Introduction to Good Road System (GRS)

innocsr

Good Road Soil Stabilized Method
for Sub-base / Base Pavement

InnoCSR Co., Ltd

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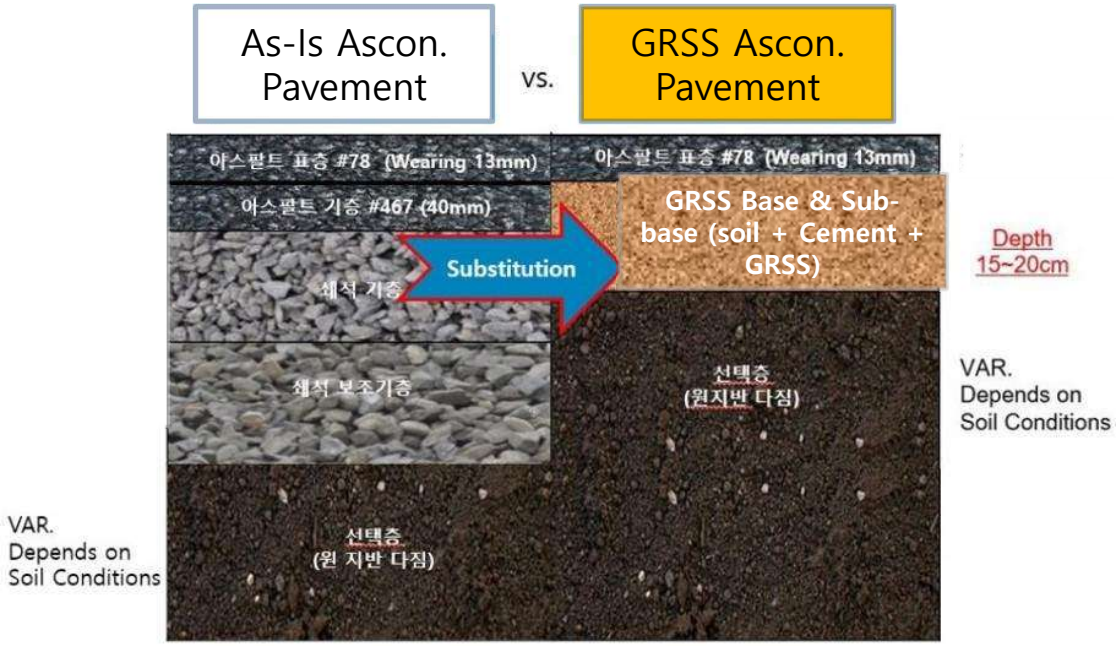
Chapter

What is Good Road System?

Good Road System (GRS)

- Good Road System is cost effective construction method for Pavement Sub (base) using highly compacted mixture of soil/aggregate with cement, and extra small amount of Good Road Soil Stabilizer (GRSS: Chemical admixture, i.e. Soil Stabilizer)
- **Normal Mixing Ratio: Appr. Soil (91.8~95.8%) + 0.2% (GRSS) + 4~8% (Cement)**
- **Subbase and Base Thickness (15cm ~ 20cm) reduction with high strength and durability ⇒ Green Solution for Low Cost, Fast Construction, and Better Quality**



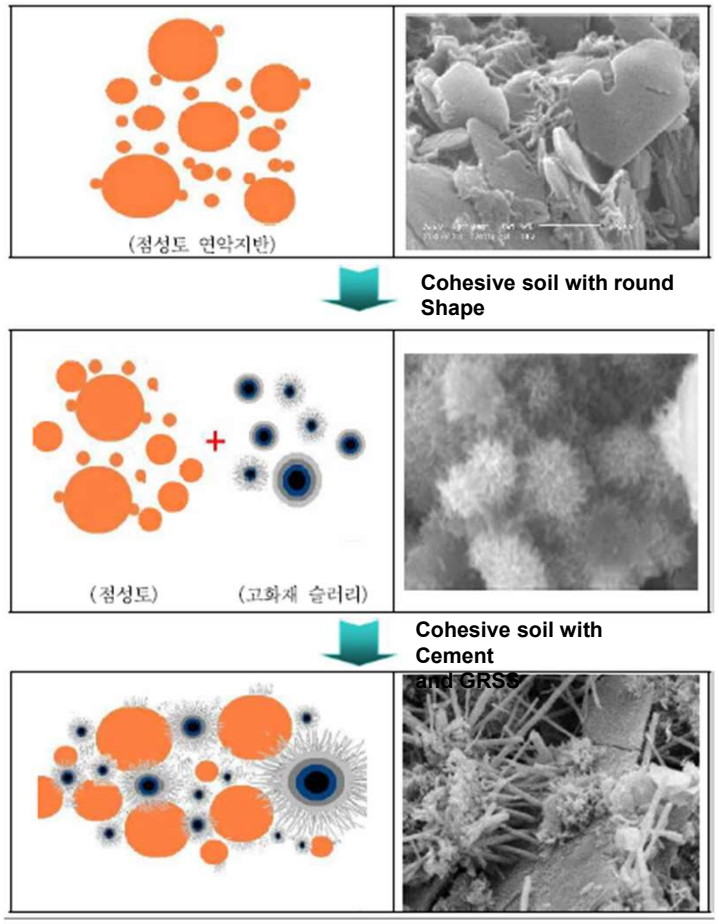
What is GRSS?

GRSS?

1. **Chemical admixture** made by a Korea convergence technology development
2. **Eco-friendly powder** composed of inorganic materials
3. **Excellent on-site applicable** due to adjustable ingredient according to the soil composition
4. **Addition of extra small amount** of soil weight about 0.1 ~ 0.3%

⇒ **Amount of Cement (less than appr. 4~8%) could be minimized than the other any admixture**

Solidification Process with GRSS (by electron Microscope)



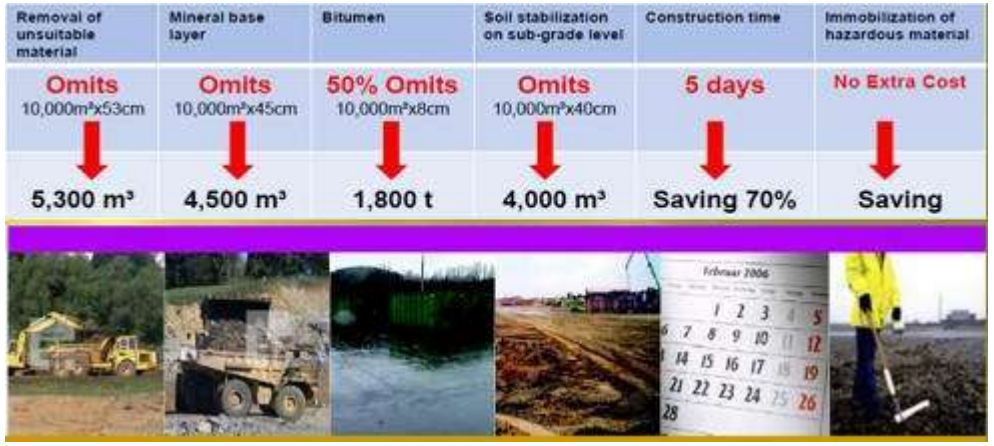
Pozzolanic reactions due to the ionic bonding of organic matter with addition of GRSS

Outstanding Features of GRS

A. Low Cost

- Reduced Excavation/Reclamation
- Granular Material of Sub-base/Base
- Cut in Construction Time **(Min. 50%)**
- A bituminous surface thickness

Reduction (Min. 20%)



Source: GeoCrete Homepage www.geocretespecialist.com

At least 25% Cost Saving

B. Quality Improvement

- Differential Settlement with Stiffness
- Crack from Differential Settlement
- Sink Hole, Potholes, Puddles, etc

Prevention

Analysis of Cost Saving by GRS

➢ 10,000 m2 Ascon. Pavement Cost Reduction **(Save 25% on average)**

Work	Design		As-Is Method	GRS Method	Remarks
Asphalt Concrete Pavement	Surface (Wearing) D = 5cm	Materials (WC-2 #78)	0.05m x 10000m2 x 2.4t/m3 x 60 US $/t = 72,000 US $	Same as Left 77,000 US $	
		Const. cost	10000m2 x 0.57 US $/m2 = 5,700 US $		
	Base course D = 5cm	Materials (BB-2 #467)	0.05m x 10000m2 x 2.4t/m3 x 57 US $/t = 68,400 US $	**No need**	GRSS Method replaces the Ascon. Base & Aggregates Sub-base & Reduction Depth D: 40cm → 20cm
		Const. cost	10000m2 x 0.57 US $/m2 = 5,700 US $		
Aggregates Sub-Base Pavement	Sub-Base Course D = 40cm	Materials	0.40m x 10000m2 x 24 US $/m3 = 96,000 US $	81,000 US $ (Humus + Cement)	
		Const. cost	0.40m x 10000m2 x 7.7 US $/m3 = 30,800 US $	0.20m x 10000m2 x 11 US $/m3 = 22,000 US $	
Transportation(Embankment & cutting) + labor Cost			240,000 US $	180,000 US $	
SUM			**Appr. 518,600 US $**	**Appr. 360,000 US $**	

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Chapter

Construction & Equipment

GRS Construction Sequence

GRS - Simple and Easy Two STEP Construction Method

- 1st STEP: Mixing (Mixing ratio: Soil 92~94% + 0.2% GRSS + 5~8% Cement + Water]
  2nd STEP: Normal Compaction for only two Layer (Each Layer: 20 ~ 30cm)

1st STEP : Mixing (4 Option for Field Condition)


Opt #1: Back Hoe


Opt #2: Mobile Mixer


Opt #3: Batch Plant Installation in Field


Opt #4: Mobile Rapid Mix Batch Plant

2nd STEP : Normal Compaction


1. Soil Transportation


2. Dumping to Finisher


3. Base/Subbase Levelling


4: Compaction

3
Chapter

Case Study

Construction Site Photo (at LH Dongtan 5-1 in Korea)

Before (2018 May.19 : 8 AM) → After (2018 May.20 : 3 PM)

AADT(annual Average Daily Traffic : 1,000 units 40 ton Dump Trucks

Construction Site Pics (at LH Dongtan 5-1 in Korea)

1st. Day : GRSS Mixing, Paving and Compaction

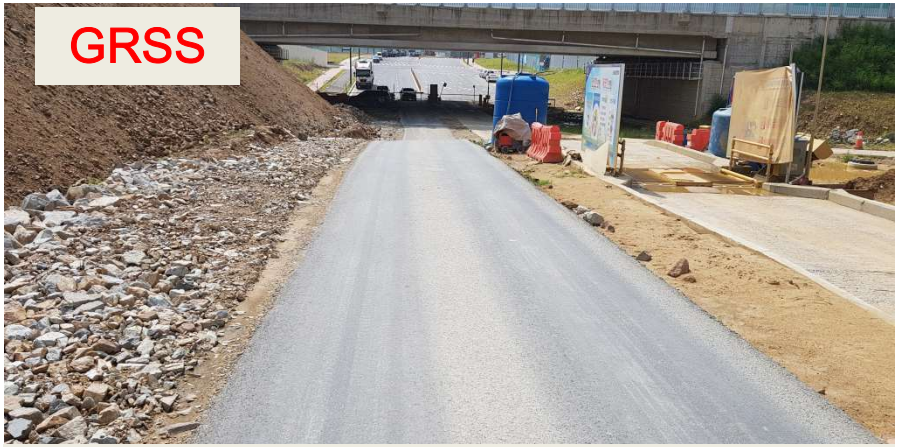
2nd. Day : Tack Coating & ASCON Paving

Construction Site Pics (at LH Dongtan 5-1 in Korea)

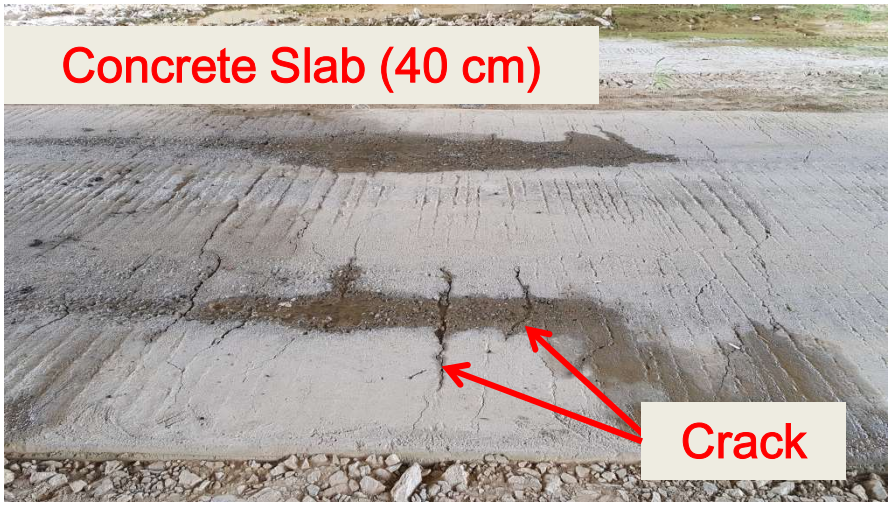
Before (2018 May.18 : 3 PM) → After (2018 May.23 : 11 AM)

Compare GRS vs. conventional Paving

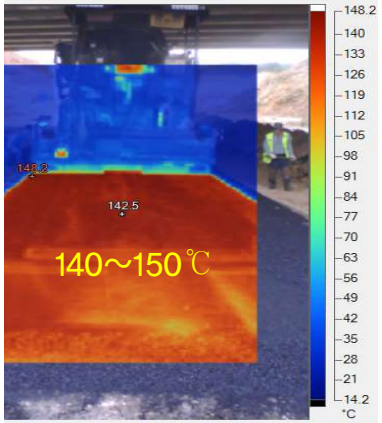
Comparison with GRS and Concrete Slab Pavement

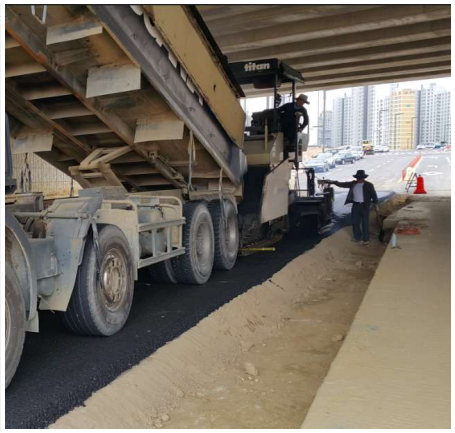


No Crack and Deflection after 5 month



Asphalt Pavement





After 6 months Road Layer

Analysis of Cost Saving by GRS

➢ Case Study: Dongtan 5-1 Area, South Korea/ Traditional Method

Quantity Estimation (560 m2, in Dongtan 5-1 Area, South Korea)

1. Road Design.

Length	140 m
width	4 m
Surface Layer	0.26 m
Base Layer Depth	0.4 m

Road Desingn Spec. (560 m2)	Layer	Specification	Depth	Remarks
	1. Wearing (surface)	Ascon(#78, WC-2)	6 cm	
	2. Ascon Middle layer	Ascon(#67, WC-4)	5 cm	
	3. Ascon Base Layer	Ascon(#467, BB-2)	10 cm	
	4. Aggregates Sub-Base	40mm	40 cm	

As-Is Method

2. Quotation Detail (Unit : US $)

Classification	Process & Standard	unit	quantity	Material		Labor			Equipment cost			SUM.		Remarks
				unit price	sum	unit price	Work day	sum	unit price	Work day	sum	unit price	sum	
Material	Aggregates	m3	224 m3	20	**4,480**							20	4,480	Ex Spot Price
	Ascon (#467)	ton	134.4 ton	55	**7,392**							55	7,392	
	Ascon (#67)	ton	67.2 ton	58	**3,898**							58	**3,898**	
	Ascon (#78)	ton	80.64 ton	60	**4,838**							60	4,838	Ascon Gravity =2.4
	Sub-Total				20,608								**20,608**	
Equipment for paving	Back Hoe (6W)	ea	1						600	7	4,200		4,200	
	Roller (Tandum)	ea	1						600	8	4,800		4,800	
	Asphalt Finisher	ea	1						800	1	800		800	
	Dump Truck	ea	1						500	8	4,000		4,000	
	Sub-Total												**13,800**	
Labour for pavement	Labour Local	person	3			300	24	21,600					21,600	
	Korean Expert	person	1			600	8	4,800					4,800	
	Sub-Total							26,400					**26,400**	
Grand Total					20,608			26,400			13,800		**60,808**	

Daily Transportation : Daily 40MT 500-1000 Trucks

Total Days: 8 Days

Total Period: 8 Days

Total Cost: Appr. 60K USD

Analysis of Cost Saving by GRS

➢ Case Study: Dongtan 5-1 Area, South Korea/ New Method

Quantity Estimation (560 m2, in Dongtan 5-1 Area, South Korea: Soil Stabilizer)

1. Road Design.

Length	140 m
width	4 m
Surface Layer	0.09 m
Base Layer Depth	0.2 m

2. Component Consumtion

HUMMUS	3 kg/m3
CEMENT	130 kg/m3
Soil	1800 kg/m3
Volume	112 m3

	Layer	Specification	Depth
Road Desingn Spec. (560 m2)	1. Wearing	Ascon(#78, WC-2)	9 cm
	2. Ascon Base	Ascon (#467)	0
	3. Base layer	Humus-B	20 cm

3. Quotation Detail (Unit : US $)

Classification	Process & Standard	unit	quantity	material Cost		Labour cost			Equipment cost			SUM.		Remarks
				unit price	sum	unit price	Work day	sum	unit price	Work day	sum	unit price	sum	
Material for HUMMUS (Soil Stabilizer) Compaction	HUMUS-B	m3	336 kg	20.0	**6,720**							20	6,720	FOB Korea
	Cement	m3	14560 kg	0.06	**874**							0.06	874	Portland
	Soil	m3	201600 kg	-	-							-	-	free of cost
	Ascon (#78, WC-2)	ton	121 ton	60	**7,258**							60	7,258	Ascon Gravity =2.4
	Sub-Total				14,851								**14,851**	
Equipment for paving	Back Hoe (6W)	ea	1						600	1	600		600	
	Roller (Tandum)	ea	1						600	2	1,200		1,200	
	Asphalt Finisher	ea	1						800	2	1,600		1,600	
	Dump Truck	ea	1						500	2	1,000		1,000	
	Sub-Total												**4,400**	
Labour for pavement	Labour Local	person	3			300	6	5,400					5,400	
	Korean Expert	person	1			600	2	1,200					1,200	
	Sub-Total							6,600					**6,600**	
Grand Total					14,851			6,600			4,400		**25,851**	

Daily Transportation : Daily 40MT 500-1000 Trucks

Total Days: 2 Days

Total Period: 2 Days

Total Cost: Appr. 25K USD (60% Saving)

Results of the Test Pit at Dongtan city in Korea

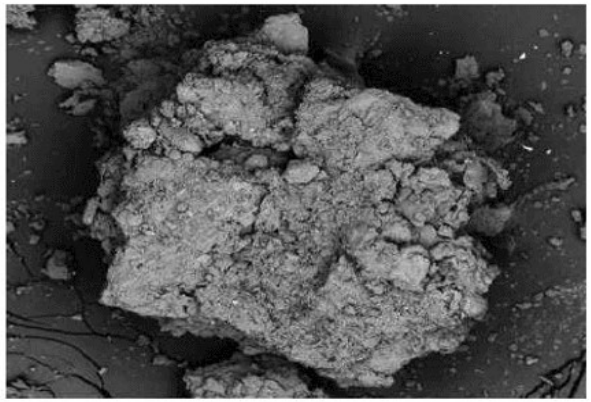
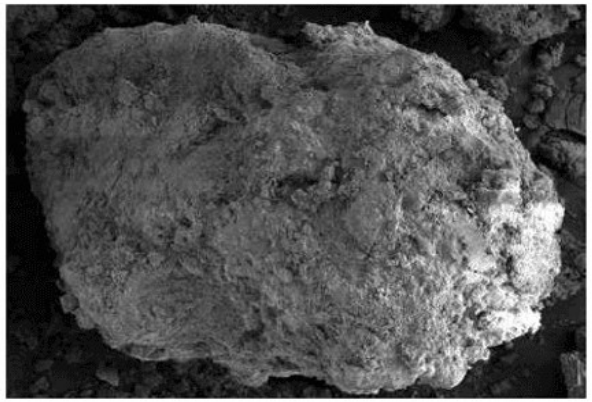
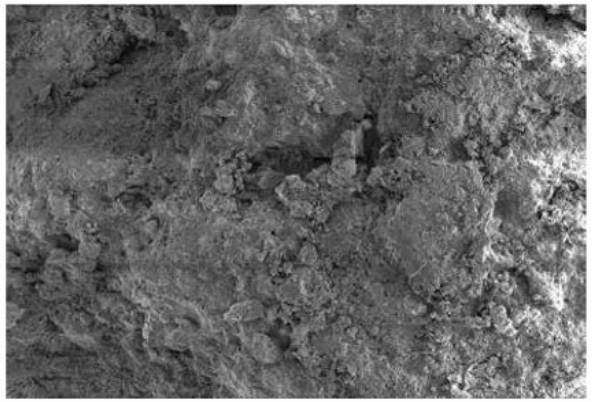
Pavement Condition after 8 Month (18. Jan. 2019) : No deformation, No crack

The Volume of Traffic (40MT DUMP) : 150,000 over , 300 ~ 800 passing per day

⇒ Compatible for 20 years durable life

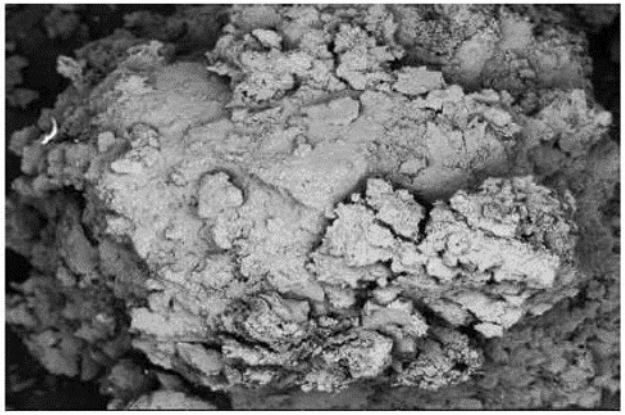
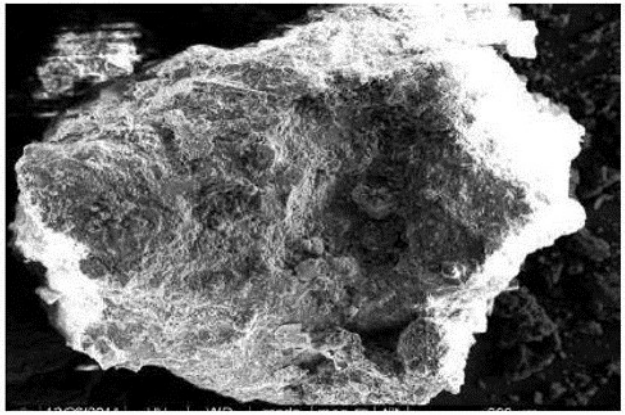
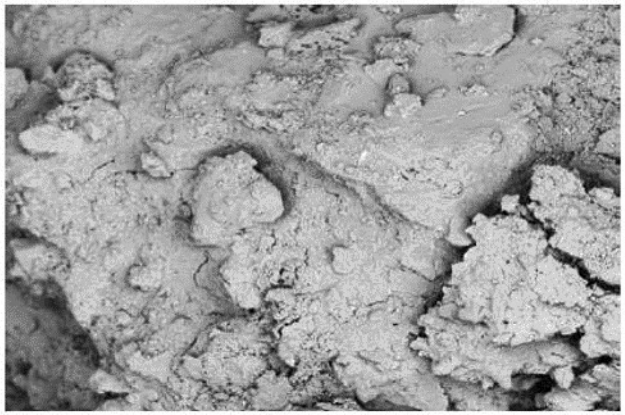
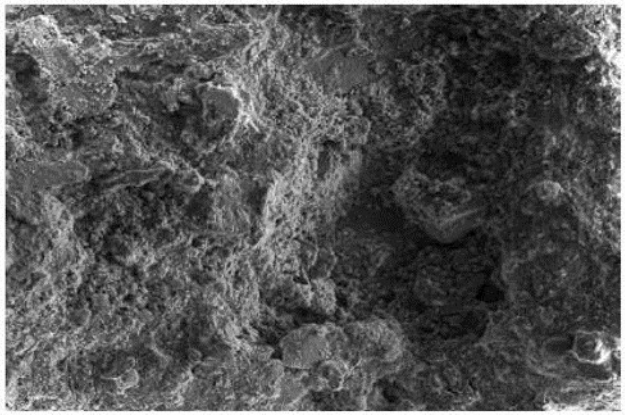
Appendix

GRSS Additive Effects – by SEM

×200		
	Cement + Soil + GRSS (0%)	Cement + Soil + GRSS (0.2%) 2%)
×500		
	Cement + Soil + GRSS (0%)	Cement + Soil + GRSS (0.2%) 2%)

SEM Picture (After 7 days curing)

GRSS Additive Effects – by SEM

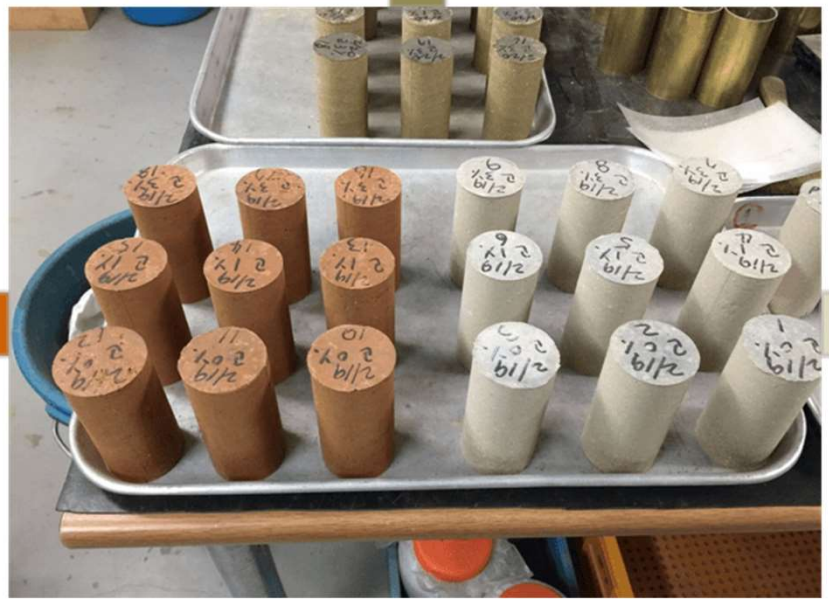
×200		
	Cement + Soil + GRSS (0%)	Cement + Soil + GRSS (0.2%) %)
×500		
	Cement + Soil + GRSS (0%)	Cement + Soil + GRSS (0.2%) %)

SEM Picture (After 28 days curing)

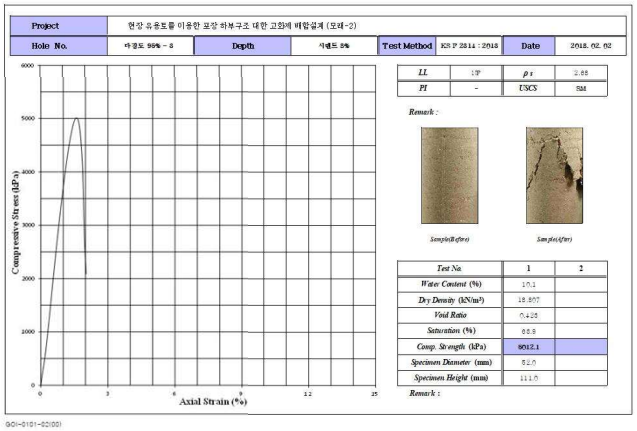
Applicable to Various Soil (Sand, Silt, Clay etc.)

SM : Sand

CL : Clay



ML : Silt



Unconfined Compression Test

Project	현장 유동토를 이용한 포장 하부구조 대한 고화제 배합설계 (모래-2)				
Hole No.	다짐도 95% - S	Depth	시멘트 8%	Test Method	KS F 2314 : 2018	Date	2018. 02. 02

LL	19	ρs	2.65
PI	-	USCS	SM

Remark :

Sample(Before) Sample(After)

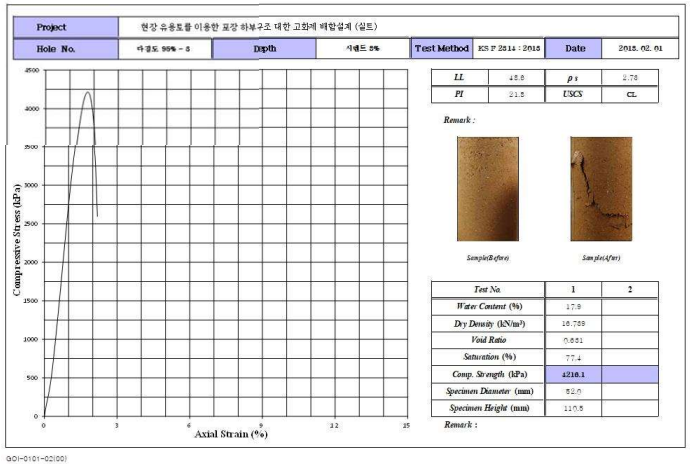
Test No.	1	2
Water Content (%)	10.1	
Dry Density (kN/m³)	18.857	
Void Ratio	0.428	
Saturation (%)	63.8	
Comp. Strength (kPa)	8012.1	
Specimen Diameter (mm)	52.0	
Specimen Height (mm)	111.0	

Remark :

Compressive Stress (kPa)

Axial Strain (%)

GOI-0101-02(00)



Unconfined Compression Test

Project	현장 유동토를 이용한 포장 하부구조 대한 고화제 배합설계 (실트)				
Hole No.	다짐도 95% - S	Depth	시멘트 8%	Test Method	KS F 2314 : 2018	Date	2018. 02. 01

LL	48.8	ρs	2.76
PI	21.5	USCS	CL

Remark :

Sample(Before) Sample(After)

Test No.	1	2
Water Content (%)	17.9	
Dry Density (kN/m³)	16.769	
Void Ratio	0.651	
Saturation (%)	77.4	
Comp. Strength (kPa)	4218.1	
Specimen Diameter (mm)	52.0	
Specimen Height (mm)	110.5	

Remark :

Compressive Stress (kPa)

Axial Strain (%)

GOI-0101-02(00)

Soil Cement vs. GRS

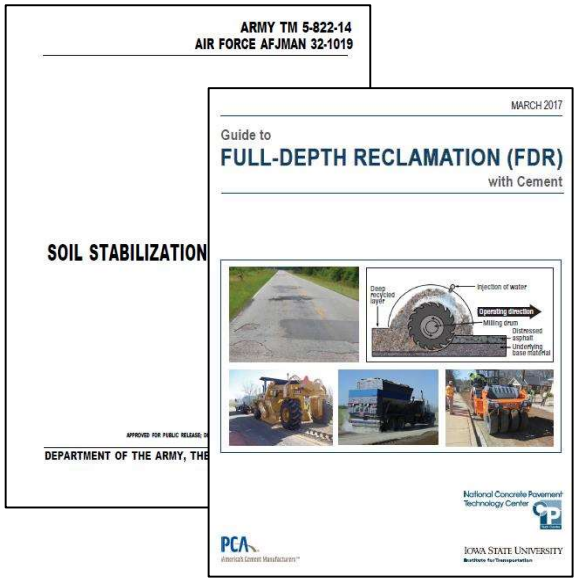
Comparison of GRS & Soil Cement

Description	Soil Cement (Specification)		GRS
Max. Size of Soil and Aggregate	Soil above 80% pass #4 (4.76mm) sieve.	PCA (Portland Cement Association 2017 USA)	Less than 40 mm
Allowing Mixing Time	Within 2 hours		Within 12 hours
Construction Joint	Need		No need
Construction Method	In situ Pulverizing (Special Equipment)		Ready Mix (Normal Equipment)

Specification of Global Soil Cement Base & Sub Base

1. GLOBAL Specification

Country	Kind of Road	Compressive Strength	Remarks
U.K	Express Way	2.75 MPa	
	General Road	2.40 MPa	
	Service Road	1.71 MPa	
Australia	General Road	2.40 MPa	
Japan	Under 2,000 cars	1.96 MPa	1day Traffic Volume
	2,000~7,500 cars	2.45 MPa	
	More than 7,500 cars	2.94 MPa	
US Army	Flexible Pavement	5.17 MPa	Sub Base 1.72 MPa
	Rigid Pavement	3.45 MPa	



2. KOREA Specification (Ministry of Land, Infrastructure and Transport)

Specification	Apply	Compressive Strength	Remarks
General Specification of Civil Works (2016)	Asphalt Pave.	3.0 MPa	Wet 6days Soaking 1day Curing
	Concrete Pave.	2.0 MPa	
	Soil Cement Stable Base (7days Curing)	3.0 MPa	
Specification of Road Construction	Lean Concrete	5.0 MPa	

Thank you !