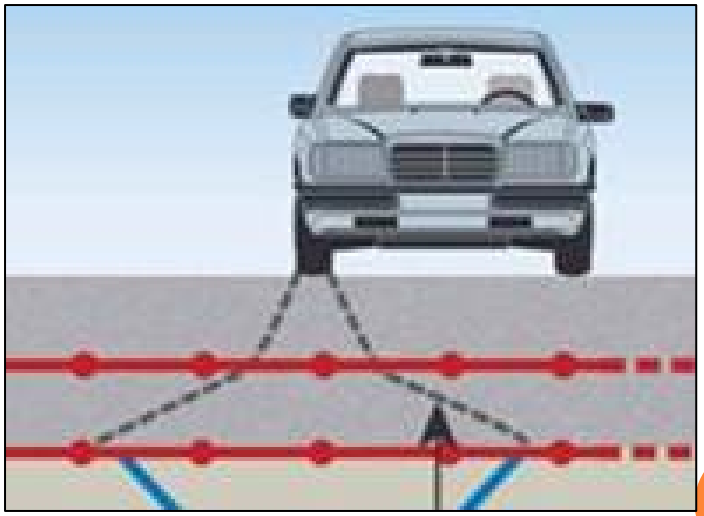


FUNCTIONS

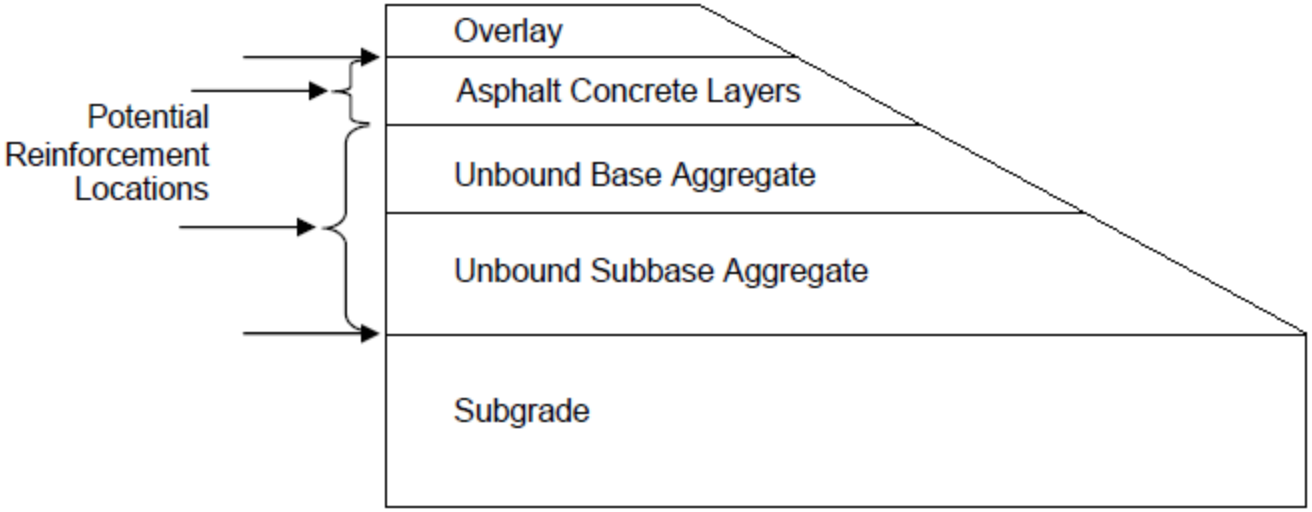
REINFORCEMENT

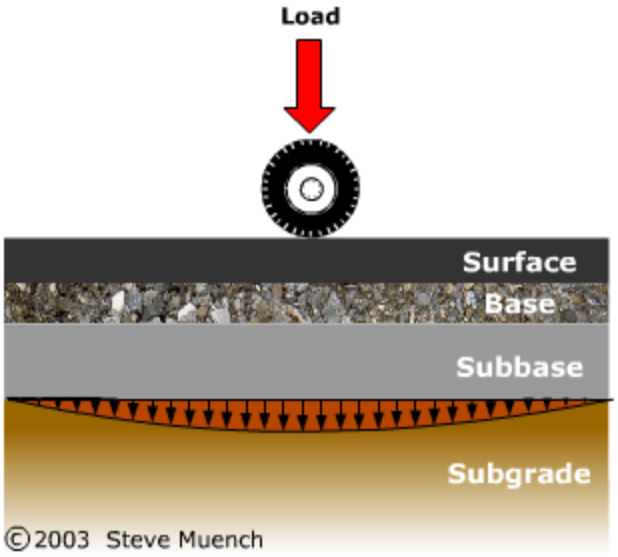
- Lateral Confinement
- Load Distribution
- It helps in maintaining the pavement integrity and uniformity.
- It reduces the differential settlement in roadways.





TYPICAL FLEXIBLE PAVEMENT SECTION AND POTENTIAL REINFORCEMENT LOCATION





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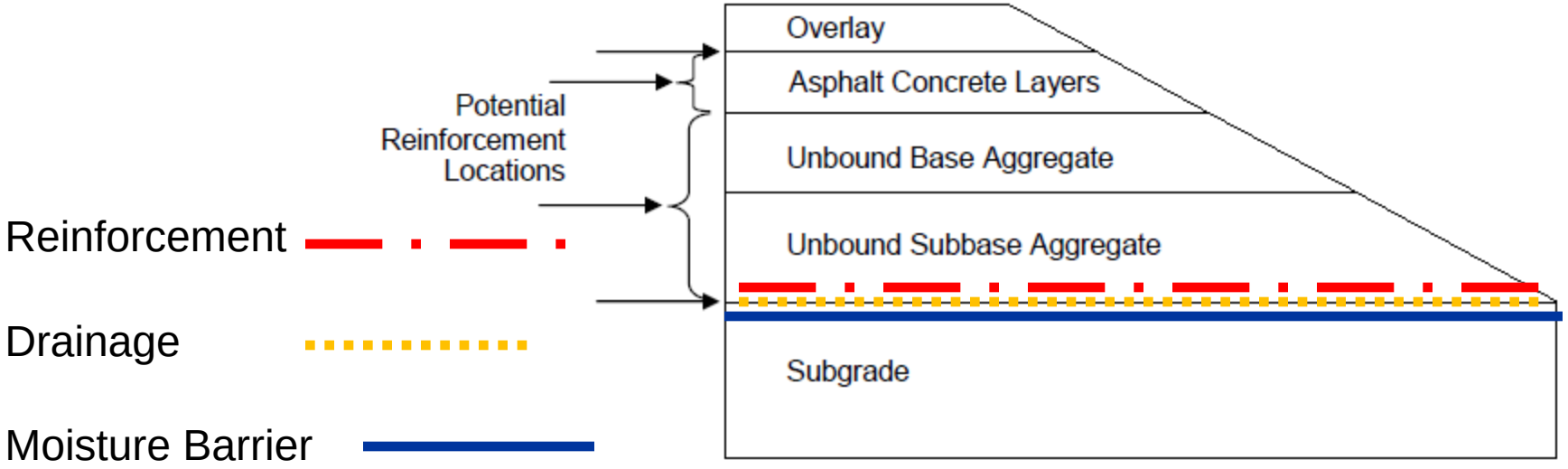
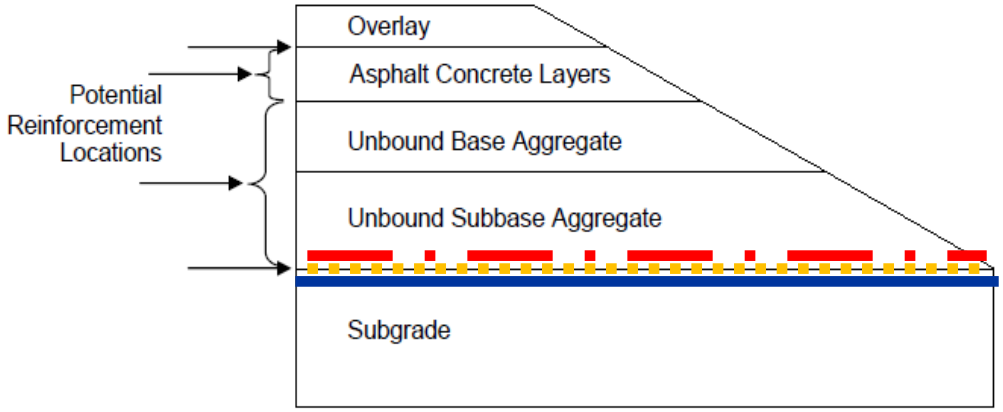
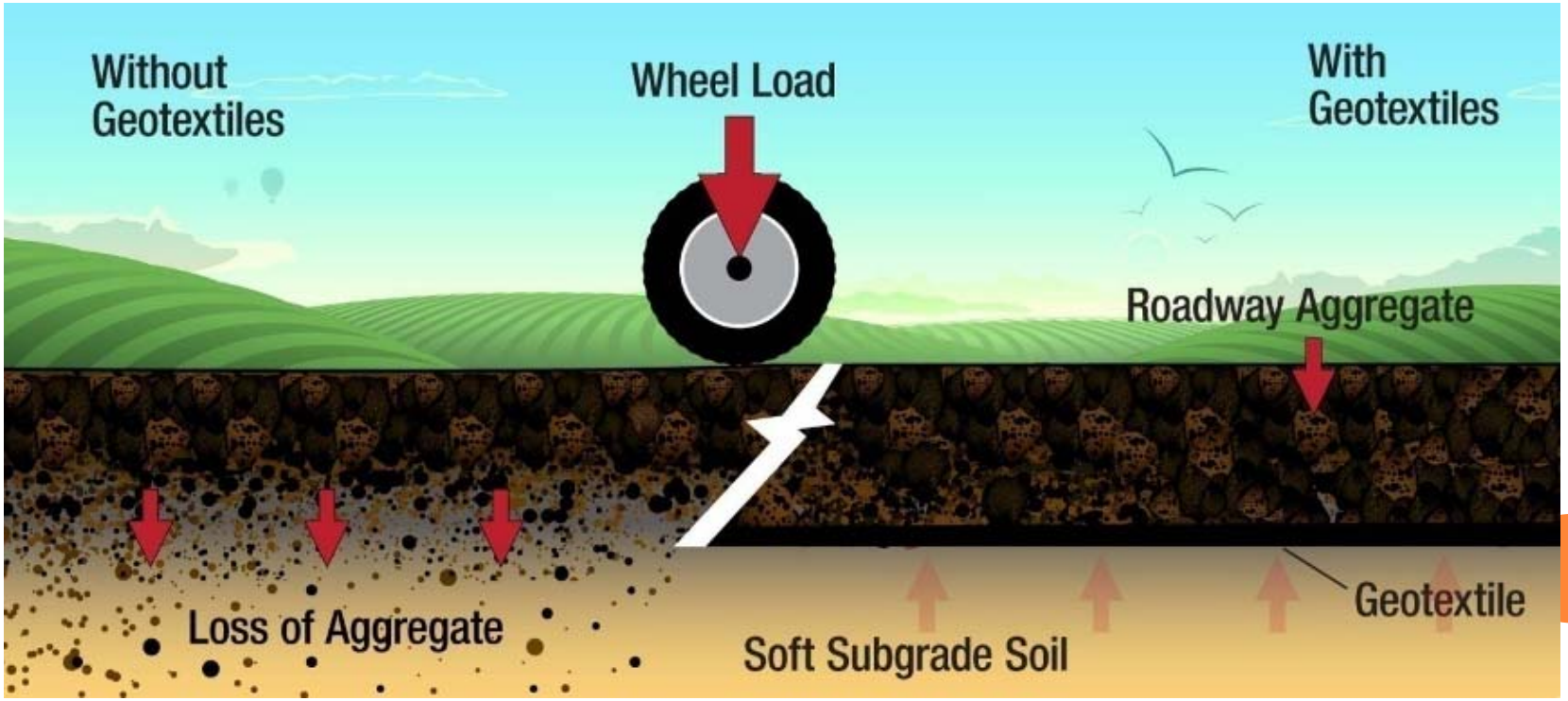


Layer	Benefit
Subgrade	Reduce rutting due to construction traffic Provide working platform Improve subgrade bearing capacity Reduce differential settlement when spanning soft zones Reduce need for chemical stabilization

TYPICAL FLEXIBLE PAVEMENT SECTION AND POTENTIAL REINFORCEMENT LOCATION





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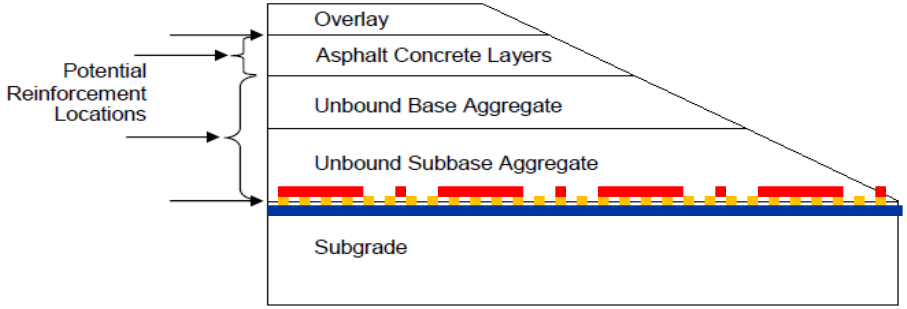
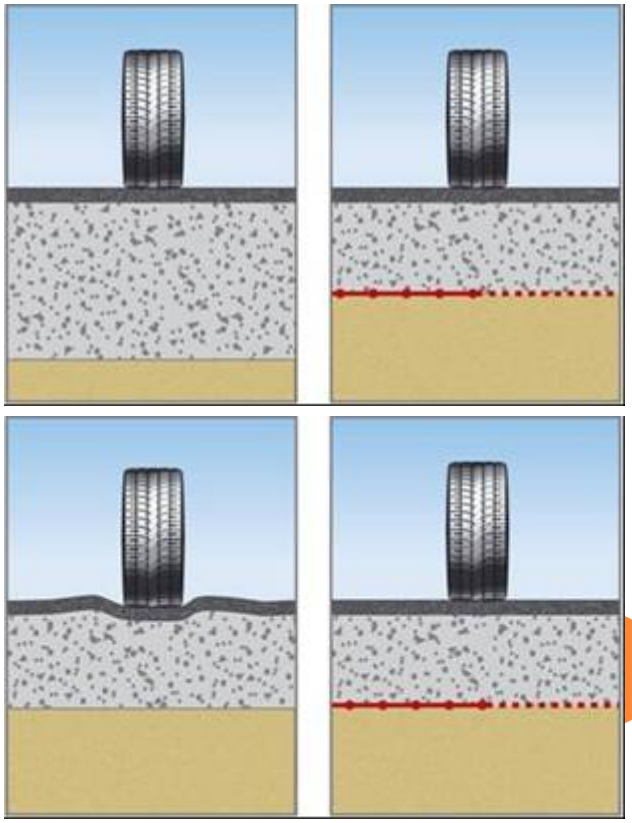


Design Approach 1:

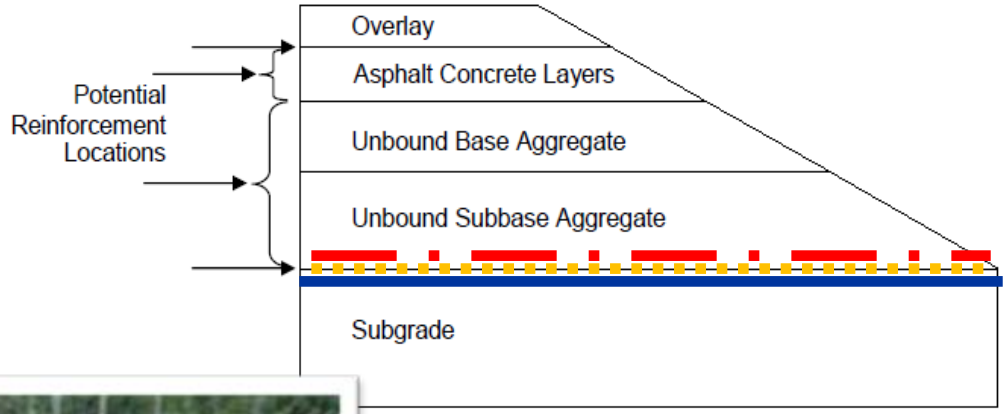
ALLOWS FOR REDUCTION IN AGGREGATE BASE FOR SAME SREVICE LIFE



Design Approach 2:

INCREASE THE PAVEMENT SERVICE LIFE

TYPICAL FLEXIBLE PAVEMENT SECTION AND POTENTIAL REINFORCEMENT LOCATION



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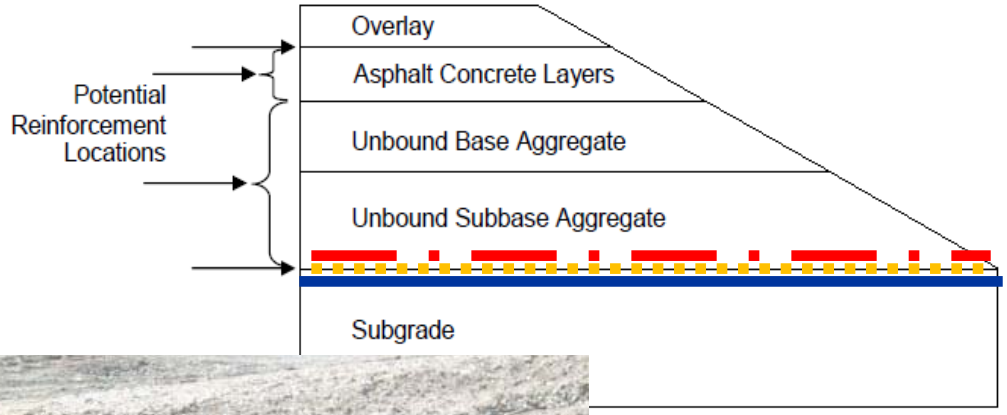

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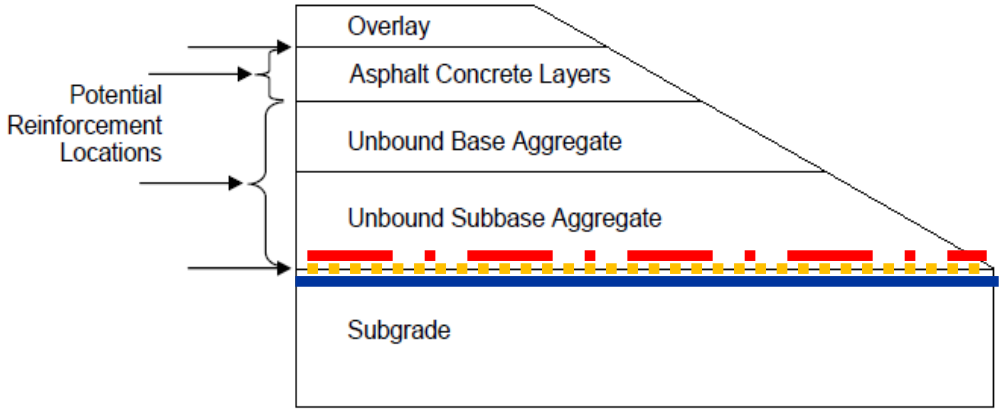

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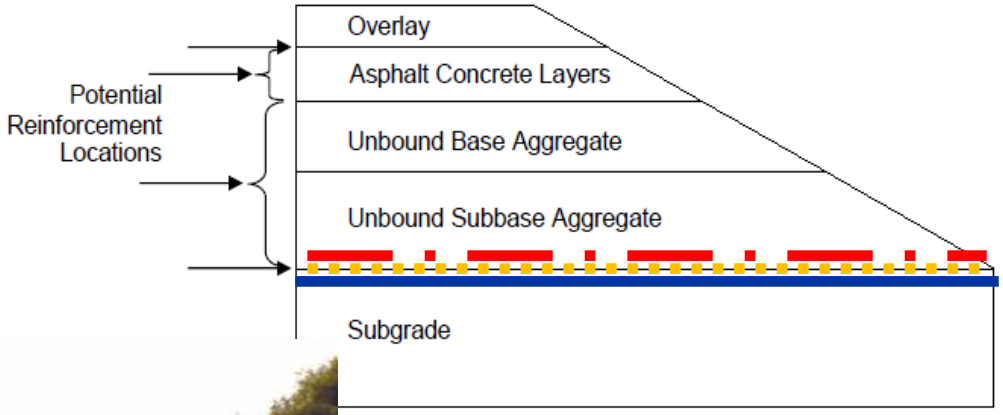

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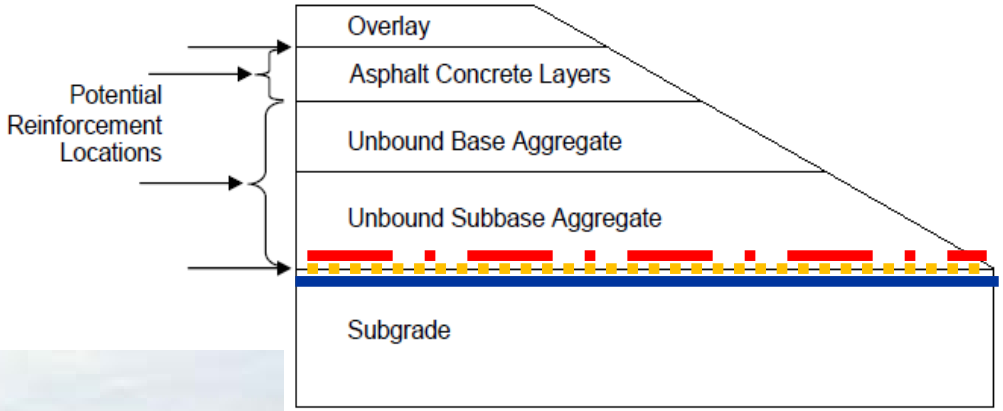

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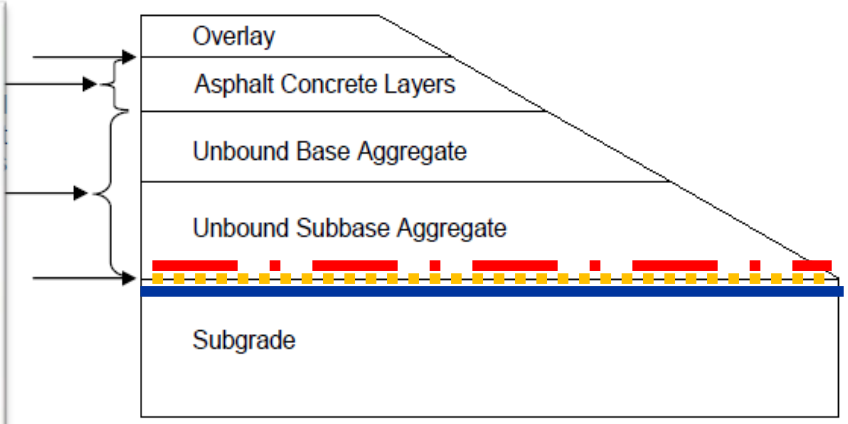

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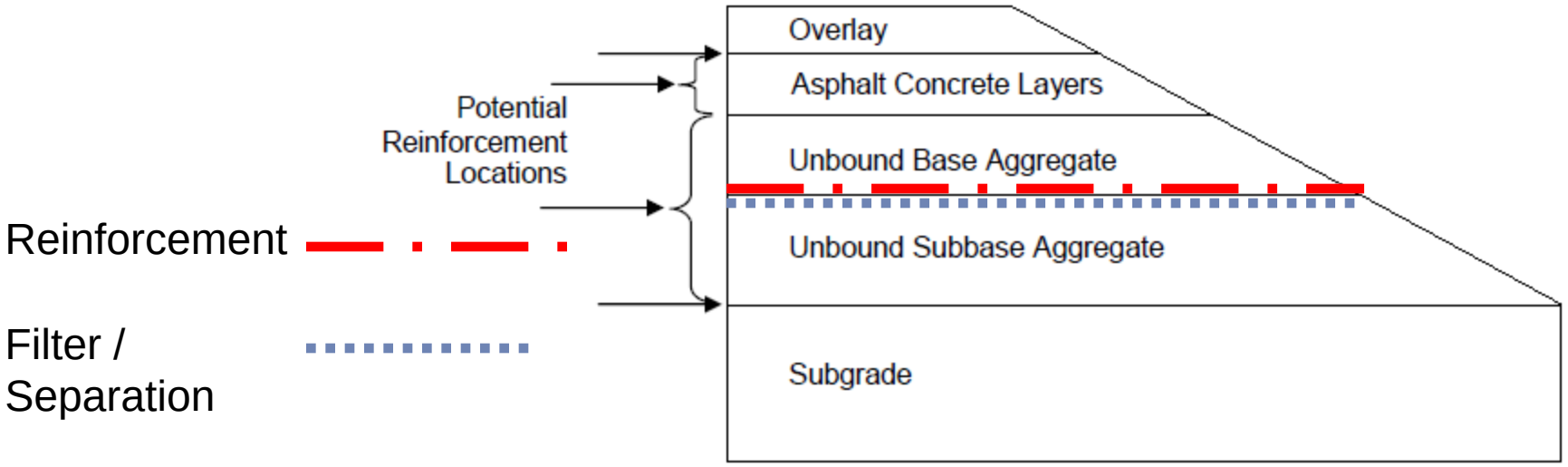

Layer	Benefit
Base and Subbase Aggregate	Reduce surface deformation by reducing permanent deformation in unbound aggregate and subgrade layers Reduce fatigue cracking in asphalt concrete layers by reducing dynamic deformation

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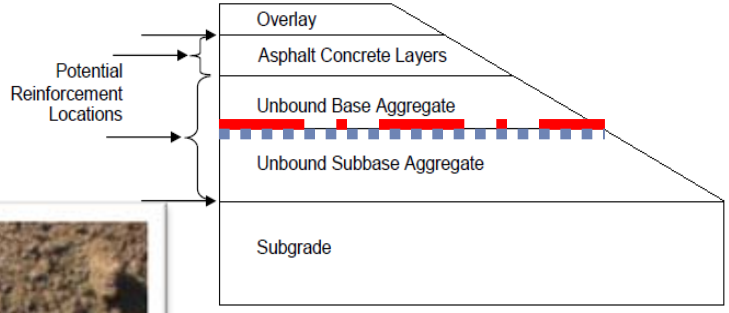

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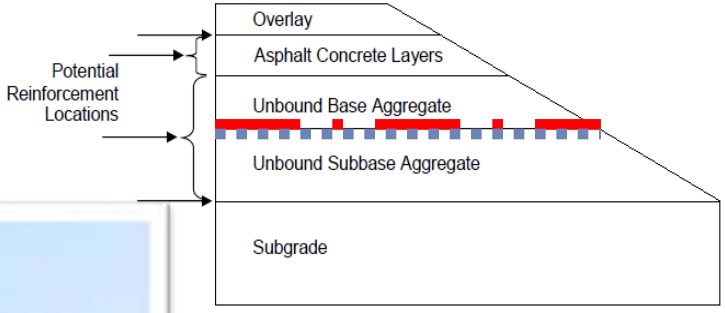

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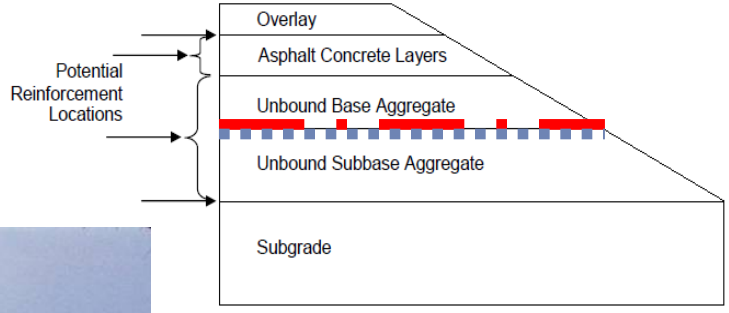

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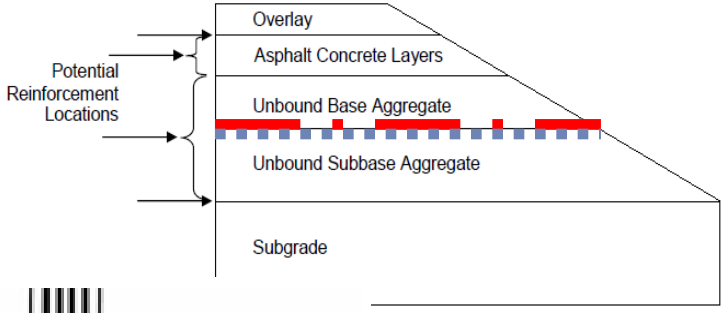

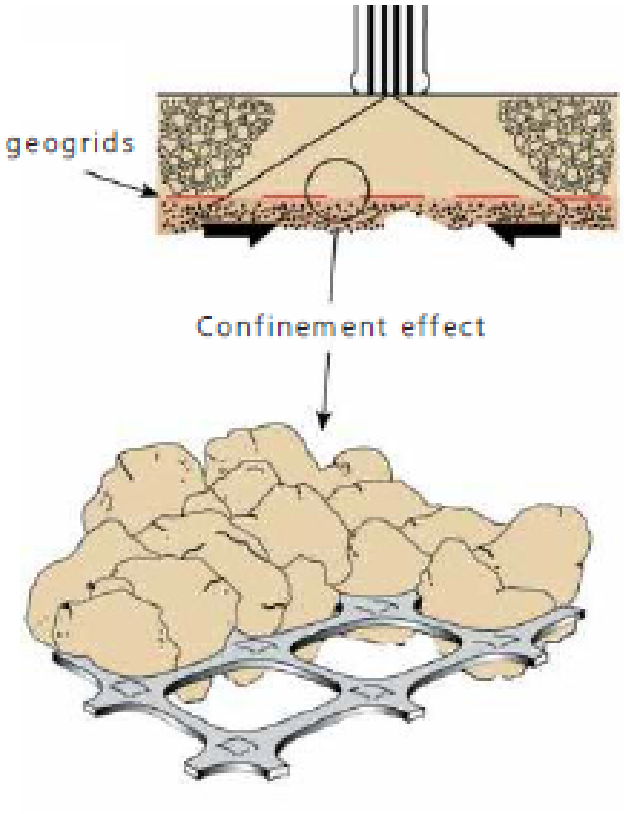

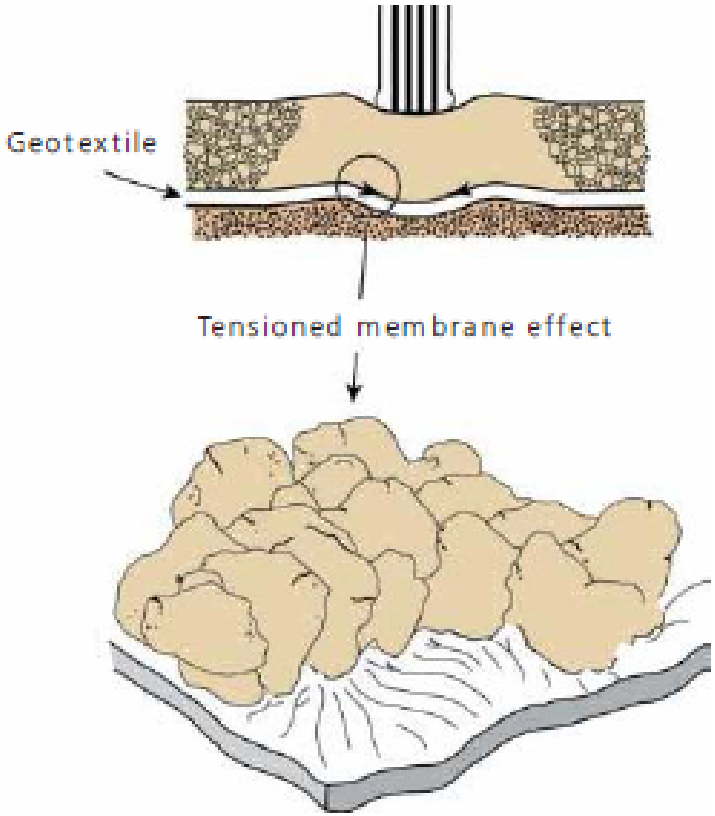

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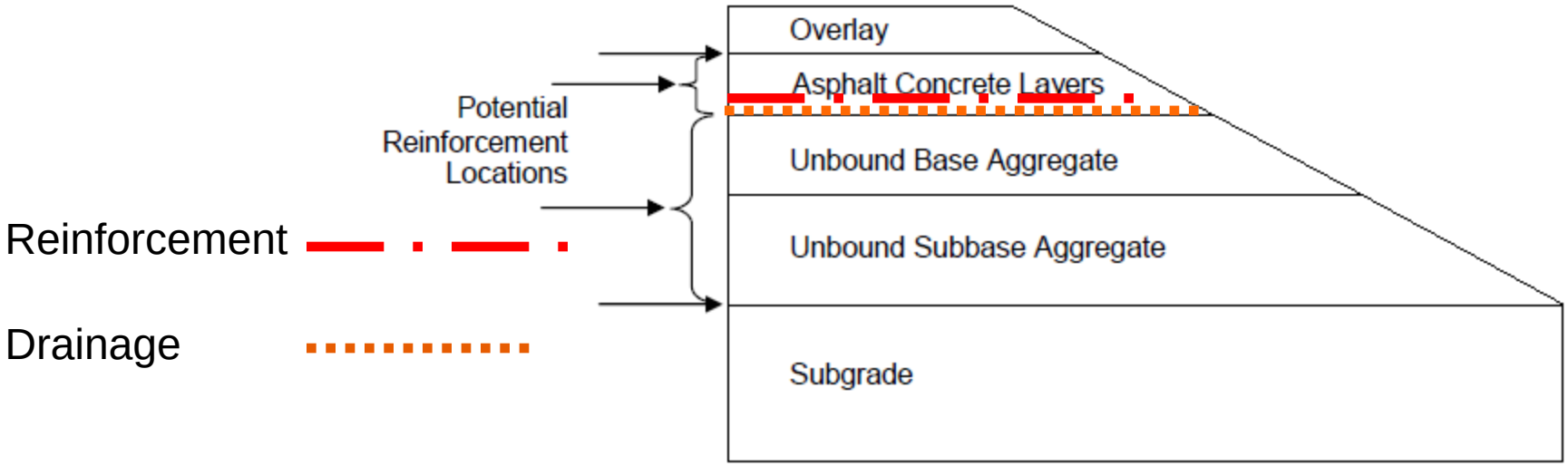

Layer	Benefit
Asphalt Concrete Reinforcement	Reduce fatigue cracking Reduce frost heaving and cracking due to heaving

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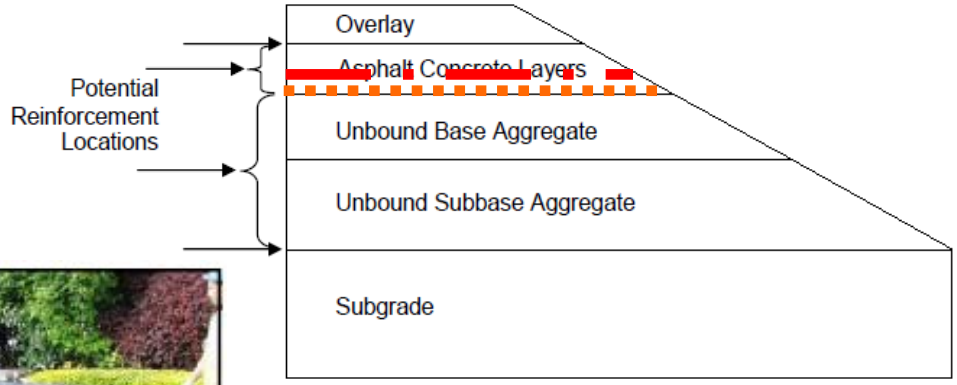
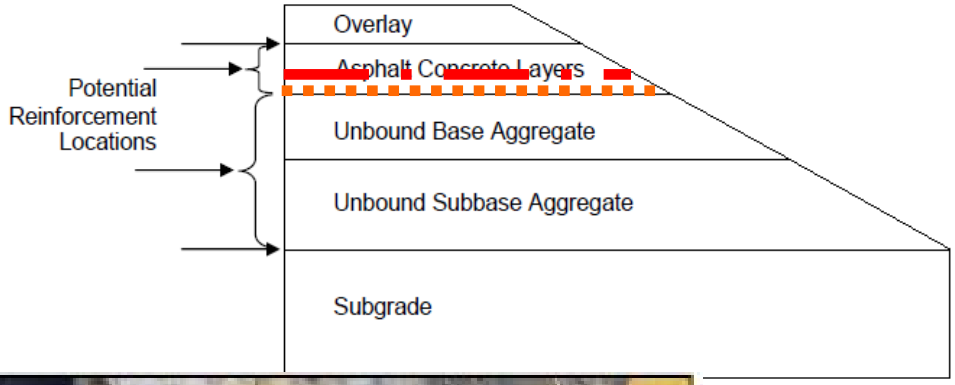
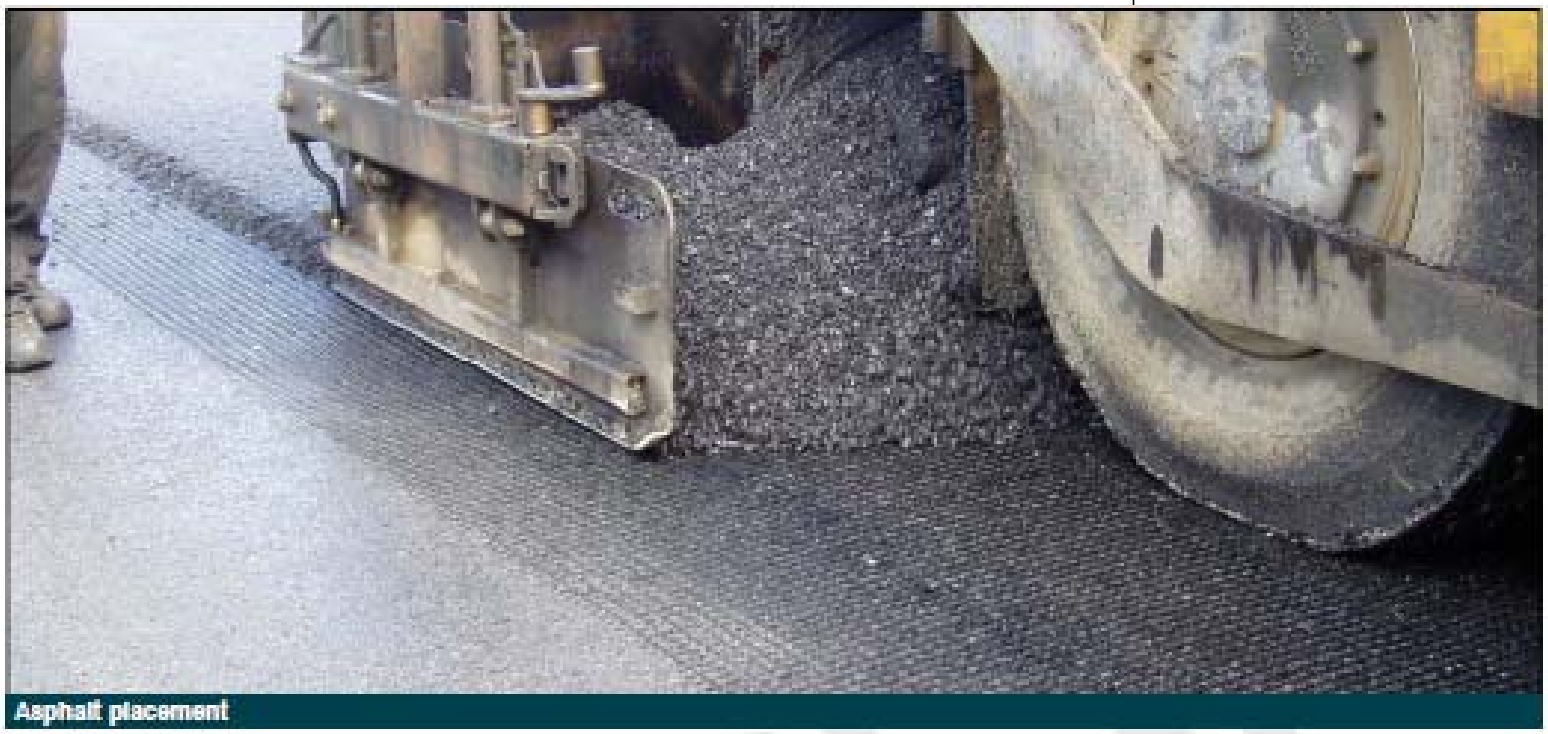


Laying MacGrid™ AR onto road surface

TYPICAL FLEXIBLE PAVEMENT SECTION AND POTENTIAL REINFORCEMENT LOCATION




Asphalt placement

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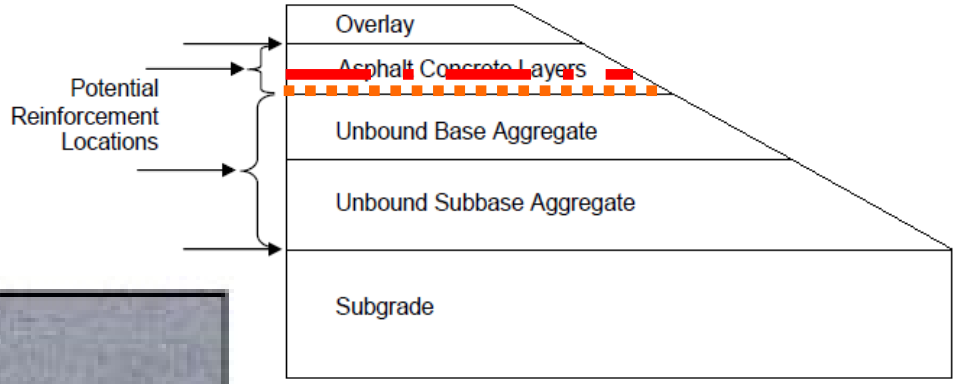

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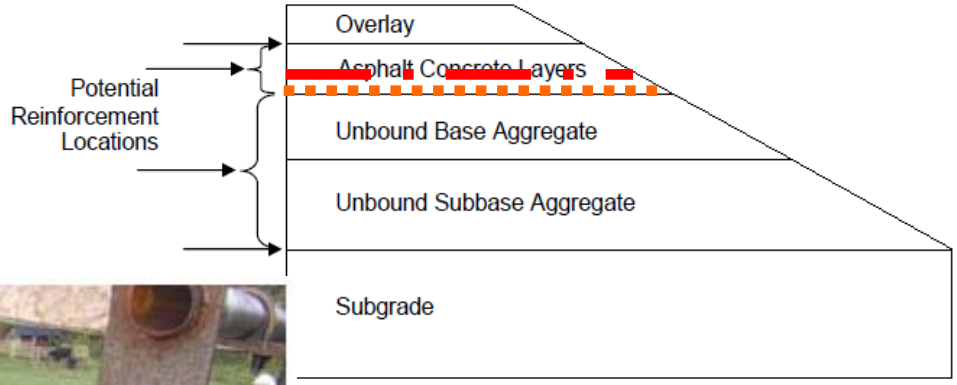
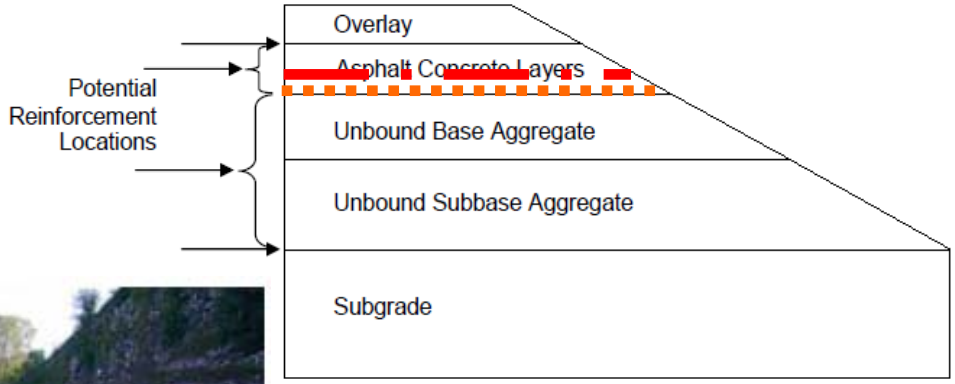
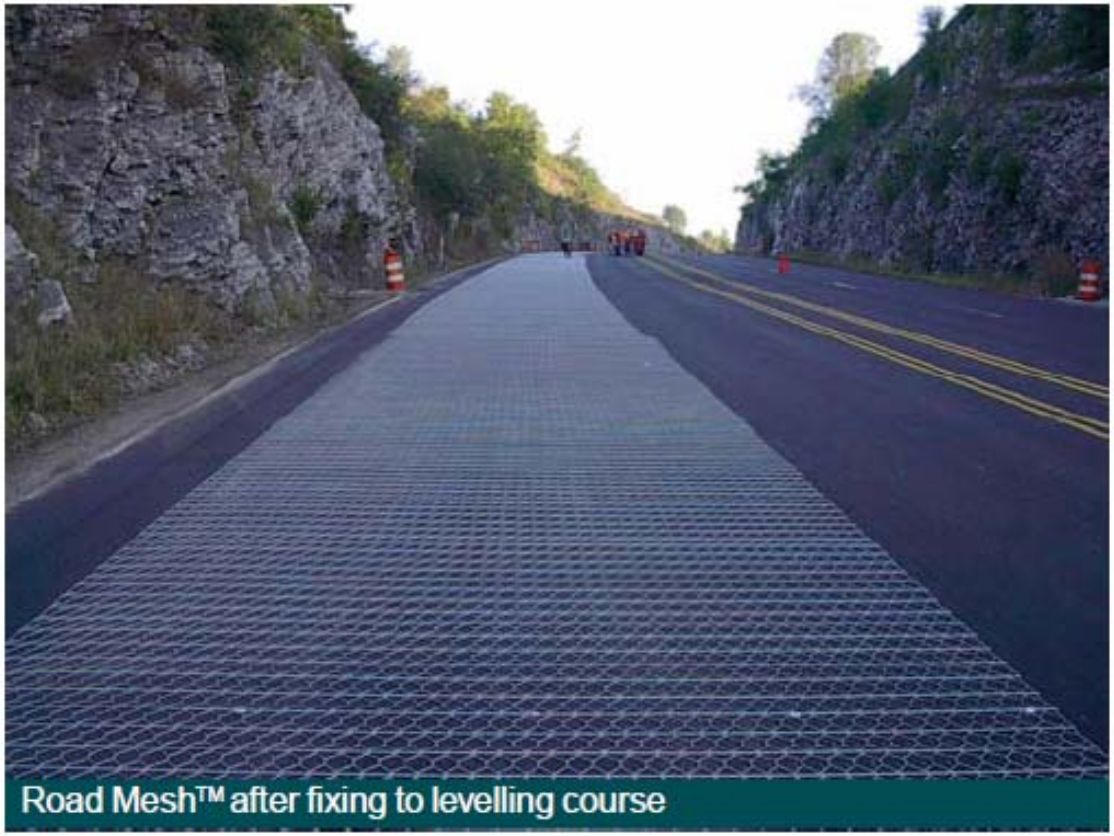


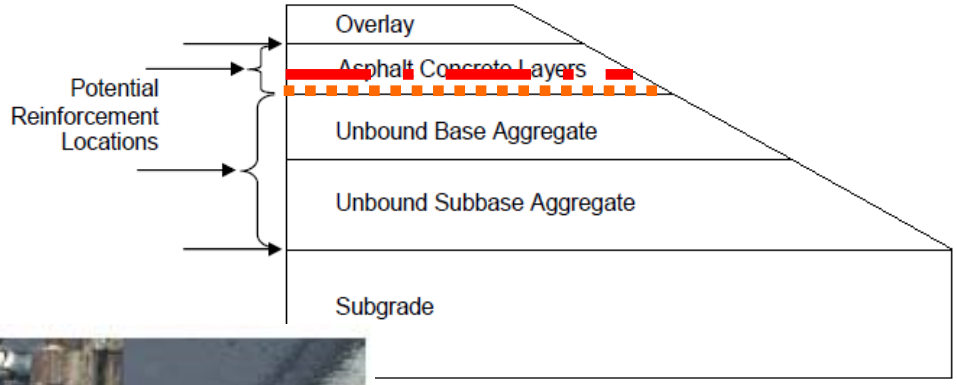
Deployment of Road Mesh™ using spreader bar

TYPICAL FLEXIBLE PAVEMENT SECTION AND POTENTIAL REINFORCEMENT LOCATION




Road Mesh™ after fixing to levelling course

TYPICAL FLEXIBLE PAVEMENT SECTION AND POTENTIAL REINFORCEMENT LOCATION



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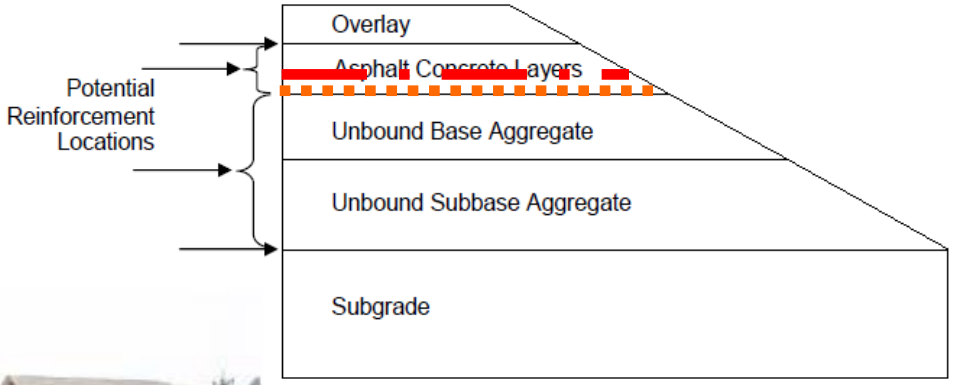
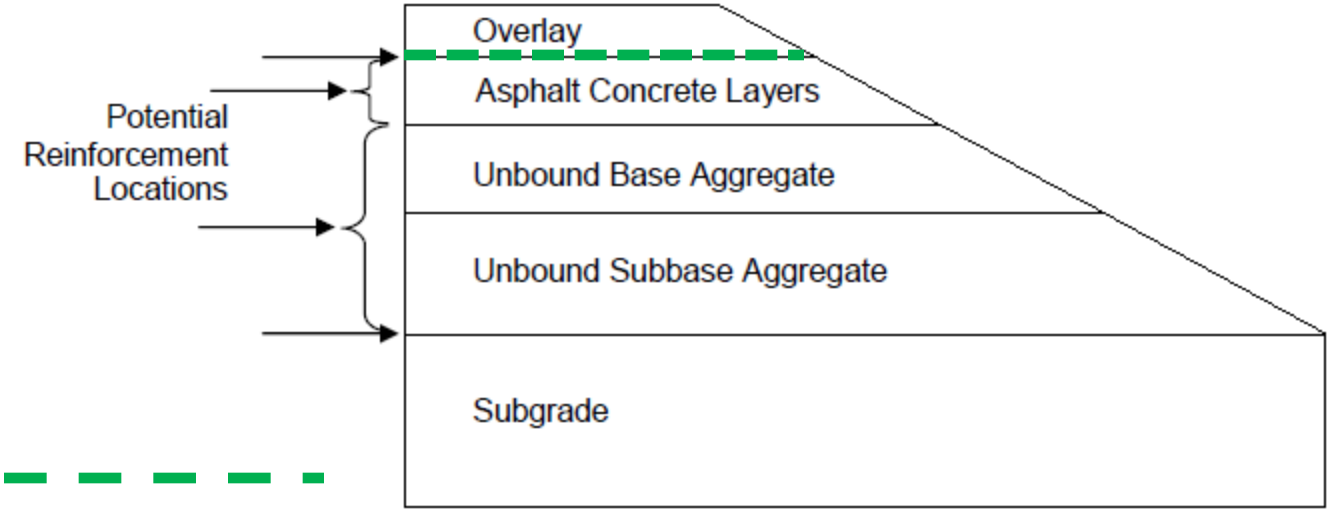


Road Mesh™ overlap to reduce construction joint cracking

TYPICAL FLEXIBLE PAVEMENT SECTION AND POTENTIAL REINFORCEMENT LOCATION



Asphalt Overlay
Moisture Barrier

Layer	Benefit
Overlay	Reduce reflective cracking, Reduce water infiltration

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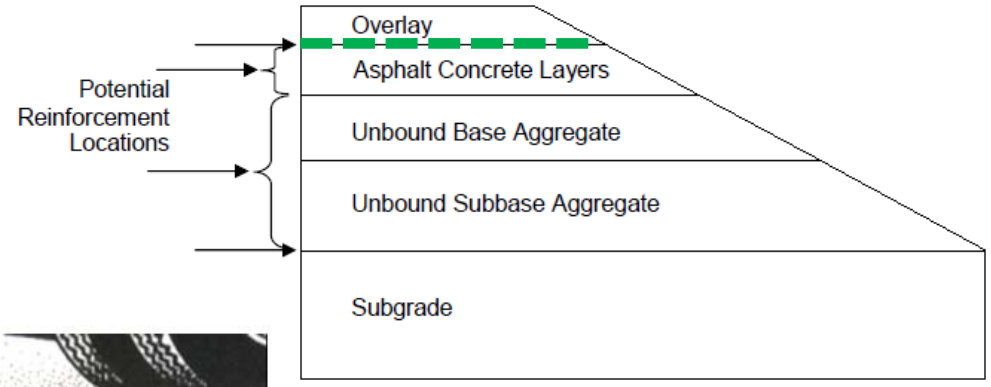
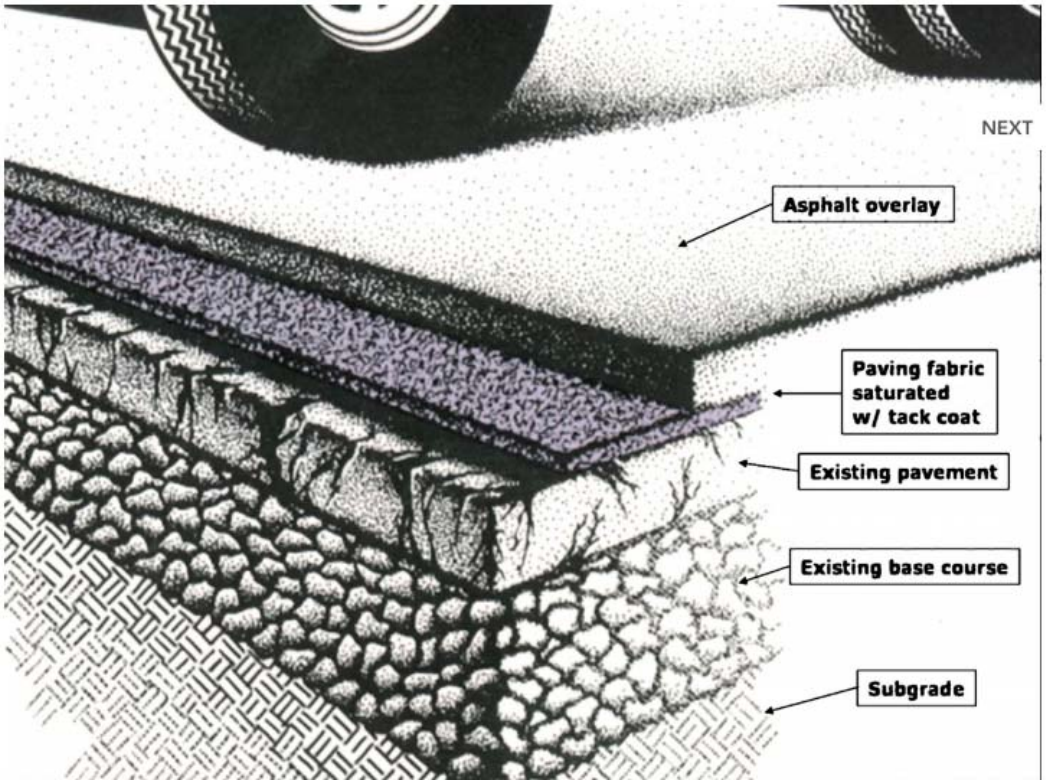
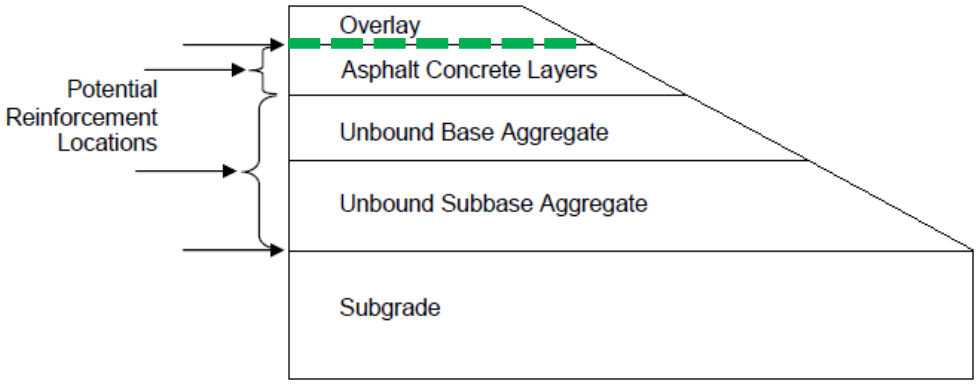




SUMMARY OF APPLICATION AREAS AND BENEFITS OF GEOSYNTHETICS IN FLEXIBLE PAVEMENT



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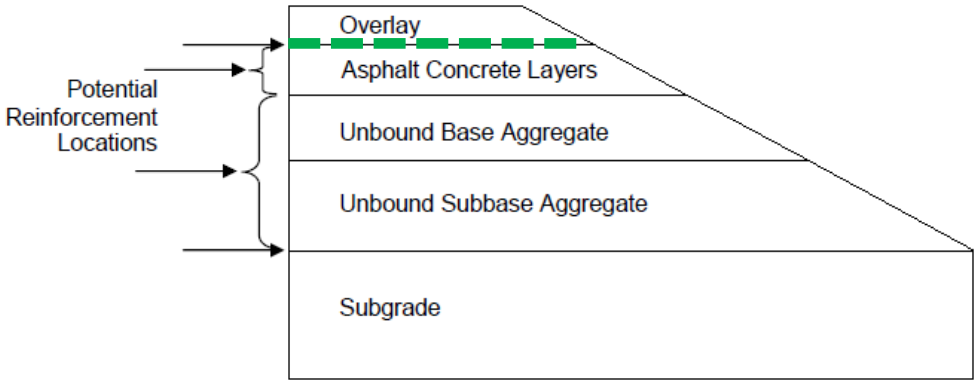

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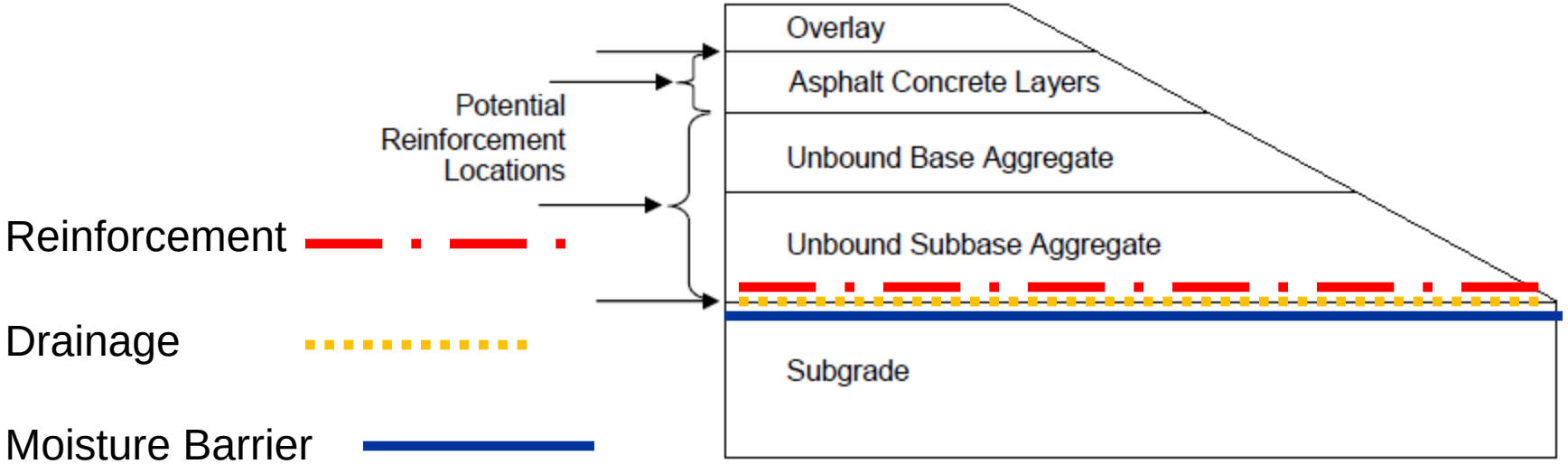

WHAT ABOUT THE WATER INFILTRATED IN THE PAVEMENT SECTION? WHERE DOES IT GO?

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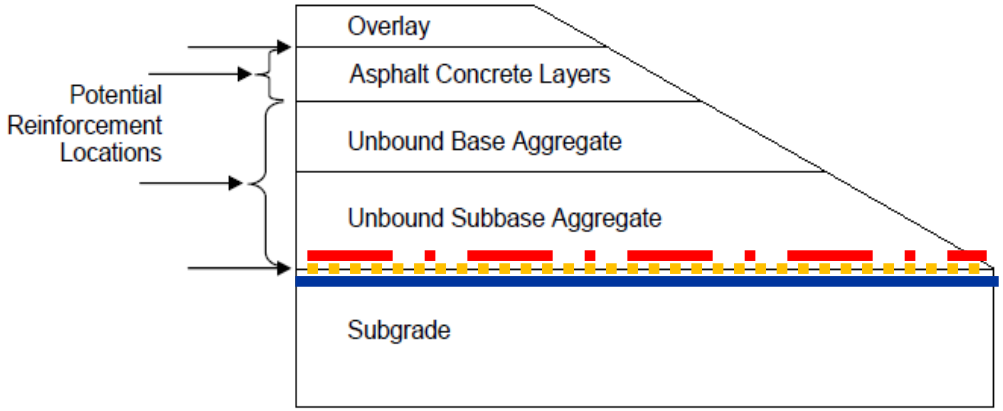

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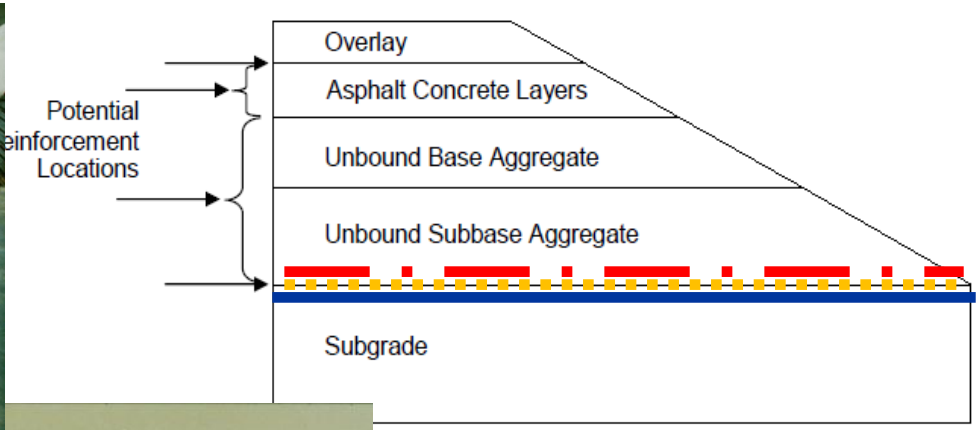


MACCAFERRI

MACCAFERRI SOLUTIONS FOR FLEXIBLE PAVEMENT

	Product	Feature / Benefit		
Asphalt layers	**Road Mesh™**	Steel wire hexagonal mesh with transverse steel bars. Road Mesh™ provides the highest level of protection against rutting, shoving, fatigue, thermal, reflection and settlement cracking.		Grid Size: 80x100mm Strength: 40 - 60kN/m
	MacGrid® AR	Glass fibre or polyester woven geogrid with coating. With high tensile strength and high modulus of elasticity at low elongation, MacGrid® AR is a cost effective solution for preventing cracks in the upper pavement layers.		Grid Size: 12.5mm or 40mm Strength: 50 - 200kN/m
	MacGrid® AR G	Glass fibre or polyester woven geogrid with coating and geotextile backing. MacGrid® AR G is impregnated with bitumen to provide crack prevention with a waterproof membrane and improved bond between the asphalt layers.		Grid Size: 12.5 or 40mm Strength: 50 - 200kN/m
Unbound layers	**MacGrid® EG**	Extruded polypropylene biaxial geogrids. MacGrid® EG controls deformation and rutting, enabling the thickness of granular layers to be reduced.		Grid Size: 38mm Strength: 15 - 40kN/m
	MacGrid® WG S	Woven polyester geogrids with polymer coating. MacGrid® WG provides cost effective, long term control of deformation and rutting with soft subgrades or high axle loads.		Grid Size: 20 - 35mm Strength: 20 - 300kN/m
	MacTex® W1/W2	Woven polypropylene (W1) and polyester geotextiles (W2) provide separation and reinforcement for construction on soft ground.		Strength: (W1): 20 - 110kN/m Strength: (W2): 40 - 880kN/m
	MacTex® N / H	Non-woven needle-punched polyester geotextiles. MacTex® N/H are used to separate granular materials preventing interlayer contamination.		Strength: 6 - 35kN/m
Drainage	**MacDrain®**	Drainage geocomposites with a polymeric drainage core and a non-woven geotextile filter on one or both sides to stop the core clogging with soils.		Drain core and textile performance selected to suit application

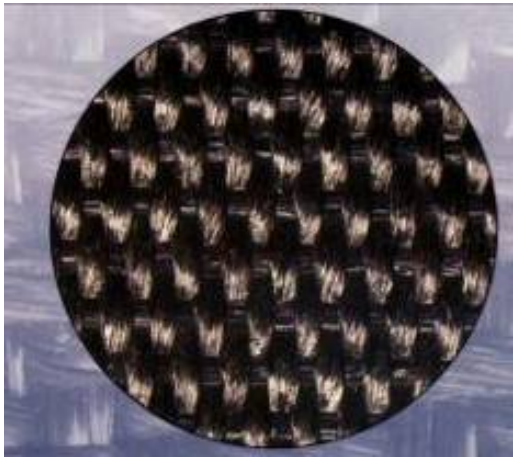
MACCAFERRI

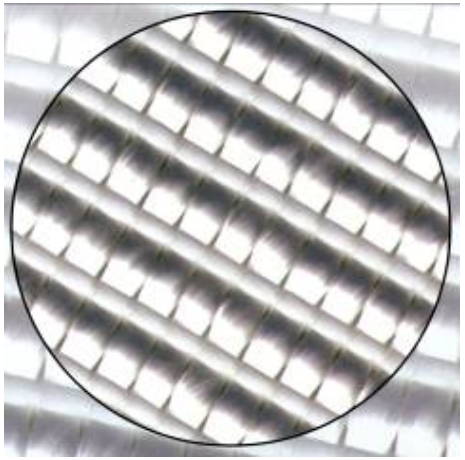
MACTEX W1 & W2

Geotextile woven in monofilament of polypropylene (W1) or polyester (W2)

High tensile strength (up to 800 KN/m) for short and long term application

High resistance against damaging and environment.





MACTEX™ W1

POLYPROPYLENE WOVEN FABRICS

MACTEX™ W1 geotextiles are planar woven structures manufactured by weaving in the warp and weft directions polypropylene tapes and/or polypropylene monofilaments.

MACTEX™ W1			25	35	45	55	65	85	105
Mechanical and Hydraulic properties									
Tensile strength (MD)	EN ISO 10319	kN/m	27	31	41	46	63	83	100
Tolerance			-3	-3	-3	-3	-3	-3	-3
Extension at max load (MD)	EN ISO 10319	%	15	16	17	16	17	19	20
Tolerance			± 3	± 3	± 3	± 3	± 3	± 3	± 3
Tensile steenth (CD)	EN ISO 10319	kN/m	28	33	42	50	61	81	104
Tolerance			-5	-5	-5	-5	-5	-5	-5
Extension at max load (CD)	EN ISO 10319	%	12	17	12	13	13	15	16
Tolerance			± 3	± 3	± 3	± 3	± 3	± 3	± 3
CBR (Static Puncture Resistance)	EN ISO 12236	kN	3,0	3,5	5	5	8	10	10,5
Tolerance			-0,5	-0,5	-0,5	-0,5	-0,5	-0,5	-0,5
Cone Drop Test (Dynamic Puncture	EN ISO 13433	mm	14	11	12	10	10	7,5	11
Tolerance			+3	+3	+3	+2	+2	+2	+0,3
Permeability (Normal to plane)	EN ISO 11058	m/sec	0,015	0,016	0,021	0,018	0,014	0,022	0,033
Tolerance			-0,005	-0,005	-0,005	-0,005	-0,005	-0,005	-0,005
Opening Pore size O_{90}	EN ISO 12956	µm	200	230	250	100	160	120	470
Tolerance			± 60	± 60	± 60	± 30	± 50	± 50	± 50
Physical properties - typical									
Polymer-warp and weft			Polypropylene						
Roll width			Ranging from 4 to 5.3						
Roll length			200	200	200	200	200	200	200

MACTEX W2

MACTEX W2			30	50	70	80	100	120	150	180	200	220	250	300	350	400	450	500	550	600	650
Mechanical and Hydraulic properties																					
Tensile strength (MD)	EN ISO 10319	kN/m	30	50	70	80	100	120	150	180	200	220	250	300	350	400	450	500	550	600	650
Tolerance			-5	-5	-10	-10	-10	-10	-15	-15	-20	-20	-20	-30	-30	-40	-45	-50	-50	-60	-60
Elongation at max load (MD)	EN ISO 10319	%	8	8	8	8	10	10	10	10	10	10	10	10	10	12	12	12	12	12	12
Tolerance			±2	±2	±2	±2	±2	±2	±2	±2	±2	±2,5	±2	±2,5	±2	±2	±2	±2	±2	±2	±2
Tensile steenth (CD)	EN ISO 10319	kN/m	30	50	70	80	100	120	150	180	200	220	250	300	350	400	450	500	550	600	650
Tolerance			-5	-5	-10	-10	-5	-10	-15	-15	-10	-5	-20	-5	-10	-5	-5	-5	-10	-5	-10
Elongation at max load (CD)	EN ISO 10319	%	8	8	8	8	10	8	10	8	10	10	10	10	11	11	11	11	11	10	10
Tolerance			±2	±2	±2	±2	±2	±2	±2	±2	±2	±2,5	±2	±2,5	±2,5	±2	±2	±2	±2	±2,5	±2,5
CBR (Static Puncture Resistance)	EN ISO 12236	kN	3	4	6	7	8	8	10	7	11	11	11	17	+10	+10	11	14	14	13	11
Tolerance			-1	-2	-2	-2	-2	-3	-4	-2	-3	-3	-5	-5	-5	-5	-4	-5	-5	-5	-5
Cone Drop (Dynamic Puncture)	EN ISO 13433	mm	21	20	16	15	20	20	16	21	13	13	10	15	13	8	20	20	8	8	
Tolerance			+5	+5	+5	+4	+5	+4	+5	+7	+3	+7	+5	+4	+4	+2	+5	+5	+5	+5	+4
Permeability (Normal to plane)	EN ISO 12958	m/sec	0,07	0,07	0,06	0,06	0,06	0,04	0,05	0,04	0,02	0,04	0,02	0,015	0,015	0,04	0,015	0,015	0,002	0,05	
Tolerance			-0,03	-0,03	-0,03	-0,03	-0,03	-0,02	-0,02	-0,02	-0,01	-0,02	-0,01	-0,01	-0,01	-0,025	-0,02	-0,004	-0,005	-0,005	-0,02
Opening Pore Size O_{90}	EN ISO 12956	µm	650	1300	150	300	650	440	600	600	400	400	400	150	150	300	200	200	200	80	150
Tolerance			±200	±200	±200	±200	±200	±150	±200	±200	±200	±200	±100	±50	±50	±200	±50	±50	±50	±50	±50
Physical properties - typical																					
Polymer-warp and weft			High tenacity polyester																		
Roll width		m	5 m width																		
Roll length		m	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

MACCAFERRI

MACGRID EG S

High modulus high density PP grids

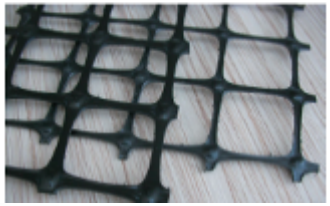
Simmetric tensile strength up to 40 KN/m

High Elastic modulus 30% UTS at 3% and 70% UTS at 5%

MACGRID® EG
POLYPROPYLENE BI-AXIAL GEOGRIDS

MACGRID® EG are high modulus polypropylene geogrids, produced by an extrusion process characterized by a tensile resistance both in the longitudinal and in the transverse direction.
They are inert to all chemical existing in natural soils 4<ph<9.
MACGRID® EG are mainly used for "soil stabilization" and for some kinds of soil reinforcements applications.

MACGRID EG			15S	20S	30S	40S
Mechanical Properties						
Minimum Average Tensile Strength Longitudinal direction	EN ISO 10319 ASTM D 6637	kN/m	15.0	20.0	30.0	40.0
Tensile strength at 2% strain Longitudinal		kN/m	5.0	7.0	10.5	14.0
Tensile strength at 5% strain Longitudinal		kN/m	7.0	14.0	21.0	28.0
Typical strain at M.A.T.S. - Longitudinal		%	13	13	13	13
Minimum Average Tensile Strength Transverse direction		kN/m	15.0	20.0	30.0	40.0
Tensile strength at 2% strain - Transverse		kN/m	5.0	7.0	10.5	14.0
Tensile strength at 5% strain - Transverse		kN/m	7.0	14.0	21.0	28.0
Typical strain at M.A.T.S. - Transverse		%	10	10	10	10
Typical junction strength efficiency Typical value	GRI GG2/GG1	%	95	95	95	95
Physical - Chemical Properties						
Grid Structure			Extruded bi-axial			
Polymer			100% stabilized UV polypropylene			
Carbon Black content		%	≥ 2			
Color			Black			
Mesh Opening size nominal value (1)		mm	38x38	38x38	38x38	38x38
Roll Length		m	50			
Roll Width		m	3.95			



(1) The mesh size refers to length x transverse directions.
Aperture tolerance ± 3mm.
Larger openings as 65x65 are available on request.

For the optimization and improvement process of the technical characteristics of the products, the producer reserves the right to modify standard and characteristics of the product without any warning. The information contained herein is to the best of our knowledge accurate, but since the circumstances and conditions in which it may be used are beyond our control, we do not accept any liability for any loss or

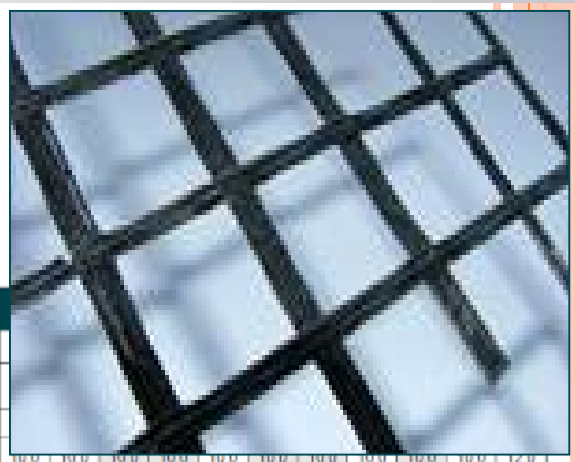
MACCAFERRI

MACGRID WG S

-High tensile strength (220 KN/m) for short and long term applications with a cross tensile strength of 20 KN/m or symmetric up to 130 KN/m

-Woven geogrid made of high tenacity polyester multifilament yarns

- PVC or PE coating



MACGRID WG		2	3	3S	4	4S
Mechanical properties (typical values)						
Tensile strength - MD (EN ISO 10319)	kN/m	25	40	40	45	45
Tolerance		-5	-5	-5	-5	-5
Strain at max strength - MD (EN ISO 10319)	%	10.0	10.0	10.0	10.0	10.0
Tolerance		± 2.5	± 2.5	± 2.5	± 2.5	± 2.5
Tensile strength - CMD (EN ISO 10319)	kN/m	25	25	40	25	45
Tolerance		-5	-5	-5	-5	-5
Strain at max strength - CMD (EN ISO 10319)	%	12.0	12.0	12.0	12.0	12.0
Tolerance		± 2.5	± 2.5	± 2.5	± 2.5	± 2.5
Physical properties						
Mesh size (nominal)		20 x 20 - 25 x 25 - 35 x 35				
Geogrid core		high tenacity polyester				
Polimeric coating (standard)		EVA or PVC				
Roll width (standard)	m	from 3.6 to 5.3 accordino to stock and production availability				
Roll length (standard)	m	100				

NOTE

- MD means length direction
- CMD means transverse direction
- Special products can be manufactured on request for specific projects. The white columns are the standards products available on stock; the coloured columns are special products to be manufactured on request and generally not available on stock.
- The material is flammable
- The material can be stocked in open space and piled until a maximum height of 5 rolls.
- Info related to tensile strength at 2%, 5% and 6% strain available on request

MacGrid™ is a geogrid for soil reinforcement, made from high molecular weight, high tenacity polyester multifilament yarns. The yarns are woven on tension in machine direction and finished with a polymeric coating. MacGrid™ geogrids are engineered to be mechanically and chemically durable, and resistant to biological degradation.

WOVEN HIGH TENACITY POLYESTER GEOGRID

PARAGRID & PARALINK


Electronic Copy

Linear Composites Limited

BBA BRITISH BOARD OF AGREMENT

Agrément Certificate No 03/4065

Designated by Government to take European Technical Approvals

PARALINK GEOCOMPOSITE PRODUCTS

Product

Regulations

1 The Building Regulations 2000 (as amended) (England and Wales)

In the opinion of the British Board of Agrément, Paralink Geocomposite Products for use as basal reinforcements are not subject to these Regulations.

2 The Building Standards (Scotland) Regulations 1990 (as amended)

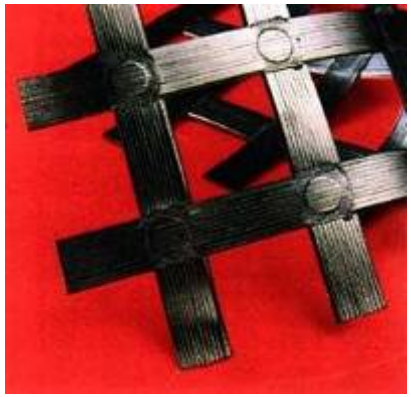
In the opinion of the BBA, Paralink Geocomposite Products for use as basal reinforcements are not controlled under these Regulations.

3 The Building Regulations (Northern Ireland) 2000

In the opinion of the BBA, Paralink Geocomposite Products for use as basal reinforcements are not controlled under these Regulations.

4 Construction (Design and Management) Regulations 1994 (as amended) Construction (Design and Management) Regulations (Northern Ireland) 1995 (as amended)

Information in this Certificate may assist the client, planning supervisor, designer and contractors to address their obligations under these Regulations.



High tensile strength (up to 1350KN/m) for short and long term applications with a cross tensile strength from 5 to 15KN/m

Strip bonded geogrids with high tenacity polyester core and polyethylene coating

Certified BBA, NTPEP

MACCAFERRI

MACDRAIN W

Manufactured by thermobonding a draining core in extruded monofilaments (GMA) with one filtering nonwoven geotextile that may also be working as separation or protecting layer.

The draining three dimensional core will have a “W” configuration as longitudinal parallel channels.

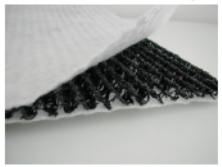
MACCAFERRI

TECHNICAL DATA SHEET
Rev. 03, Date 10.12.2010

MACDRAIN™ W 1061
DRAINAGE COMPOSITE

Geocomposite for planar drainage (GCD), realized by thermobonding a draining core in extruded monofilaments (GMA) with two filtering nonwoven geotextiles that may also be working as separation or protecting layers. The draining three dimensional core will have a “W” configuration as longitudinal parallel channels.

	Standard	Unit	Value	Tolerance
EXTERNAL FILTERS (GTX)				
Structure: needlepunched and thermotreated nonwoven geotextiles				
Raw Material: UV stabilized polypropylene				
Mass per unit area	EN ISO 9864	g/m²	130	average value
Thikness at 2 kPa	EN 9863-1	mm	0.80	+/-15%
Tensile strength MD & CMD	EN ISO 10319	kN/m	10.0	-1.3
Static puncture resistance	EN ISO 12236	N	1600	-20%
Dynamic puncture resistance	EN ISO 13433	mm	26	+20%
Flux perpendicular to the plane	EN ISO 11058	l/(m².s)	100	-30%
Characteristic opening size O_{90}	EN ISO 12956	micron	90	+/-30%
DRAINAGE CORE (GMA)				
Structure: three dimensional geomat made by extruded monofilaments set in longitudinal parallel channel configuration				
Raw Material: polypropylene UV stabilized by carbon black				
Mass per unit area	EN ISO 9864	g/m²	400	+/-10%
Width		cm	415	+/-2%
GEOCOMPOSITE (GCO)				
Thickness at 2 kPa	EN 9863-1	mm	7.0	-10%
Thickness at 20 kPa	EN 9863-1	mm	6.2	-10%
Mass per unit area	EN ISO 9864	g/m²	660	+/-10%
Tensile strength MD	EN ISO 10319	kN/m	19	-2
Strain at max load MD	EN ISO 10319	%	50	+/-20%
In plane flow capacity MD	EN ISO 12958	l/(m.s)		-30%
	gradient i =		0.03	1.0
soft/soft contact	20 kPa		-	1.80
rigid/soft contact	20 kPa		0.32	2.10
	50 kPa		0.14	1.00
	100 kPa		0.07	0.70
STANDARD DIMENSIONS OF GEOCOMPOSITE				
Width (1)		cm	420	average value
Length		m	75	average value
Roll area		m²	315	+/-4%
Roll diameter		cm	80	average value



(1) Material is available in submultiple of standard width; check feasibility with our commercial dpt.

MD : longitudinal direction
CMD : transversal direction

The producer, for his optimisation and improving process of the product's technical characteristics, has the faculty to modify the standards and the characteristics of the product without any pre-advice. All the information are given in base to our experience; in any case no responsibility for an incorrect use could be referred to the producer or one of his distributors.

THANK YOU…

Sachin Mandavkar, M. Tech. Civil - Geotechnical .

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MACCAFERRI

Engineering a better solution