NovoCrete®
Soil Stabilization Technology

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NovoCrete

Stabilization Technology

- CTB
- CTSB
- FDR
- PQC

- *Futuristics Pavement Technology*
- *Pavement Crust By Waste Converting To Wealth*

DESCRIPTION

NovoCrete is a Powder made from 100 % mineral components containing alkaline and alkaline earth constituents.

NovoCrete Neutralizes PH levels, and Provides a Higher water impermeability. Using the additive leads to the result in complete closure of the open pores of the Cement. It provides higher tensile strength as well as an improved modulus of elasticity

NovoCrete is an environment friendly mineral, Recyclable upto 100%

APPLICATIONS

- *Roads*
- *Paths*
- *Railway*
- *Harbour*
- *Foundation*
- *Runway*

STORAGE & HANDLING

NovoCrete® should be stored in dry conditions and not exposed to moisture

SUSTAINABILITY

For NovoCrete®, Sustainability is central to our Business strategy. Our mission is to provide advanced material solutions shaping a better and more sustainable future, adding value to our stakeholders Nationally.

QUALITY ASSURANCE

CTB / CTSB layer is Designed According to Grading Table of MoRTH 400.4 (MORTH. 250.2013), Mix Design is prepared and tested in accordance with IRC:SP:89:2019 (Part-II)

FDR (clause 6.3 IRC-120:2015), is designed according to Grading Table of MoRTH 400.4 (MORTH.250.2013), mix design is prepared and tested in accordance with IRC:37:2012 & 2018, IRC:SP:89:2018 (Part-II)

WASTE TO WEALTH

Use of Steel Slag for Pavement Construction

ADVANTAGES

- *Reduces Time*
- *Save Material*
- *More Economical*
- *Longer Lifespan*
- *100% Recyclable*
- *Emit Less CO2*
- *Groundwater Protection*

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Soil Stabilization Technology

Innovative Solutions Provided by :

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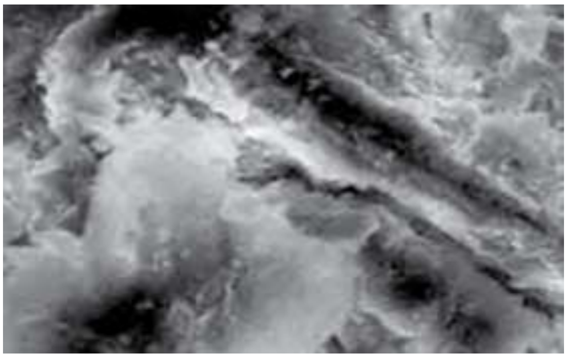
About NovoCrete® Technology

Introduction

NovoCrete® is used for the construction of high-quality bearing layers using the existing soil, it accelerates the cement hydration process and increases the resistance to pressure, the static and dynamic moduli of elasticity, the resistance to bending and tensile strength, the resistance to freezing and soil stabilization rich in humus. The elastic behavior of the layers results in an altered set of cement hydration because NovoCrete® boosts this process and at the same time modify the reaction of the cement. Common cements reaches the major unconfined compression after 28 days, by adding NovoCrete® a new crystalline structure during hydration process is forming up to 90 days. This chemical reaction cause in growth of crystals during the hydration process and of the intense crystalline interlocking, using NovoCrete®, it is possible to increase strength and bearing capacity besides to minimize tensile stresses of soil. Unlike the traditional methods of construction, with NovoCrete® and cement, the coating of the upper layers of multipurpose roads is possible without the use of mineral bearing layers, thus saving money and time for construction.

Pure Cement: open pore structure



Cement with NovoCrete®: closed dense structure

Product description

NovoCrete® is a whitish powder consisting of alkaline and alkaline earth elements or complex compounds. It promotes cement hydration process and inhibits the action of fulvic acids and carbonic acids. Apart from improving the above mentioned parameters, NovoCrete® also promotes the immobilization of pollutants, such as heavy metals and organic parameters, which get permanently embedded in the new crystal structures in the soil. During the chemical reaction ($CaCL_2$ x $6H_20$) arise Antarcticit (kind of Calcium-chloride Dihydrate) which grows in a trigometrical crystal system. This new aggregate can form needle-crystals up to 15 cm. This growth in combination with the other Novocrete® minerals gives the desired elasticity and strenght to the base layer. Stabilized bases courses treated with cement only, usually combine high stiffness with a high risk on premature cracking. This undesirable combination was regarded as a major handicap for stabilization.

25 kg
Bags

1.000 kg
Big Bags

Experience: > 22 years - projects: > 1.000 - countries: > 50

About NovoCrete® Technology

NovoCrete® Soil Stabilization Technology

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Advantages at a glance

> Much faster construction process
> Roads can be re-opened for traffic already after 24 hours
> Possibility to build roads with and without pavement
> No need for soil exchange or additional gravel material, in-situ material can be used
> 90 day hydration process: next to no cracking with binder from up to 14%
> During the hydration process, long crystal needles are formed, allowing very high bearing strengths
> With a binder content of >10%, after 1 to 2 days values of at least 150 MN/m^2 can be attained, and can continue to increase for up to 90 days
> The stabilized layers show low bending tensile strength. Concrete anchors may be installed
> Water does not penetrate, nor any other fluid, into the stabilized layers, guaranteeing safety from frost
> Longer lifespan as it is water-resistant, and increased acid and salt resistant
> Lifespan can be prolonged by laying a thin wearing course
> No problems with loamy or clayey soils containing high levels of sulphur associated with high cement content
> Adaptable to nearly all soil types - even grainy sands or organic material can be reinforced
> Soils with high levels of salt can be stabilized
> Stabilizing contaminated soils is possible
> No problems from frost, thaw or changes in conditions, as water-resistant base courses may even be constructed from in-situ soils
> Stabilization measures can be customised and adapted to particular soil conditions
> Less to no expenses for maintenance are required for years
> Restoration of surfaces to original condition is possible

Environmental friendly technology

1 | CO_2 saving
Less environmental impact due to significant reduction of
> transportation of equipment
> transportation of material
> use of machinery (working hours)
> general traffic (deviations and traffic jams)

2 | Saving of material
Reduction of new layers and processing of existing material such as
> old, existing asphalt layers
> old, existing base layers
> in-situ soil material instead of applying natural resources

3 | Groundwater protection
Active protection due to
> impermeable, leak-proof surfaces
> compliance with the boundary values of the Drinking Water Ordinance

4 | Sustainability
Quality intensification compared to conventional construction methods by
> resistant and durable results
> significantly reduced maintenance costs
> reduced thickness of the layers
> saving of landfill sites
> reduction of waste disposal expenses
> protection of resources
> capability for complete dismantling of stabilized layers

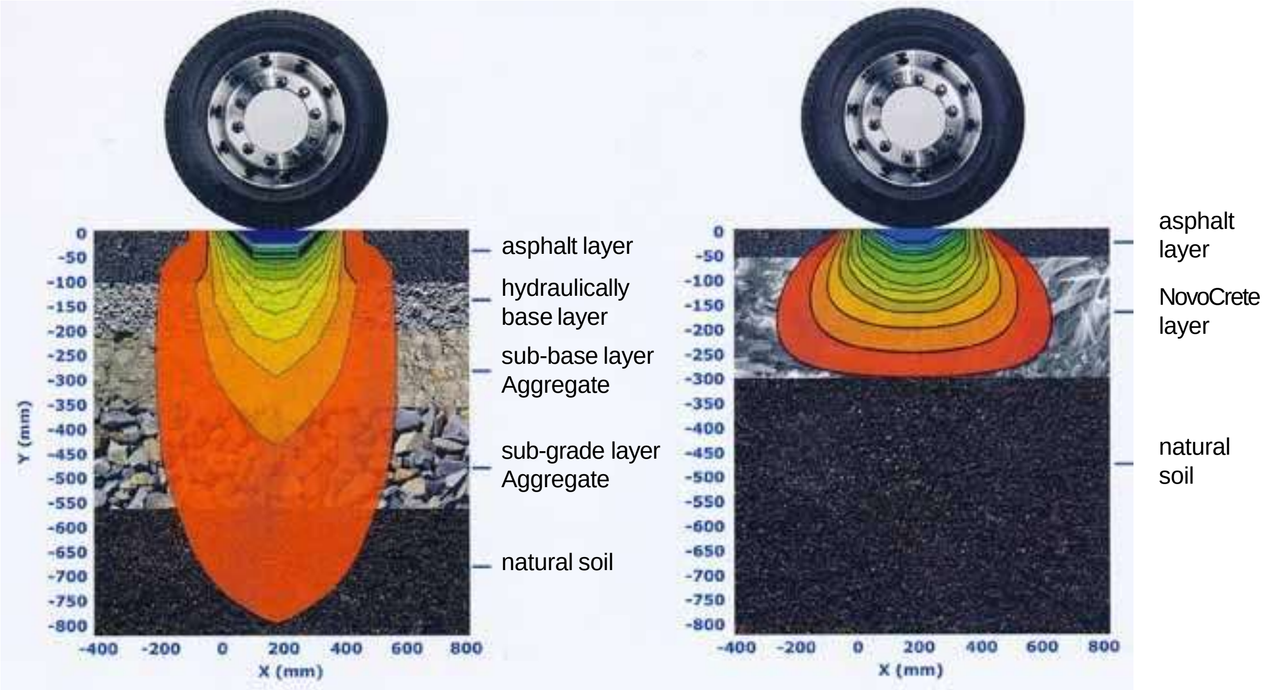
5 | 100 % recyclable
Use of
> purely mineral components
> nontoxic
> not harmful components

6 | Immobilization
The process of the soil stabilization
> immobilizes hazardous substances
> makes contaminated soils usable

Experience: > 22 years - projects: > 1.000 - countries: > 50

Further Advantages

High flexibility - Distribution of Tension and Deformations



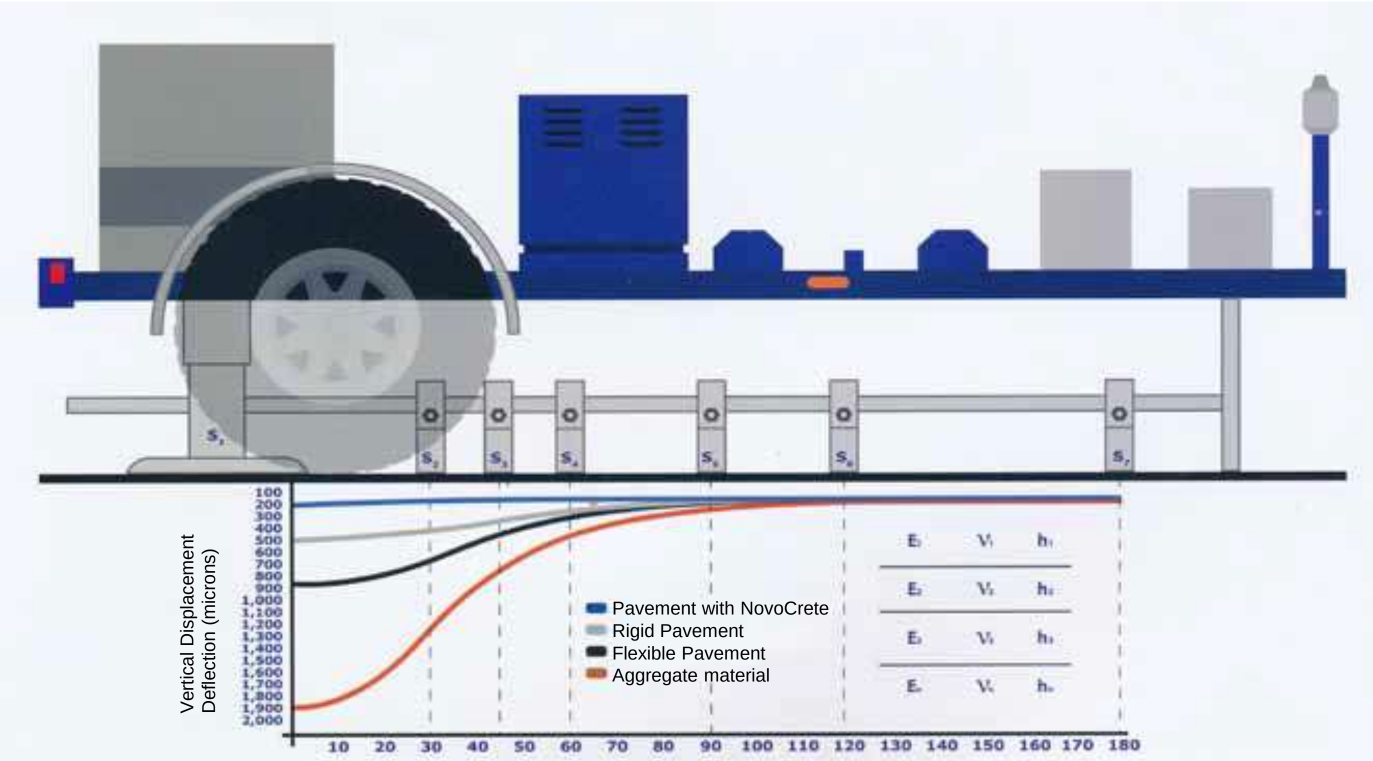
Conventional construction   NovoCrete® construction

High load bearing capacity

Experience: > 22 years - projects: > 1.000 - countries: > 50

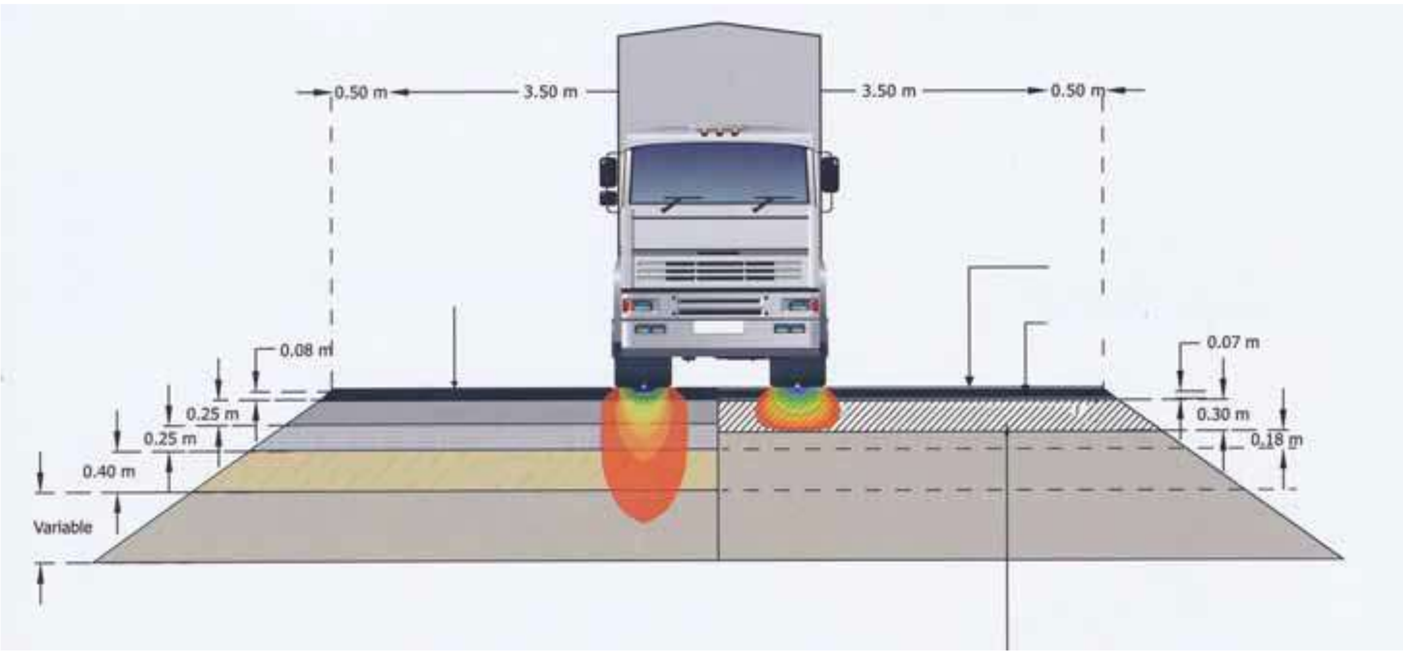
Further Advantages

Deformations in the pavement structure



Separation (cm)

High flexibility

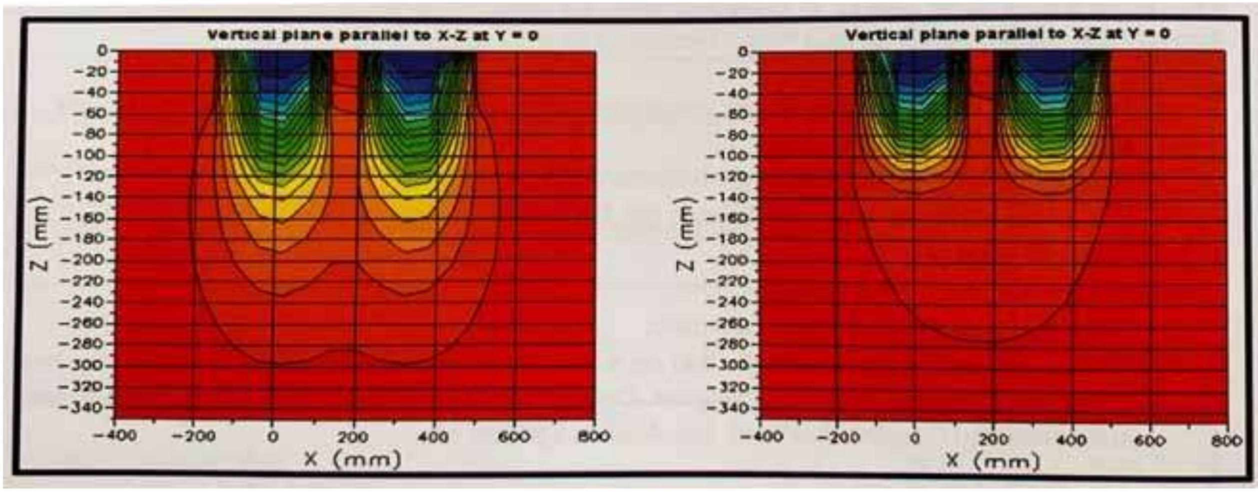


Conventional construction NovoCrete® construction

Distribution of Tension and Deformations

The Bulk of Distribution of Deformation is wider, reason why, the deformations transmitted are distributed in a greater area, with what the magnitude of the efforts reduces of considerable way, minimizing the deformations in the inferior layers with floors of minor specification and as a consequence, drastically increases its useful life.

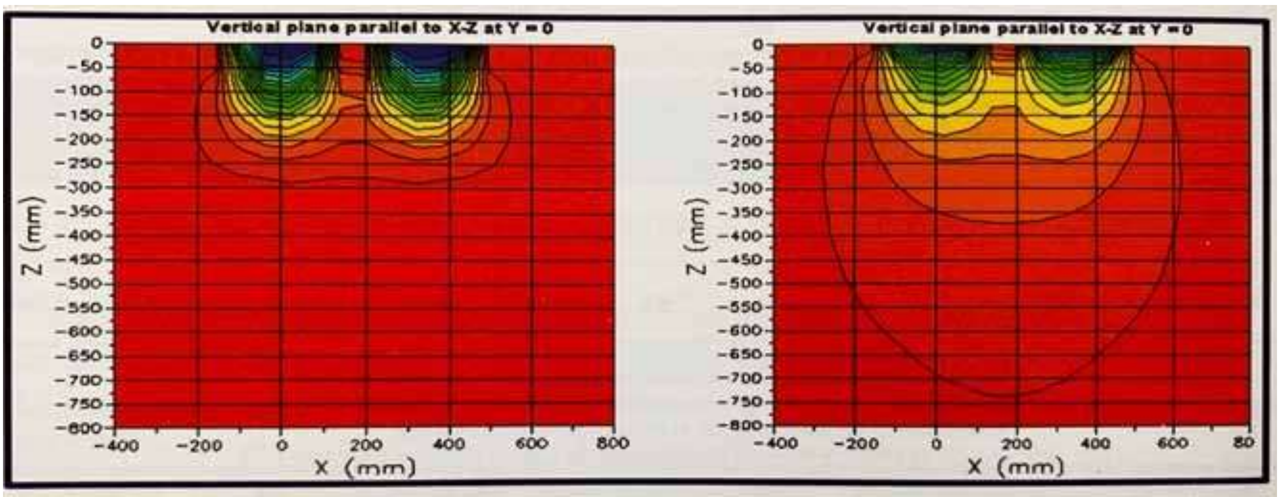
Picture: Comparison of the Bulbs of Distribution of Deformation in Rigid Pavements



NovoCrete® construction **Conventional construction**

In the case of Flexible Pavements, the difference is more noticeable. Note that the Deformation Distribution Bulb with „in-situ“ materials + NovoCrete + Portland Cement is wider and shallower, distributing and dissipating the major Efforts in the modified soil layer and the structure with materials conventional distributes greater efforts with less area in materials of lower specification at greater depth, increasing deformations and decreasing its useful life.

Picture: Comparison of the Bulbs of Distribution of Deformation in Flexible Pavements



NovoCrete® construction **Conventional construction**

Possible Savings

NovoCrete®
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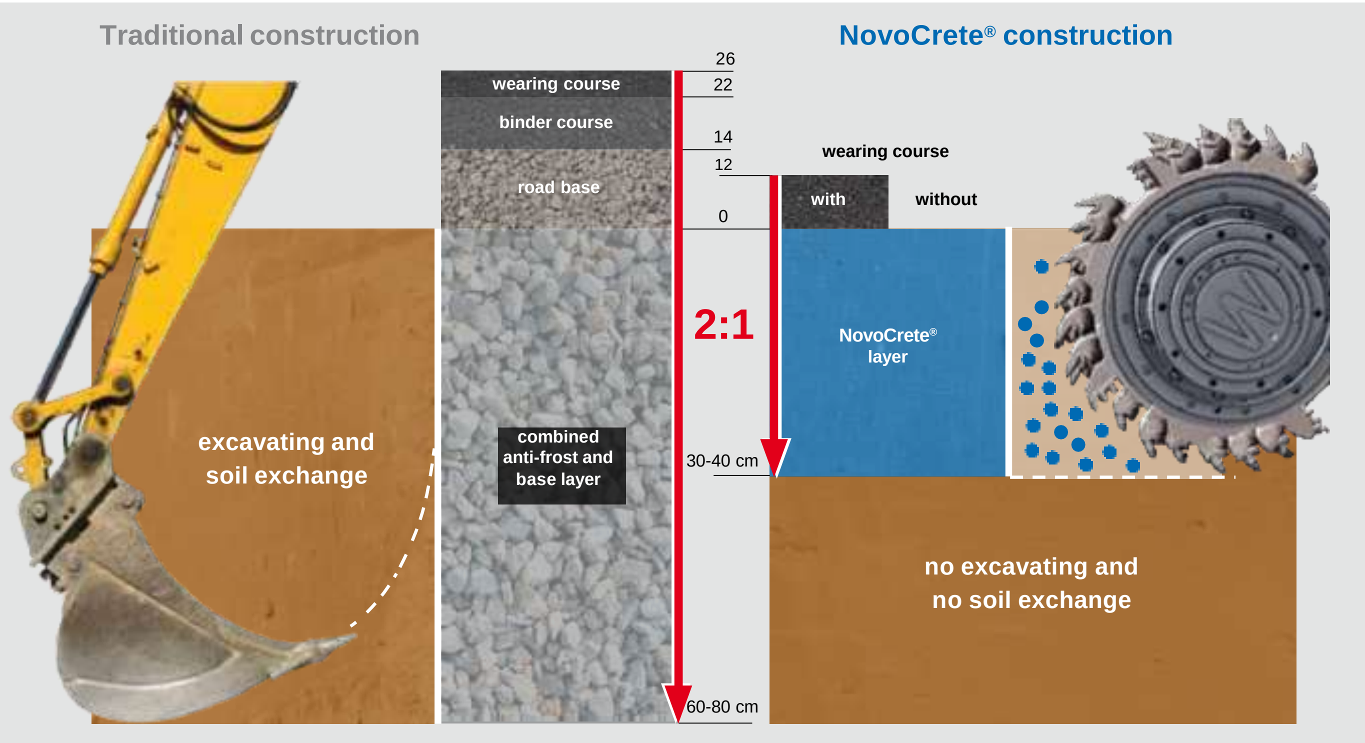
The difference 2:1



Examle Road: length 1 km, width 7,5 m

	Traditional	NovoCrete	Reduction
Truck movements	113	8	93 %
New materials (tons)	2560	168	92 %
Materials for disposal (tons)	1312	0	100 %
Diesel fuel (liters)	7125	1180	83 %
Completion time (days)	20	3	85 %
CO_2 emissions (tons)	3177	645	80 %

Areas of use

> Road and motorway construction
> Footpaths, cycle paths, forest paths and agricultural roads
> Access routes for the oil, gas and wood industries
> Establishment of base layers under hall floors
> Taxiways and parking areas
> Railway tracks
> Tunnel and sewage system construction
> General foundations
> Parking, container storage points, logistics centres
> Harbour premises and wharves
> Storage areas for wood, metal, etc.
> Foundation for windfarms
> Embankment stabilization
> Slope reinforcements, grouting
> Dam reinforcements
> Landfill sites
> Replacement of depth foundations

Experience: > 22 years - projects: > 1.000 - countries: > 50

NovoCrete®
Soil Stabilization Technology

Application and Results

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Procedure steps

Spreading of cement-NovoCrete®

Milling of cement-NovoCrete®

Static and dynamic compaction

Levelling with a Grader

Watering

Installation of asphalt after 48h

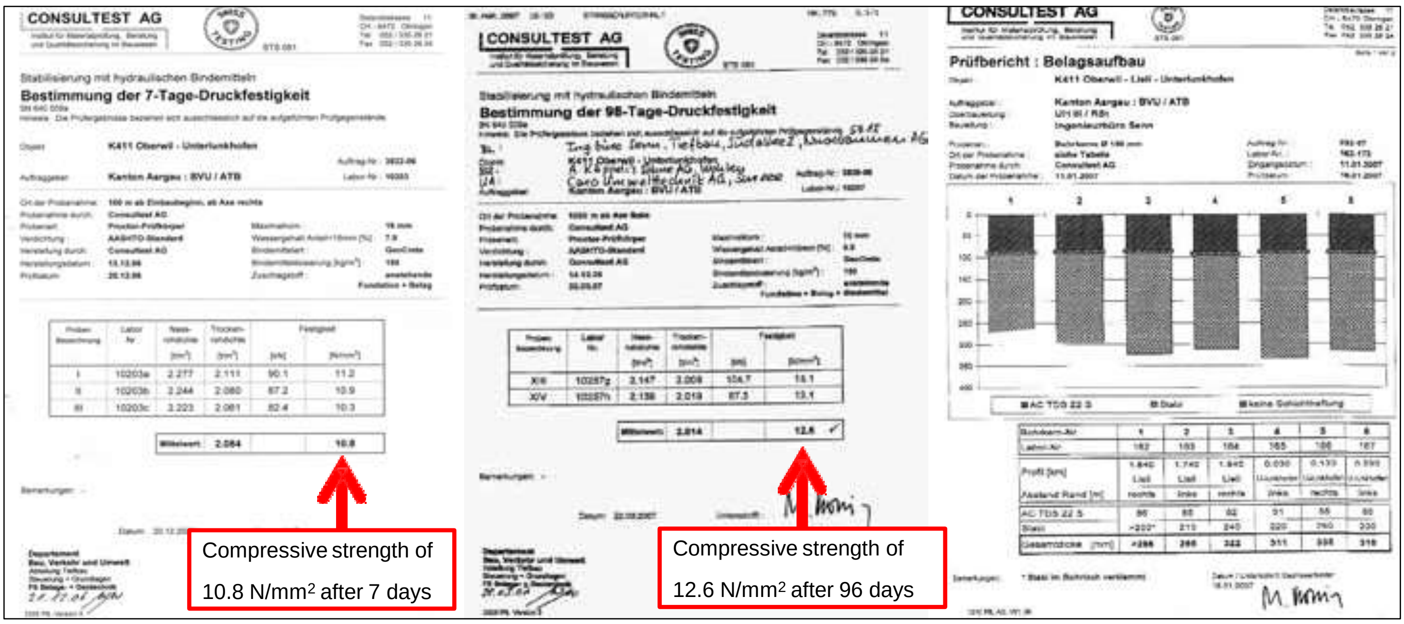
Comparison of expected results using conventional technology vs. NovoCrete® technology

	Conventional technology	NovoCrete® technology
Load bearing capacity (MN/m²)	< 150 MN/m²	min. 150 - 500 MN/m² (or higher)
Compressive strength (after 7 days) N/mm²	not measurable	2,0 up to 9,0 N/mm² (depending on soil type/dosage)
Modulus of elasticity (MPa)	not measurable	2.000 up to 12.500 MPa
Tensile strength (MPa)	not measurable	0,5 up to 1,5 MPa
Water impermeability (m/s)	permeable	10^{-6} to 10^{-9} m/s (depending on soil type)
Frost resistant	yes	yes
Soil exchange required	yes	no
Aggregate required	yes	no
Thickness of base layer	40 up to 100 cm	25 up to 40 cm (depending on soil type, road class, traffic volume)
Pavement required	yes	not mandotary
Thickness of asphalt layer can be reduced	limited	yes
Construction process	weeks/months	up to 3.000 m² per day
Re-open for traffic	after weeks/months	after 48 hours Reduction of construction time minimum 60%
Immobilization of pollutants in the same process with stabilization	no	yes
Warranty	5 years (Germany)	5 years (Germany)
Life cycle	Max. 10 years	20 years

Experience: > 22 years - projects: > 1.000 - countries: > 50

Results

Taking of drill cores



Finding of IIT'S/CRRI on Novocrete

Red Soil

1. Novocrete and Cement blended clayey silt (binder content of 180 kg/m3) has a soaked CBR value of 103.5 i.e.,13.8 times more than soil without any binder content while [with a binder content of 200 kg/m3] has a soaked CBR value of 110.2 which is 14.7 times more than soil without binder, When Novocrete and cement is mixed with clayey silt, its CBR value increased by 9.5% compared to the soil mixed with cement only.
2. Novocrete and Cement blended clayey silt [with a binder content of 180 kg/m3] has a UCS of 3346 kPa after 7 days curing, 3271 kPa after 14 days curing, and 3812 kPa after 28 days curing. This is 24.8 times more than soil without any binder content (after 7 days), 24.3 times more than soil without any binder content (after 14 days), and 26.76 times more than soil without any binder content (after 14 days) 3)Novocrete and Cement blended clayey silt [with a binder content of 180 kg/m3] has an initial elastic modulus of 129 MPa after 7 days curing, 153 MPa after 14 days curing, and 268 MPa after 28 days curing. This is 21.9 times more than soil without any binder content (after 7 days), 26 times more than soil without any binder content (after 14 days), and 45.6 times more than soil without any binder content (after 28 days).
3. Average water absorption for Novocrete and cement blended red soil after 28 days of curing is 25% and average change in volume is 1.6%.

Black Soil

1. Soil without any binder exhibited a swell potential of 8% and soil with binder contents (Cement+Novocrete) exhibited a swell of only 0.11%. (Novocrete+OPC) blended soil has a soaked CBR value of 80.25 i.e. 57.3 times more than BC soil without any binder content. (Novocrete+SRC) blended BC soil has a soaked CBR value of 49.9 i.e. 35.6 times more than BC soil without any binder content
2. (Novocrete+OPC) blended BC soil has a UCS of 1059 kPa after 7 days curing, 1423 kPa after 14 days curing, and 1531 kPa after 28 days curing. This is 5.32 times more than the BC soil without any binder content (after 7 days), 7.15 times more(after 14 days), and 7.69 times more (after 28 days).An average UCS of a (OPC+Novocrete®) blended BC soil for all curing periods is 1337 kPa, This is 6.72 times the BC soil without any binder content. (Novocrete+SRC) blended soil has a UCS of 1306 kPa after 7 days curing, 1435 kPa after 14 days curing, and 1535 kPa after 28 days curing. This is 6.56 times more than the BC soil without any binder content (after 7 days), 7.21 times more (after 14 days), and 7.71 times more (after 28 days). An average UCS of (SRC + Novocrete®) is 1425.3 kPa. This is 7.16 times the BC soil without any binder content. (Novocrete+OPC) blended BC soil has a Poisson's ratio of 0.38 at the end of curing period of 28 days.

Clayey Soil

1. NovoCrete® as a valuable stabilizer, particularly as a secondary additive or activator that enhances the performance of cement as a stabilizing agent. The addition of NovoCrete® alongside even a small amount of cement has been shown to significantly improve the mechanical properties of soils for construction applications.
2. The research identified the optimal dosage of NovoCrete® with cement for each soil type. Furthermore, microstructural analyses shed light on the underlying mechanisms responsible for these enhancements, with a particular focus on the formation of cementitious compounds. These findings offer promising prospects for achieving higher strength with minimal cement usage, making it a sustainable and effective approach to soil stabilization in construction projects.
3. When 4% cement+ Novocrete is mixed with soft clay , strength is approx. 1.6Mpa on 7 days test on UCS. When 6% cement+ Novocrete is mixed with soft clay , strength is approx. 1.8Mpa on 7 days test on UCS. When 7% cement+ Novocrete is mixed with soft clay , strength is approx. 1.9Mpa on 7 days test on UCS. When 10% cement+ Novocrete is mixed with soft clay , strength is approx. 2.1Mpa on 7 days test on UCS

****Data are taken from IIT Palakkad, IIT Bhubaneswar, IIT Mumbai**

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Finding of IIT'S/CRRI on Novocrete

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FDR

1. MDD and OMC of the FDR mix with 5% cement stand-alone was reported as 1.854 g/cc and 4.2%. NovoCrete additive at 2% by wt. of Cement was added to enhance the density of the FDR material. The MDD and OMC of the FDR mix with 4% Cement plus 2% NovoCrete additive was found to be 1.862 g/cc and 4.1%. This demonstrates that the addition of 2% of NovoCrete additive marginally improved the MDD value by about 0.43% while the OMC was decreased by nearly 0.1%, respectively.
2. the 7-day's UCS value of the FDR material with 5% Cement stand-alone was found to be 1.53 MPa. For the FDR material with 4% Cement and 2% NovoCrete additive (by wt. of Cement), the 7-day's UCS strength was reported as 1.64 MPa. This demonstrates that the addition of 2% NovoCrete (by wt. of Cement) can improve the 7-days UCS value of the FDR material by about 7.5%.

Overall Observations

Based on the analysis and interpretation of various test results carried-out at IIT Bombay, India on two distinctly different types of soils, it can be concluded that Novocrete® and Cement blended soil has superior properties than the soil without any binder content. Partly significant improvement in unconfined compressive strength and CBR were observed. The observed early strength of Novocrete® and cement treated soil, compared with only cement treated soil indicates a significant early release of road for traffic. The most important characteristic of expansive soil that affect infrastructure, its swelling is considerably restrained due to the application of Novocrete and cement. This shows the significance of Novocrete® for using to improve base course layerand other allied applications. From the observations made at the laboratory level the Novocrete® binder (added in addition with cement) has a potential as soil stabilizer in base course layers. The observed results meet the required target values for construction of base course layers of requirements in Indian conditions.

Date: October 30, 2023
Place: IIT Bombay, Powai, Mumbai, INDIA

(Prof. B.V.S. Viswanadham)

Observation by IIT Mumbai

CHAPTER 5 CONCLUSIONS AND RECOMMENDATIONS

In conclusion, the study investigated the influence of NovoCrete® and cement on the mechanical properties and microstructure of three different soil types: laterites, black cotton soil, and soft clay. The key findings and insights obtained from this research can be summarized as follows:

5.1 Microstructural Studies

XRD and SEM analyses provided insights into the mineralogical composition and microstructural changes in the soils due to the addition of NovoCrete® and cement. It was observed that the optimum dosage of NovoCrete® and cement for laterites, black cotton soil, and soft clay shown gain in strength only when the NovoCrete® percentage is 2% along with cement. These analyses revealed the formation of hydration products such as CSH, CASH, and ettringite, contributes to denser and more compact soil structures.

5.2 Influence of NovoCrete® ® and cement on soil stabilization

Unconfined Compressive Strength Test: When the cement content was adjusted with 2% of NovoCrete®, there was a remarkable and rapid enhancement in the UCS values when the cement was 10% for all the soils. This enhancement was credited to the pozzolanic reaction facilitated by NovoCrete® and the formation of calcium aluminosilicate hydrate (C-A-S-H). The interaction of released calcium ions with the soil significantly improved its strength and stability. It was observed that the strength values of Laterites exceeded those of other soil types, which might be due to the high silt content in laterite and its higher silica content. These characteristics were responsible for the greater production of C-A-S-H gel, contributing to the substantial strength observed in laterites. The linear shrinkage test shows great results as no shrinkage was observed after the addition of NovoCrete®. Furthermore, no major cracks were seen in the mix was 2% NovoCrete® +cement.

In summary, this study highlights NovoCrete® as a valuable stabilizer, particularly as a secondary additive or activator that enhances the performance of cement as a stabilizing agent. The addition of NovoCrete® alongside even a small amount of cement has been shown to significantly improve the mechanical properties of soils for construction applications. The research identified the optimal dosage of NovoCrete® with cement for each soil type. Furthermore, microstructural analyses shed light on the underlying mechanisms responsible for these enhancements, with a particular focus on the formation of cementitious compounds. These findings offer promising prospects for achieving higher strength with minimal cement usage, making it a sustainable and effective approach to soil stabilization in construction projects.

In the future, the utilization of various sustainable stabilizers like fly ash and GGBS can pave the way for reduced cement usage, positioning NovoCrete® as an eco-friendly stabilizer. These research findings hold substantial significance for the field of soil stabilization in road construction and various civil engineering applications, promising enhanced performance and increased longevity of pavement foundations.

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Conclusion and Recommendation by IIT Palakkad

**Data are taken from IIT Palakkad, IIT Bhubaneswar, IIT Mumbai

Cement Treated Sub-Base (CTSB)

The material used for cementitious (cement treated) sub-base may consist of soil, river bed materials, natural gravel aggregates, reclaimed concrete aggregates, crushed aggregates or soil aggregate mixture modified with different cementitious materials such as cement, lime, lime- flyash, commercially available stabilizers, etc(IRC:37:2018[7]). For use in a sub-base course, the material shall have a grading shown in Table 400.4(mort.250.2013). It shall have a uniformity coefficient not less than 5, capable of producing a well-closed surface finish. For use in a base course, the material shall be sufficiently well graded to ensure a well-closed surface finish and have a grading within the range given in Table. If the material passing 425 micron sieve is plastic, it shall have a liquid limit not greater than 45 percent and a plasticity index not greater than 20 percent determined in accordance with IS:2720 (Part 5). The physical requirements for the material to be treated with cement for use in a base course shall be same as for Grading I Granular Sub-base, Clause 401.2.2(mort.250.2013[400]).

Table 400.4 (mort.250.2013)

Grading Limits of Material for Stabilization with cement

IS sieve size	Percentage by mass passing Sub Base/Base within the range
53.00mm	100
37.5mm	95-100
19.0 mm	45-100
9.5 mm	35-100
4.75 mm	25-100
600 micron	8-65
300 micron	5-40
75 micron	0-10

Quantity of Cement in Cement Treated Sub-Base

The quantity of cement shall be more than 2 percent by weight of cement mix. The mix design shall be done to achieve a strength of 1.75 MPa when tested on cylindrical specimens compacted to the density at optimum moisture content, tested in accordance with IS:2720 (Part 8 as specified in the contract) after 7 days moist curing. The design mix shall indicate the proportions of cement and fly ash and the quantity of water to be mixed (mort.250.2013[400]).

E_{CTSB} = 1000 * UCS Where,

UCS = 28-day unconfined compressive strength (MPa) of the cementitious granular material. It should be ensured that the average laboratory strength value should be more than 1.5 times the required (design) field strength.

E_{CTSB} = Elastic modulus (MPa) of 28-day cured CTSB material

CTSB with grading IV of IRC:SP:89[28] having strength in the range 0.75-1.5 MPa is not recommended for major highways but it can be used for roads with design traffic less than 10 msa. When the CTSB with UCS in the range of 0.75 to 1.5 MPa is used its modulus value may be taken as 400 MPa as specified in IRC:SP:89 (Part II)[27]. (IRC:37:2018[7])

The pavement thickness should be based on 4-day soaked CBR value of the soil.(IRC:37:2018[6])and recommended minimum thickness for CTSB layer is 200 mm.(IRC:37:2018[7])

Weather Limitations

Stabilization shall not be done when the air temperature in the shade is less than 10ºC (mort.250.2013[400]).

Cement Treated Base (CTB)

Cemented base layers consist of aggregates, reclaimed asphalt material, crushed slag, crushed concrete aggregates or soil-aggregate mixture stabilized with chemical stabilizers such as cement, lime, lime-fly ash or other commercially available stabilizers which can produce mix of requisite strength.

The aggregate gradation for CTB shall be as given in table 400-4 of MoRTH Specifications[23]. The CTB material shall have a minimum UCS of 4.5 to 7 MPa as per IRC:SP:89 in 7/28 days since the strength gain in such materials is a slow process. Low grade aggregates such as moorum and kankar may give lower modulus at lower cement contents. Fine grained soil may require larger quantity of cementitious additive for higher strength and may develop wider cracks upon curing.(IRC:37-2018)

Poisson's ratio value of CTB material may be taken as 0.25

Table 400.4 (mort.250.2013)

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19.0 mm	45-100
9.5 mm	35-100
4.75 mm	25-100
600 micron	8-65
300 micron	5-40
75 micron	0-10

The modulus of rupture (MRUP) or flexural strength of the CTB material is required for carrying out fatigue damage analysis of the cement treated base. The values of modulus of rupture (MPa) for cementitious bases may be taken as 20 per cent of the 28-day UCS value (MPa)[12] subject to the following limiting (maximum) values:

- Cementitious stabilized aggregates - 1.40 Mpa
- Lime-flyash-soil - 1.05 Mpa
- Soil-cement - 0.70 Mpa

Flexural Strength is approximately 1.5 times the ITS value for cement bound aggregates. (IRC:37-2018)(Clause 8.2.2)

The minimum quantity of cementitious material in the bound base layer should be such that in a wetting and drying test (BIS: 4332 Part-IV[29], the loss of weight of the stabilized material does not exceed 14 % after 12 cycles of wetting and drying. In cold and snow bound regions like Arunachal Pradesh, Jammu & Kashmir, Ladakh, Himachal Pradesh etc., durability should also be evaluated by freezing and thawing test and the loss of weight should be less than 14 % after 12 cycles as per BIS:4332 Part-IV. (IRC:37-2018)

Novocrete satisfy the Technical Requirement of MoRTH/IRC

Full Depth Reclaimation (FDR)

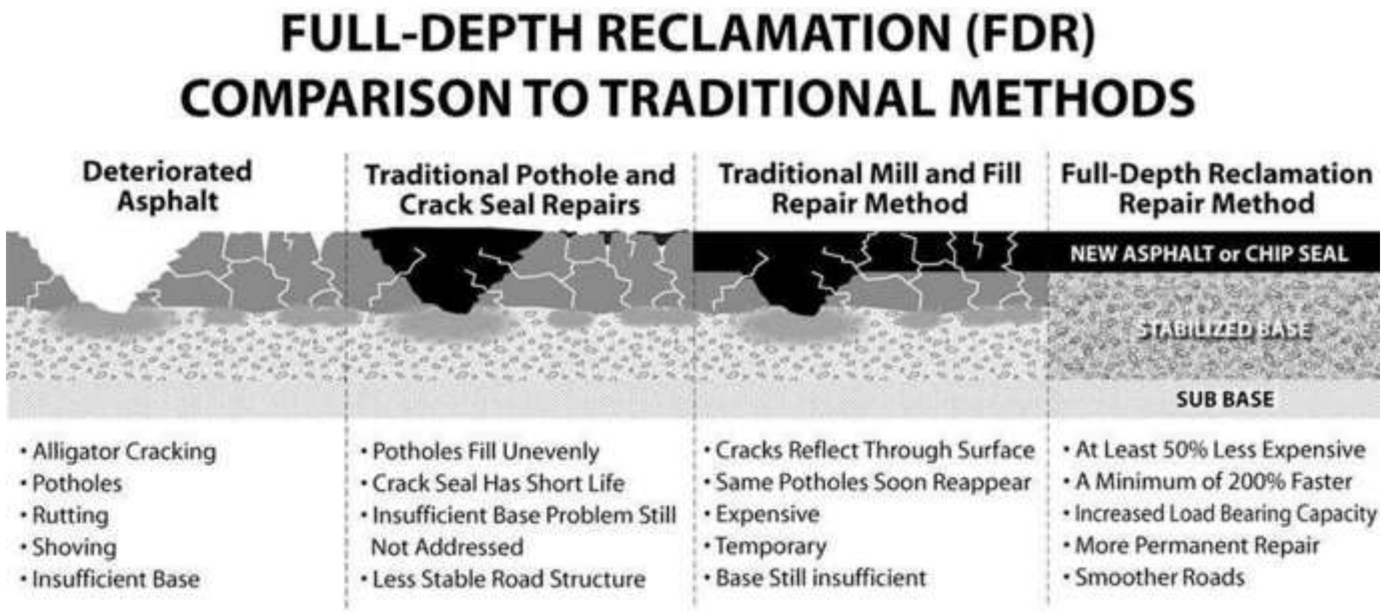
Full Depth Reclamation (FDR) is basically a cold mix recycling process,with or without fresh materials, in which different types of additives such as foam bitumen, bituminous emulsions and chemical agents such as cement, fly ash, and lime, including commercially available cementitious stabilizers are added, mostly in-situ, and compacted to obtain an improved base.The four main steps in this process are pulverization, introduction of additive, mixing, compaction, and application of a surface or a wearing course. (IRC:120-2015)

- Pulverization should produce minus 40 mm size and should conform to the gradation as per IRC 37 and in Table 400.4(mort.250.2013) for the purpose of stabilization.

- The Sand Equivalent (SE) value from the combined materials should not be less than 30%.

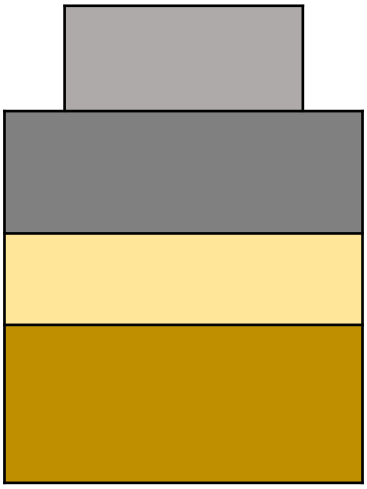
- Emulsion content, in case of bitumen stabilization should be such that indirect tensile strength in dry and wet conditions (100 mm specimen) is more than 225 KPa and 100 KPa respectively and voids in the range of 6–8%.
- Resilient modulus for all stabilized material should be in accordance with the IRC 37.

- Stabilization should be done in-situ with suitable plants and equipment. Where it is not possible to have these plants and equipment (for smaller jobs), WMM plant can be used for mixing.

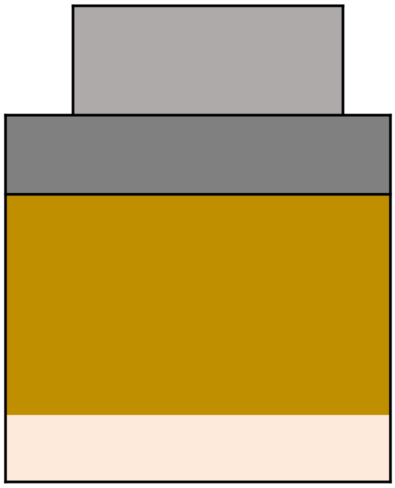


NovoCrete® in Pavement Crust Comparison (Bitumen Road) 50 MSA, 7% CBR

Conventional Pavement



NovoCrete® Pavement

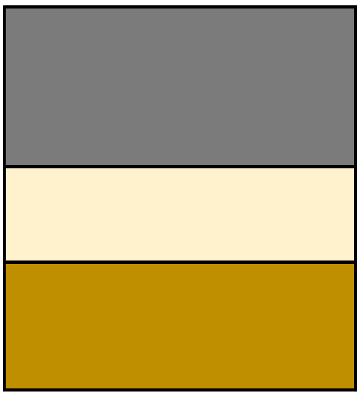


Conclusion:-

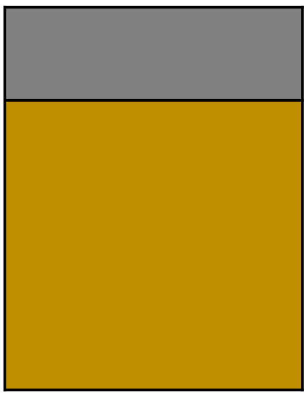
- Saving in Construction Cost - 20%
- Saving in Maintenance Cost during DLP – 50%
- Less Rutting, More Fatigue life with equivalent composition.

Design and Construction of Steel Slag road with *NovoCrete®*

Conventional Pavement



EAF Steel Slag and NovoCrete® Pavement



Conclusion:-

- Similar Design life.
- Saving in Construction Cost – 20%
- Waste Steel Slag utilization (90-100%), Replacing stone Aggregate.
- Converting Waste to Wealth

Lab

(At Mahnar Bachhwara near NH122B Hazipur (Bihar)

NovoCrete® Soil Stabilization Technology

KKS GLOBAL INFRA

Seiving

Compaction of Cube by Proctor Hammer

Moulding of Cube

Moulded Cube

Cube

UCS Test of Cube

Sr No	Soil Description	Mix	OMC (%)	MDD (gm/cc)	Load (Kn)	7 days strength Mpa	Avg. Mpa
1	Ganga Sand(70%) + 30% Soil (Borrow Area)	Sample +Cement content10%+2% Additive	9	1.844	46	2.04	3
					62	2.76	
					73	3.24	
2	70% Ganga Sandy Soil+ 30% soil (Borrow Area)	Sample+ Cement content12%+ 2% Additive	9	1.844	97	4.31	4.42
					102	4.53	
3	50% Ganga Sandy Soil +20%agg(10mm down)+ 30% soil (Borrow Area)	Sample+ Cement content 14% + 2% Additive	9	2.01	119	5.28	5.26
					127	5.64	
					109	4.84	
4	55% Ganga Sand+15%agg(12mm down)+ 30% soil (Borrow Area)	Sample+ Cement content 12% + 2% Additive	9	2.05	95.5	4.24	4.35
					102	4.53	
					96	4.26	

NovoCrete®
Soil Stabilization Technology

Lab

(At Prayagraj)

KKS GLOBAL INFRA

Gradation of Soil

Oven Drying

CBR Test

CBR Test

CBR

Compaction of Cube by Proctor Hammer

Weighing of Cube

UCS Test of Cube

Experience: > 22 years - projects: > 1.000 - countries: > 50

Lab Report

(At Prayagraj)

Ram Path

Sr No.	Soil Description	Mix	Cement (%)	OMC (%)	MDD (gm/cc)	Load (Kn)	7 days strength Mpa	Avg. Mpa
1	60% Ganga sand + 10% soil + 30% Aggregate (10 mm down)	Sample+ Cement content 5% + 2% Additive	5	8	2.0`	55	2.44	1.97
	60% Ganga sand + 10% soil + 30% Aggregate (10 mm down)		5	8	2.0`	33	1.47	
	60% Ganga sand + 10% soil + 30% Aggregate (10 mm down)		5	8	2.0`	45	2	
2	60% Ganga sand + 10% soil + 30% Aggregate (10 mm down)	Sample+ Cement content 5.5% + 2% Additive	5.5	8.2	2.0`	49	2.18	2.18
	60% Ganga sand + 10% soil + 30% Aggregate (10 mm down)		5.5	8.2	2.0`	51	2.27	
	60% Ganga sand + 10% soil + 30% Aggregate (10 mm down)		5.5	8.2	2.0`	47	2.09	
3	60% Ganga sand + 10% soil + 30% Aggregate (10 mm down)	Sample+ Cement content 7% + 2% Additive	7	8	2.03	95	4.22	4.50
	60% Ganga sand + 10% soil + 30% Aggregate (10 mm down)		7	8	2.03	105	4.67	
	60% Ganga sand + 10% soil + 30% Aggregate (10 mm down)		7	8	2.03	104	4.62	
4	60% Ganga sand + 10% soil + 30% Aggregate (10 mm down)	Sample+ Cement content 8% + 2% Additive	8	8	2.04	85	3.78	5.1
	60% Ganga sand + 10% soil + 30% Aggregate (10 mm down)		8	8	2.04	109	4.84	
	60% Ganga sand + 10% soil + 30% Aggregate (10 mm down)		8	8	2.04	150	6.67	
5	60% Ganga sand + 10% soil + 30% Aggregate (10 mm down)	Sample+ Cement content 9% + 2% Additive	9	8.2	2.02	81	3.6	5.48
	60% Ganga sand + 10% soil + 30% Aggregate (10 mm down)		9	8.2	2.02	155	6.89	
	60% Ganga sand + 10% soil + 30% Aggregate (10 mm down)		9	8.2	2.02	134	5.96	

MoRTH

Sr No.	Soil Description	Mix	OMC(%)	MDD(gm/cc)	Load (Kn)	7 days strength Mpa	Avg. Mpa
1	70% sand (yamuna sand) + 30% soil	Sample+ Cement content 5% + 2% Additive	10	2.02	32.2	4	2.69
					31.1	1.38	
					21.8	0.97	
3	70% sand (yamuna sand) + 30% soil	Sample+ Cement content 9% + 2% Additive	10	2.02	90.1	4	4.27
					102.2	4.54	

NovoCrete®
Soil Stabilization Technology

Lab Report

(At Ahmedabad)

KKS GLOBAL INFRA


Taking Soil Sample


Soil Permeability Test


Compaction of Cube by Proctor Hammer


Soil Mix Preparation


Casted cubes

Gradation

Seive Size (mm)	Percent by mass passing Sub Base/Base within the range
10	100
4.75	98.12
2.36	95.23
1.18	87.69
0.6	59.11
0.3	28.76
0.15	7.71
0.075	3.3

UCS Test Result

Sr No.	Soil Description	Mix	OMC(%)	MDD(gm/cc)	Load (Kn)	7 days strength Mpa	Avg. Mpa
1	Mundra sand	Sample + cement 6% + 2% Additive	5.8	1.99	65.5	2.91	2.70
					56	2.49	
2	Mundra sand	Sample + cement 8% + 2% Additive	9.5	2.03	73	3.24	3.17
					69.5	3.09	
3	Mundra sand	Sample + cement 10% + 2% Additive	10.5	2.04	79	3.51	3.41
					74.5	3.31	

NovoCrete®
Soil Stabilization Technology

Lab Report

(At Raichur)

KKS GLOBAL INFRA

Taking Black soil Sample

Mixing of Black soil + cement + Novocrete

Curing of Black soil cube

UCS Test Result

Sr. No.	Soil Description	Mix	OMC(%)	MDD(gm/cc)	Load (Kn)	7 days strength Mpa	Avg. Mpa
1	Black Cotton Soil	Sample + Cement 2% + 2% Additive	15.73	1.79	27	1.20	1.28
					29	1.31	
					30	1.33	
2	Black Cotton Soil	Sample + Cement 4% + 2% Additive	11.3	1.89	38	1.68	1.67
					37	1.63	
					38	1.69	
3	Black Cotton Soil	Sample + Cement 6% + 2% Additive	15.6	1.86	66	2.92	2.91
					68	3.01	

Chemical Test Report (Black Cotton Soil)

Sr. No.	Property	Units	Result Obtained
1	Ph	-	7.56
2	Electrical Conductivity(1:2.5)	Micro Mhos/cm	812
3	Sulphate(as So4)	%wt./wt.	0.038
4	Organic Matter	%wt./wt.	0.85
5	Texture	-	Clayey silt with Gravels
6	Nitrogen (as N)	%wt./wt.	0.12
7	Phosphorous	%wt./wt.	0.012

Black Cotton Soil

Sr. No.	Properties	Unit	Value
1	**Liquid Limit**	%	30.4
2	**Plastic Limit**	%	13.51
3	**Plasticity index**	%	16.89
4	**Free Swell Index**	%	80

NovoCrete®
Soil Stabilization Technology

Lab

(At Balaghat - Gondiya)

KKS GLOBAL INFRA

Shoulder

Borrow Area

Gradation of Aggregate

Taking Sample

Wet Gradation

Seiving

Making of Mould

Moulding

Moulding and Curing

NovoCrete®
Soil Stabilization Technology

Lab Report

(At Balaghat - Gondiya)

KKS GLOBAL INFRA

UCS TEST ON WMM + GSB + SOIL										
Sr No.	**Trial no.**	**Soil Description**	**Mix**	**Cement (%)**	**OMC (%)**	**NMC(%)**	**MDD (gm/cc)**	**Load (Kn)**	**7 days strength Mpa**	**Avg. Mpa**
1	Trial no 01	45% (WMM+GSB) + 55% SOIL	Sample+ Cement content 6% + 3% Additive	6	6.74	0.00	2.21	127	5.64	5.60
		45% (WMM+GSB) + 55% SOIL		6	6.74	0.00	2.21	119	5.29	
		45% (WMM+GSB) + 55% SOIL		6	6.74	0.00	2.21	132	5.87	
2	Trial no 02	45% (WMM+GSB) + 55% SOIL	Sample+ Cement content 8% + 2% Additive	8	7.03	0.00	2.27	104	4.62	3.75
		45% (WMM+GSB) + 55% SOIL		8	7.03	0.00	2.27	91	4.04	
		45% (WMM+GSB) + 55% SOIL		8	7.03	0.00	2.27	58	2.58	
3	Trial no 03	45% (WMM+GSB) + 55% SOIL	Sample+ Cement content 5% + 2% Additive	5	6.62	0.00	2.25	111	4.93	4.58
		45% (WMM+GSB) + 55% SOIL		5	6.62	0.00	2.25	112	4.98	
		45% (WMM+GSB) + 55% SOIL		5	6.62	0.00	2.25	86	3.82	
4	Trial no 04	45% (WMM+GSB) + 55% SOIL	Sample+ Cement content 7% + 2% Additive	7	7.01	0.00	2.28	90	4.00	4.03
		45% (WMM+GSB) + 55% SOIL		7	7.01	0.00	2.28	95	4.22	
		45% (WMM+GSB) + 55% SOIL		7	7.01	0.00	2.28	87	3.87	

Gradation of Trial Sample					
Sieve Size (mm)	**% Passing Trial no-1**	**% Passing Trial no-2**	**% Passing Trial no-3**	**% Passing Trial no-4**	**Specification Limits As per MoRTH Table No 400-4**
					Zone I
53	100	100	100	100	100
37.5	98.56	96.59	97.57	96.62	95-100
19	83.36	82.53	84.19	83.35	45-100
9.5	60.8	62.02	63.02	63.26	35-100
4.75	46.6	45.20	45.67	45.30	25-100
0.6	14.76	15.61	15.76	16.01	8-65
0.3	7.96	8.64	8.33	8.41	5-40
0.075	5.36	5.52	5.20	5.36	0-10

NovoCrete®
Soil Stabilization Technology

Lab Report

(At JSWBPSL, Jharsuguda)

KKS GLOBAL INFRA

Use of Waste Iron Slag for Rigid Pavement Construction in JSW Plant at Jharsuguda


Milling


Rolling


Groove Cutting


Construction of Pavement


Finishing of Pavement

UCS Test Result

Sr. No.	Sample Description	Mix	Cube Wt. (Kg)	Load (Kn)	7 days strength Mpa	Avg. Mpa	Cube Wt. (Kg)	Load (Kn)	28 days strength Mpa	Avg. Mpa
1	20mm Slag + 10mm Slag + 6mm Dust + Sand	Sample + Cement + 2% Additive	9.114	610	27.11	27.85	9.346	950	42.22	43.55
			9.3	540	24		9.342	1010	44.88	
			9.242	730	32.44		9.528	980	43.55	
2	20mm Slag + 10mm Slag + 6mm Dust + Sand	Sample + Cement + 2% Additive	9.29	520	23.11	26.07	9.344	910	40.44	41.33
			9.392	640	28.44		9.312	890	39.55	
			9.274	600	26.66		9.514	990	44	

Lab

(At Mooratganj in Kaushambi)

Milling/ pulverization

Mixing

Grading and Rolling

FDR Specialist

Finished Base

Core Cutting for Testing

NovoCrete® Soil Stabilization Technology

Lab Report

(At Mooratganj in Kaushambi)

KKS GLOBAL INFRA

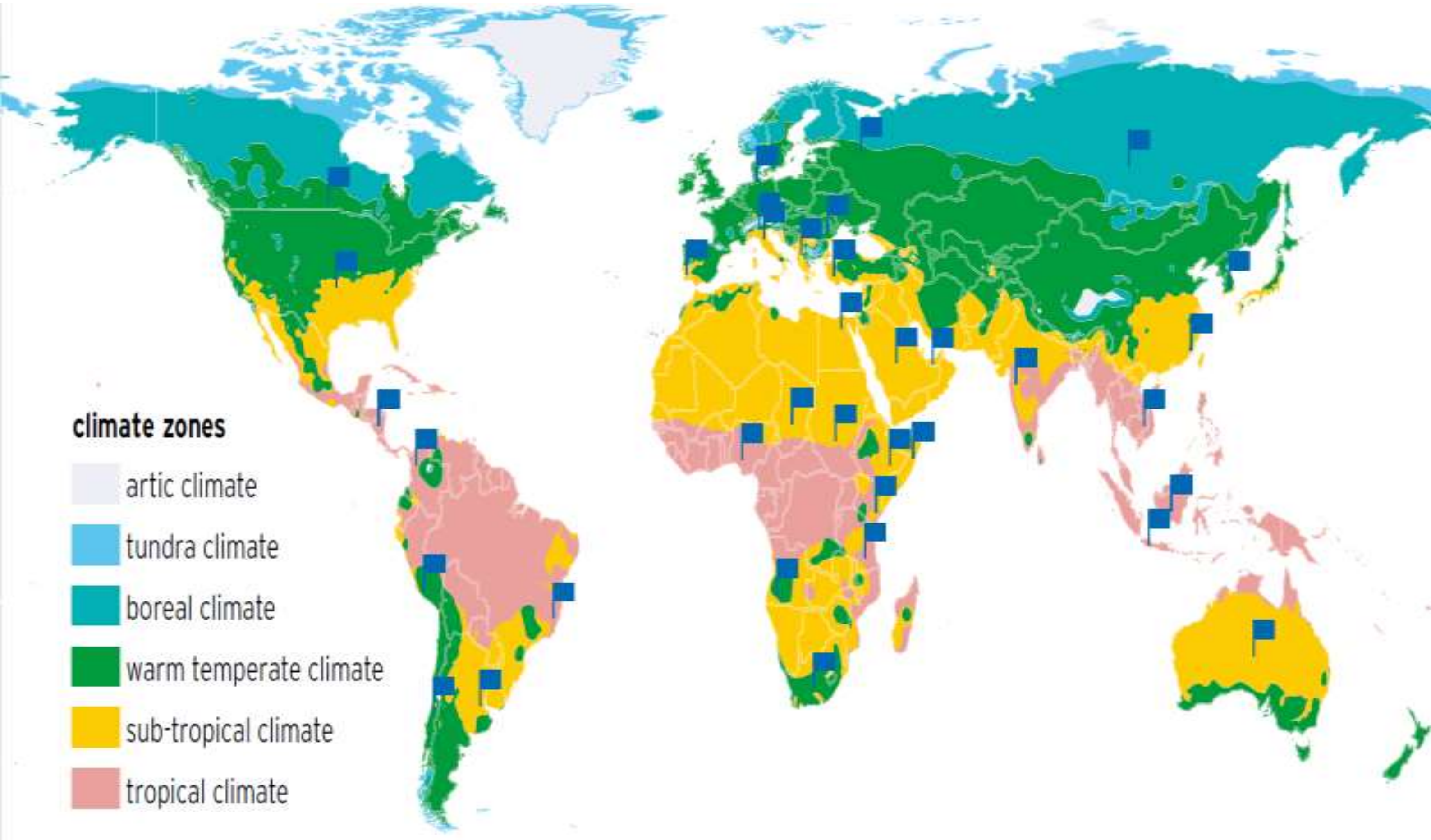
UCS TEST FOR CTB

Sr No.	Trial no.	Sample No.	Date of Casting	Material Description	Mix	Cement (%)	OMC (%)	MDD (gm/cc)	Date of testing	Days	Load (Kn)	Strength (Mpa)	Avg. Strength
		T1	11/8/2024	70% Existing WMM/GSB + 20% RAP +10% Sand		4	7.23	2.19	11/15/2024	7	105	4.67	
		T2	11/8/2024	70% Exisiting WMM/GSB + 20% RAP +10% Sand		4	7.23	2.19	11/15/2024	7	112	4.98	4.74
		T3	11/8/2024	70% Exisiting WMM/GSB + 20% RAP +10% Sand		4	7.23	2.19	11/15/2024	7	103	4.58	
		T4	11/8/2024	70% Exisiting WMM/GSB + 20% RAP +10% Sand		4	7.23	2.19	11/22/2024	14	120	5.33	
1	Trial no 01	T5	11/8/2024	70% Exisiting WMM/GSB + 20% RAP +10% Sand	Sample+ Cement content 4% + 2% Additive	4	7.23	2.19	11/22/2024	14	122	5.42	5.51
		T6	11/8/2024	70% Exisiting WMM/GSB + 20% RAP +10% Sand		4	7.23	2.19	11/22/2024	14	130	5.78	
		T7	11/8/2024	70% Exisiting WMM/GSB + 20% RAP +10% Sand		4	7.23	2.19	12/6/2024	28	135	6.00	
		T8	11/8/2024	70% Exisiting WMM/GSB + 20% RAP +10% Sand		4	7.23	2.19	12/6/2024	28	133	5.91	6.03
		T9	11/8/2024	70% Exisiting WMM/GSB + 20% RAP +10% Sand		4	7.23	2.19	12/6/2024	28	139	6.18	
		T1	11/14/2024	70% Exisiting WMM/GSB + 20% RAP +10% Sand		4	7.23	2.19	11/21/2024	7	111	4.93	
2	Trial no 02	T2	11/14/2024	70% Exisiting WMM/GSB + 20% RAP +10% Sand	Sample+ Cement content 4% + 2% Additive	4	7.23	2.19	11/21/2024	7	122	5.42	4.86
		T3	11/14/2024	70% Existing WMM/GSB + 20% RAP +10% Sand		4	7.23	2.19	11/21/2024	7	95	4.22	

Gradation of Trail Sample

Seive Size(mm)	Wt. retained in each sieve(g)	Percentage on each Sieve	Cumulative Percent Retained	Percent Finer
53	0	0	0	100
37.5	51	1	1	99.11
19	1751	30	31	68.66
9.5	1161	20	52	48.47
4.75	739	13	64	35.62
0.6	677.00	12	76	23.84
0.3	387.00	7	83	17.11
0.075	788.00	14	97	3.41
Pan	190.00	3		

NovoCrete® - usage worldwide



THANK YOU

Pl feel free to reach out to us

Contact us for:- Stabilization Additive, Design of Pavement & Execution of Pavement

Add:-Tower-B, B-111,1st floor, Noida One, Plot no:8, Block-B, Sector-62, Noida, District - Gautam Budh Nagar, Pincode-201309