JINDAL STEEL & POWER LTD.

BLAST FURNACE SLAG
PS BALL
JINDAL GLOBAL ROAD STABILISER-JGRS
JSPL CONSTRUCTION MATERIALS

• BLAST FURNACE SLAG
• P S BALLS
• JGRS
BLAST FURNACE SLAG

- **Blast Furnace Slag** is formed when iron ore or iron pellets, coke and a flux (either limestone or dolomite) are melted together in a blast furnace.

- When the metallurgical smelting process is complete, the lime in the flux has been chemically combined with the aluminates and silicates of the ore and coke ash to form a non-metallic product called blast furnace slag.

- During the period of cooling and hardening from its molten state, BF slag can be cooled in several ways to form several types of BF slag products.
Blast Furnace:

Blast Furnace: Combustion material and ore are supplied from the top while an air flow is supplied from the bottom of the chamber. This forces the chemical reaction to take place throughout the ore, not only at the surface.
TYPES OF B F SLAG

• Blast Furnace Slag can be divided in following types depending upon way of cooling & mesh size:
  
  ❖ Granulated Slag
  ❖ Cementitious Slag
  ❖ Air cooled Slag
  ❖ Air cooled blast furnace quote
  ❖ Air cooled blast furnace slag rip rap
  ❖ Expanded Slag or Pelletized Slag
APPLICATIONS OF B F SLAG

• Blast Furnace Slag can be utilized in following applications:

  ❖ Highways in a Flexible Pavement
    • Sub-Base
    • Base
    • Binder Layer as aggregates

  ❖ Concrete Aggregates
    • Coarse Aggregates
    • Fine Aggregates

  ❖ Cementitious Applications
    • Blended Cement
    • Raw material for Cement manufacturing
UTILIZATION OF BLAST FURNACE SLAG

- Blast Furnace Slag
  - Use of B F Slag in Construction of Road
    - Aggregate in Flexible Pavement
      - Earth fill, Sub-Base, Base
        - Asphalt Concrete
    - Concrete Aggregate
      - Fine Aggregate
    - Cementitious Applications
      - Blended Cement
      - Raw Material for Cement Manufacturing
      - Coarse Aggregate
GRANULATED SLAG

• **Granulated slag** is rapidly cooled by large quantities of water to produce a sand-like granule that is primarily ground into a cement commonly known as GGBS (Ground Granulated Blast Furnace Slag. It is also mixed with Portland cement clinker to make a blended Slag cement.
Blast furnace slag is allowed to slowly cool by ambient air, is processed through a screening and crushing plant and is processed into many sizes for use primarily as a construction aggregate. Common uses are as aggregates in ready-mix concrete, precast concrete, hot mix asphalt aggregate, septic drain fields and pipe backfill.
EXPANDED SLAG

- Pelletized or Expanded Slag is quickly cooled using water or steam to produce a lightweight aggregate that can be used for high fire-rated concrete masonry and lightweight fill applications over marginal soils. Due to its reduced weight, it is perfectly suited for aggregate in lightweight concrete masonry, lightweight ready-mix concrete and lightweight precast concrete.
AIR COOLED BLAST FURNACE QUOTE

• This smaller sized aggregate is primarily used in chip and seal applications, also known as "Chip Seal" or "Aggregate Seal Coating", applied to existing pavement surfaces. The primary purpose for Chip and Seal is to achieve a skid resistance on rural pavements and to maximize driving safety. It is also used in concrete masonry, concrete pavement, and hot mix asphalt.
AIR COOLED BLAST FURNACE SLAG RIP RAP

• The largest slag aggregate, riprap is a permanent cover of rock used to stabilize shorelines and stream banks, and prevent erosion along slopes and embankments. It is also used in gabion baskets, Mineral Wool manufacture (insulation), and lightweight fill.
SLAG CEMENT

• Slag cement is commonly found in ready-mix concrete, precast concrete, masonry, soil cement, concrete wallboard, floor leveling compounds and high temperature resistant building products. Its measurable benefits in concrete include improved workability and finish ability, high compressive and flexural strengths, and resistance to aggressive chemicals.
V. PS BALL

PS BALL
SLAG ATOMIZING TECHNOLOGY

diamond Slag Atomizing Technology (SAT)

Tapping

Transporting

ATOMIZING

Process Completed in
TWO HOURS

Yard Work

Delivery

Sieving & Packing

ECOMAISTER

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PS BALL-APPLICATIONS

P S Balls can be used in the construction of Sub-grade, Sub-base & base layers for the following applications:

• Asphalt Pavement- As fine aggregate
• Concrete Making- As fine aggregate
• Easy walk- Passenger path
JINDAL GLOBAL ROAD STABILISER-JGRS
(An Environment Friendly Inorganic Powder based Road stabilizer)
JGRS-INTRODUCTION

- JGRS is a unique & innovative product developed by JSPL & GCS, South Africa for stabilization of wide spectrum of soil/locally available marginal materials in an efficient & cost effective manner.

- JGRS is an inorganic hydration activated powder based soil stabilizer.

- Environment friendly Non-toxic soil stabilizer.
JGRS-USES

JGRS can be used for construction of following pavement layers in Highway/Road construction:

- Stabilized Sub-grade
- Stabilized Sub-base
- Stabilized Base
- Cold Recycling/Rehabilitation of Existing Pavement to create a strong base
JGRS-APPLICATIONS

JGRS can be used in the construction of Sub-grade, Sub-base & base layers for the following applications:

- Highways
- High altitude Roads
- Haul/Mines Roads
- Parking lots
- Airstrips, Runways, Taxiways & Helipads
- Forest roads/Rural roads/Un-surface roads
- Railways
- Ports & docks
- Rehabilitation of existing roads/highways
ADVANTAGES

• Conservation of natural resources
• Elimination/Reduction in aggregate requirement
• Reduction in Pavement thickness
• Utilization of Locally available soil/marginal materials
• Reduction in transportation cost
• Resistant to permeability comparing with granular layers
• Quick method of construction
• Non-toxic & Non hazardous material
• Environment friendly technique
• No special equipment is required
IMPROVEMENT IN SOIL PROPERTIES - JGRS

JGRS helps in improving the properties of soil in a road project are as listed below:

- Reduction in plasticity index of soil
- Reduces swell potential of soil
- Increase in CBR, UCS & durability of soil
- Creates a fully bound layer which is less susceptible to moisture ingress comparing with the conventional granular layers
- Makes the soil/material more friable & workable
LABORATORY TEST REPORTS

JGRS has been tested by various reputed institutes in India as well as abroad as mentioned below:

- **Domestic References (INDIA)**
  - IIT Kharagpur
  - IIT Roorkee
  - CRRI, New Delhi
  - National Environment Engineering Research Institute, Nagpur
  - SGS India Pvt Ltd, Gurgaon

- **International Reference**
  - Road Lab, Civil Engineering Materials Laboratory, Republic of South Africa
# LAB TEST RESULTS

## Summary of Test Results of JGRS with different types of soil

<table>
<thead>
<tr>
<th>JGRS Stabiliser %</th>
<th>CRRI</th>
<th>IIT Kharagpur</th>
<th>IIT Roorkee</th>
<th>Road Lab, RSA</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>6%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SOIL TYPE</th>
<th>CRRI</th>
<th>IIT Kharagpur</th>
<th>IIT Roorkee</th>
<th>Road Lab, RSA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay (CL)</td>
<td>-</td>
<td>3.6</td>
<td>66.8</td>
<td>74</td>
</tr>
<tr>
<td>Clay (CL)</td>
<td>-</td>
<td>2.7</td>
<td>60.9</td>
<td>95.3</td>
</tr>
<tr>
<td>Silt</td>
<td>12</td>
<td>-</td>
<td>5.4</td>
<td>29.6</td>
</tr>
<tr>
<td>Sand</td>
<td>-</td>
<td>-</td>
<td>14.7</td>
<td>97.8</td>
</tr>
<tr>
<td>Gravel</td>
<td>-</td>
<td>-</td>
<td>29</td>
<td>140</td>
</tr>
</tbody>
</table>

## UCS (Kg/cm²)

<table>
<thead>
<tr>
<th>JGRS Stabiliser %</th>
<th>CRRI</th>
<th>IIT Kharagpur</th>
<th>IIT Roorkee</th>
<th>Road Lab, RSA</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>6%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SOIL TYPE</th>
<th>CRRI</th>
<th>IIT Kharagpur</th>
<th>IIT Roorkee</th>
<th>Road Lab, RSA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay (CL)</td>
<td>-</td>
<td>7.3</td>
<td>29.7</td>
<td>24.9</td>
</tr>
<tr>
<td>Clay (CL)</td>
<td>-</td>
<td>1.9</td>
<td>23.8</td>
<td>32.7</td>
</tr>
<tr>
<td>Silt</td>
<td>16.3</td>
<td>-</td>
<td>1.8</td>
<td>13.8</td>
</tr>
<tr>
<td>Sand</td>
<td>-</td>
<td>-</td>
<td>0.38</td>
<td>4.8</td>
</tr>
<tr>
<td>Gravel</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>12</td>
</tr>
</tbody>
</table>
DURABILITY

• Durability tests were conducted by CRRI, New Delhi for evaluation of improvement of stabilized soils. Durability behaviour of JGRS stabilized samples were determined by carrying out wetting & drying tests on stabilized samples as per IS:4332 (Part-4)-1978.

<table>
<thead>
<tr>
<th>Soil Stabilizer Mix</th>
<th>Soil- JGRS loss (%) of stabilized samples</th>
<th>Permissible Soil-stabiliser loss (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compositions of Mix</td>
<td>Soil + 4% stabilizer</td>
<td>Soil + 6% stabilizer</td>
</tr>
<tr>
<td>Silt + JGRS</td>
<td>4.0</td>
<td>3.0</td>
</tr>
</tbody>
</table>
DOSAGE OF JGRS

Dosage of JGRS depends on several factors as listed below:

- Design life of road
- Traffic requirements
- Climatic conditions
- Type of soil
- Condition of existing pavement (In case of rehabilitation of an existing road)

Note: However, typical application range of JGRS varies from 2% to 8% (For Sub-base JGRS varies from 2-3% & for Base varies from 4-5%)
FACILITY & TECHNOLOGY

1. MANUFACTURING FACILITY

- JGRS is currently manufactured in JSPL-Raigarh with a capacity of 90 Metric tones/hour which can a production in excess of 1,00000 tones/year.

2. MODERN STABILIZER/RECYCLER MACHINE

- The modern soil stabilizer/recycler machine has been brought from one of the reputed road equipment manufacturer (Wirtgen Group) for efficient mixing of soil with JGRS with provisions for administering required amount of water to achieve optimum moisture content in the field.
CONSTRUCTION METHODOLOGY

• SOIL STABILIZATION
  ➢ In-situ soil stabilization
  ➢ In-Plant soil stabilization

• COLD RECYCLING
  ➢ Cold In-situ recycling
  ➢ Cold In-Plant recycling
IN-SITU STABILIZATION/RECYCLING
IN-PLANT STABILIZATION/RECYCLING

Feeders for Soil/Locally available materials

Mixer

Silo for JGRS
IN-PLANT STABILIZATION/RECYCLING
**CALCULATION OF JGRS**

JGRS can be calculated in terms of kg/m² & total quantity required for construction of an area depending upon the depth of layer & MDD of soil/materials by using a simple calculation sheet as shown below:-

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Layer Thickness (mts):</td>
</tr>
<tr>
<td>B</td>
<td>% Application (Dosage/Percentage of JGRS):</td>
</tr>
<tr>
<td>C</td>
<td>Length of Road (mts):</td>
</tr>
<tr>
<td>D</td>
<td>Width of Road (mts):</td>
</tr>
<tr>
<td>E</td>
<td>Area of Road (m²)= C x D</td>
</tr>
<tr>
<td>F</td>
<td>Max. Dry Density of Soil/Materials (kg/m³)= From Lab Reports</td>
</tr>
<tr>
<td>G</td>
<td>JGRS needed for every 1m sq (kg/m²)= (F X A) X (B/100)</td>
</tr>
<tr>
<td>H</td>
<td>Total JGRS required for area (tonnes)= (G X E)/1000</td>
</tr>
<tr>
<td>I</td>
<td>Number of One Tonne bags required= H/(1000/1000)</td>
</tr>
<tr>
<td>J</td>
<td>Number of 20 kg bags required= I/(20/1000)</td>
</tr>
<tr>
<td>K</td>
<td>Spacing between One Tonne Bags (m)= C/I</td>
</tr>
<tr>
<td>L</td>
<td>Spacing between 20 kg Bags (m)= C/J</td>
</tr>
</tbody>
</table>

Note:- Kindly note that quantities of JGRS are based upon MDD of soil/materials, In case there is any change in the soil/materials MDD the quantity of JGRS will change according to the MDD of soil.
PROJECTS

To date a few projects where JGRS has been used in India & abroad in Sub-Base & Base layer with proven performance records under extreme traffic conditions:

❖ Domestic References:
  ➢ GMR Infrastructure, Angul (Odisha)
  ➢ Industrial Roads, JSPL, Angul (Odisha)
  ➢ Industrial & Mines Roads, JSPL, Barbil (Odisha)
  ➢ State Highway, Tamnar-Raigarh (Chhattisgarh)
  ➢ Urja Nagar residential complex, JPL, Tamnar (Chattisgarh)
  ➢ Residential Complex, Jindal Global city, Sonepat (haryana)

❖ International References:
  ➢ Keipersol mines, South Africa
  ➢ Shadeed iron & steel, Oman
  ➢ Mozambique
  ➢ Bollivia
ANGUL (ODISHA)
BARBIL (ODISHA)
TAMNAR (CHATTISGARH)
SONEPAT (HARYANA)
SOUTH AFRICA

KEIPERSOL MINES
MOZAMBIQUE
CONVENTIONAL VS JGRS METHOD

CONVENTIONAL METHOD - PAVEMENT TYPE - 1

PAVEMENT TYPE - 4 (PAVEMENT DESIGN USING JGRS)
### CONVENTIONAL METHOD WITH GRANULAR LAYERS (PAVEMENT CRUST AS PER IRC:37-2012, PLATE 3, 4 Lane)

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Carriageway Length</th>
<th>Item</th>
<th>Unit</th>
<th>No.</th>
<th>Width</th>
<th>Depth</th>
<th>Quantity</th>
<th>Rate</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1000.000</td>
<td>BC Laying</td>
<td>Cum</td>
<td>2</td>
<td>8.500</td>
<td>0.040</td>
<td>680.00</td>
<td>11,000.00</td>
<td>74,80,000.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DBM Laying</td>
<td>Cum</td>
<td>2</td>
<td>8.500</td>
<td>0.115</td>
<td>1,955.00</td>
<td>10,000.00</td>
<td>1,95,50,000.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tack Coat over Bituminous Course</td>
<td>Sqm</td>
<td>2</td>
<td>8.500</td>
<td></td>
<td>17,000.00</td>
<td>14.00</td>
<td>2,38,000.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tack Coat over Prime Coat</td>
<td>Sqm</td>
<td>2</td>
<td>8.500</td>
<td></td>
<td>17,000.00</td>
<td>22.00</td>
<td>3,74,000.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Prime Coat</td>
<td>Sqm</td>
<td>2</td>
<td>8.500</td>
<td></td>
<td>17,000.00</td>
<td>44.00</td>
<td>7,48,000.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WMM Laying</td>
<td>Cum</td>
<td>2</td>
<td>8.730</td>
<td>0.250</td>
<td>4,365.00</td>
<td>2,200.00</td>
<td>96,03,000.00</td>
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<tr>
<td></td>
<td></td>
<td>GSB Laying</td>
<td>Cum</td>
<td>1</td>
<td>28.220</td>
<td>0.300</td>
<td>8,466.00</td>
<td>1,500.00</td>
<td>1,26,99,000.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Subgrade Laying</td>
<td>Cum</td>
<td>1</td>
<td>29.820</td>
<td>0.500</td>
<td>14,910.00</td>
<td>300.00</td>
<td>44,73,000.00</td>
</tr>
</tbody>
</table>

**TOTAL COST OF CONVENTIONAL PAVEMENT**: 5,51,65,000.00
### JGRS Method with Stabilized Layers (Pavement Crust as per IRC:37-2012, Plate 14)

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Carriageway Length</th>
<th>Item</th>
<th>Unit</th>
<th>No.</th>
<th>Width</th>
<th>Depth</th>
<th>Quantity</th>
<th>Rate</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1000.000</td>
<td>BC Laying</td>
<td>Cum</td>
<td>2</td>
<td>8.500</td>
<td>0.050</td>
<td>850.00</td>
<td>11,000.00</td>
<td>93,50,000.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DBM Laying</td>
<td>Cum</td>
<td>2</td>
<td>8.500</td>
<td>0.050</td>
<td>850.00</td>
<td>10,000.00</td>
<td>85,00,000.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tack Coat over Bituminous Course</td>
<td>Sqm</td>
<td>2</td>
<td>8.500</td>
<td></td>
<td>17,000.00</td>
<td>14.00</td>
<td>2,38,000.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tack Coat over Stabilized Base</td>
<td>Sqm</td>
<td>2</td>
<td>8.500</td>
<td></td>
<td>17,000.00</td>
<td>22.00</td>
<td>3,74,000.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SAMI</td>
<td>Sqm</td>
<td>2</td>
<td>8.500</td>
<td></td>
<td>17,000.00</td>
<td>80.00</td>
<td>13,60,000.00</td>
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<tr>
<td></td>
<td></td>
<td>Stabilized Base with 4% JGRS</td>
<td>Cum</td>
<td>2</td>
<td>8.600</td>
<td>0.150</td>
<td>2,580.00</td>
<td>4,105.00</td>
<td>1,05,90,900.00</td>
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<tr>
<td></td>
<td></td>
<td>Stabilized Sub-Base with 2% JGRS</td>
<td>Cum</td>
<td>1</td>
<td>27.500</td>
<td>0.250</td>
<td>6,875.00</td>
<td>1,557.00</td>
<td>1,07,04,375.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Subgrade Laying</td>
<td>Cum</td>
<td>1</td>
<td>29.000</td>
<td>0.500</td>
<td>14,500.00</td>
<td>300.00</td>
<td>43,50,000.00</td>
</tr>
</tbody>
</table>

**TOTAL COST OF STABILIZED PAVEMENT USING JGRS**  
4,54,67,275.00

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Net Profit</th>
<th>96,97,725.00</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>%Age Profit</td>
<td>17.58</td>
</tr>
</tbody>
</table>
THANK YOU

Contact us:
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: Gaurav Chawla, GM-Sales & Mktg.-Construction Materials
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