DEVELOPMENT OF SCC MIXES AS PER IS 10262:2019
BYUTILIZING CONSTRUCTION AND DEMOLITION WASTE
AS FILLER MATERIAL, FINE AND COARSE AGGREGATE
FOR SUSTAINABLE CONSTRUCTION

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      Construction and Demolition Waste, RMC Sludge, Granite Dust, SCC mixes, Recycled
      Concrete Aggregates (RCA).

Introduction
The potential for infrastructure growth caters demand for more construction activity especially in developing countries. The advancements and modern construction materials are in demand since they cater quality and durability of structures from which they are constructed. Self-Consolidating Concrete (SCC) is one such special concrete which is in great demand in the present day. The infra creation also generates large volumes of construction and demolition (C&D) waste.

C & D waste involves 'large volumes of materials' that are often being dumped along roadsides, water bodies, landfills and other open spaces; illegally which in turn causes negative impacts on health, environment and economic well-being. This requires urgent and immediate attention to dispose these materials safely and effectively. One of the effective means of disposal is to re-use and manage these materials in construction activity in different ways so the construction becomes efficient, economical and ecofriendly.

Till date, the design and development of SCC mixes was carried out as per ACI, EFNARC, Nan-Su method, Okamura Method, Re-proportioning, Gettu Method, Volume Fraction Method etc., The IS code for developing SCC Mixes were not available, however, BIS has come out with IS 10262:2019- Guidelines for Design and Development of Different types of Concrete Mixes –which includes design methods for SCC mixes. The code was available for public use since Feb 2019.

Objectives:
The present study intends to develop SCC mixes as per (IS 10262:2019)by utilizing only C&D Waste as ingredients with OPC as binder. The main objectives are:
1. Develop the SCC mixes as per IS 10262:2019 guidelines by utilizing C&D waste such as RMC Sludge and Granite Fines (GF) as fines; Recycled Concrete Aggregates (RCA) as Fine and Coarse Aggregate; Ordinary Portland Cement (OPC) as binder.
2. Study fresh properties of SCC mix as per EFNARC guidelines; hardened properties as per IS guidelines.

Scope:
The scope of present study involves procuring C&D waste and utilizing them in the preparation of SCC as per the procedure laid through IS 10262: 2019. The different category of C&D wastes used in present study includes, RMC Sludge – obtained from RMC plants; Granite Fines (GF) procured from nearby granite polishing units; RCA were procured from recycling plant. For control mixes MSIL sand has been used as Natural Fine Aggregate. GGBS was used as filler material with OPC. Polycarboxylateether based chemical admixture was used as SP.

The fresh properties of SCC mixes were tested as per the EFNARC 2005 guidelines, which include slump flow, V-funnel, J-ring tests. The hardened properties include compressive strength, split tensile strength, flexural strength and MOE.

The mix proportions included utilizing above ingredients in different combinations as obtained during conduction of trial mixes:
- Binder (OPC) – M Sand (Fines) – MSIL Sand as FA – Natural Aggregates as CA
- Binder (OPC) – RMC sludge (Fines) - MSIL Sand as FA - Natural Aggregates as CA
- Binder (OPC) - Granite dust (Fines)- MSIL Sand as FA - Natural Aggregates as CA
- Binder (OPC) - RCA (Fines) – RCA as FA - RCA as CA
- Binder (OPC) – RMC sludge (Fines) - RCA as FA - RCA as CA
- Binder (OPC) - Granite dust (Fines) - RCA as FA - RCA as CA

Methodology:
1. Construction and demolition waste was procured from nearest recycling and processing plants.
2. RMC Sludge and Granite Dust was air dried, and sieved to get fines.
3. Physical and Chemical analysis of filler materials; physical properties of OPC, FA and CA.
4. SCC trail mix shall be designed as per IS 10262:2019 to get required fresh and hardened properties through trials
5. Following tests shall be conducted:
   - Fresh properties on SCC as per EFNARC guidelines
   - Compressive strength for 7 & 28 days
   - Flexural strength for 7 & 28 days
   - Modulus of elasticity
   - Comparing the hardened properties of SCC mixes with RCA as aggregates with SCC mixes with natural aggregates.
   - Microstructure Analysis through SEM/XRD

Work Done: Results
Physical Properties:
Table 1: Physical properties of materials

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Properties</th>
<th>Cement</th>
<th>GGBS</th>
<th>Granite Dust</th>
<th>RMC Sludge</th>
</tr>
</thead>
</table>

Table 1: Physical properties of materials
<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Properties</th>
<th>Natural FA</th>
<th>Recycled FA</th>
<th>Natural CA</th>
<th>Recycled CA</th>
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<tbody>
<tr>
<td>1</td>
<td>Specific Gravity</td>
<td>2.61</td>
<td>2.58</td>
<td>2.78</td>
<td>2.31</td>
</tr>
<tr>
<td>2</td>
<td>Gradation</td>
<td>Zone II</td>
<td>Zone II</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>Fineness Modulus</td>
<td>3.08</td>
<td>3.43</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>Water Absorption (%)</td>
<td>1.40</td>
<td>6.00</td>
<td>0.78</td>
<td>5.83</td>
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</tbody>
</table>

Table 2: Physical properties of Aggregates

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Properties</th>
<th>Cement kg/m³</th>
<th>Filler kg/m³</th>
<th>FA kg/m³</th>
<th>CA kg/m³</th>
<th>Fines kg/m³</th>
<th>Total Powder kg/m³</th>
<th>Water kg/m³</th>
<th>SP (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RF1</td>
<td>M Sand</td>
<td>334</td>
<td>133</td>
<td>1038(M SIL)</td>
<td>683</td>
<td>83 (MSand fines)</td>
<td>550</td>
<td>190</td>
<td>0.60</td>
</tr>
<tr>
<td>RF2</td>
<td>Granite dust</td>
<td>334</td>
<td>133</td>
<td>1038(M SIL)</td>
<td>683</td>
<td>83 (Granite dust)</td>
<td>550</td>
<td>200</td>
<td>0.70</td>
</tr>
<tr>
<td>RF3</td>
<td>RMC Sludge</td>
<td>334</td>
<td>133</td>
<td>1038(M SIL)</td>
<td>683</td>
<td>83 (RMC Sludge)</td>
<td>550</td>
<td>220</td>
<td>0.80</td>
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<tr>
<td>RF4</td>
<td>RCA Fines</td>
<td>334</td>
<td>133</td>
<td>1038(R CA)</td>
<td>683</td>
<td>83 (RCA Fines)</td>
<td>550</td>
<td>210</td>
<td>0.85</td>
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Table 3: SCC Mixes

<table>
<thead>
<tr>
<th>MIX</th>
<th>Fines used</th>
<th>Slump flow (mm)</th>
<th>T500 (seconds)</th>
<th>V-Funnel (seconds)</th>
<th>J-ring (mm)</th>
<th>7-day Comp. Strength (MPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RF 1</td>
<td>M Sand</td>
<td>605</td>
<td>2.43</td>
<td>7.18</td>
<td>5.00</td>
<td>29.32</td>
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<tr>
<td>RF 2</td>
<td>RMC Sludge</td>
<td>600</td>
<td>3.52</td>
<td>7.30</td>
<td>6.50</td>
<td>25.88</td>
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<tr>
<td>RF 3</td>
<td>Granite dust</td>
<td>605</td>
<td>3.33</td>
<td>8.00</td>
<td>7.00</td>
<td>22.95</td>
</tr>
<tr>
<td>RF 4</td>
<td>RCA</td>
<td>600</td>
<td>4.00</td>
<td>6.50</td>
<td>6.00</td>
<td>15.67</td>
</tr>
</tbody>
</table>
Concluding Remarks:
- SCC mixes can be developed using C&D wastes like RMC sludge, Granite dust and RCA.
- RMC sludge and granite dust can used as fines (up to 8%) and SCC mixes can be obtained.

Scope For Future Work:
- RMC sludge and granite dust, may be used to achieve HSC / HPC mixes.
- Marble dust, demolished brick masonry fines, slag dust and other materials having particle size less than 125 microns may be used as fines in developing SCC mixes.