A REVIEW ON FIBER REINFORCED CONCRETE

Assistant Professor, Department of Civil Engineering,
Sri Ramakrishna Institute of Technology, Coimbatore – 641 010,
Tamil Nadu, India

ABSTRACT
Concrete plays a vital role as a construction material in the world. But the use of concrete as a structural material is limited to certain extent by deficiencies like brittleness, poor tensile strength and poor resistance to impact strength, fatigue, low ductility and low durability. In the present scenario, waste materials from various industries and admixtures are added to the mix. Over 300 million tons of industrial wastes are being produced per annum by chemical and agricultural process in India. These materials pose problems of disposal and health hazards. Hypo sludge is the waste material from paper industry that has some chemical properties similar to that of cement. Hence it can be used as an economical building cementitious material thus reducing the disposal and air pollution problems caused by the paper industry. Recron 3s acts as "secondary reinforcement" in concrete which arrests shrinkage cracks resistance to impact/abrasion & greatly improves quality of construction. In this study, an experimental investigation shall be conducted on strength of concrete containing hypo sludge and recron 3s fibers. Hypo sludge has to be added at a dosage of 25%, 50% and recron 3s fibers has to be added at a dosage of 0.5%, 1% by weight of cement. In this paper, studies shall be conducted on M30 mix and tests like compression test, split tensile test, flexural test, capillary and porosity shall be conducted. Finally, the results of fiber reinforced concrete shall be compared with the conventional concrete.

Key words: Concrete, Industrial Wastes, Hypo Sludge, Recron 3s Fibers, Secondary Reinforcement, Fiber Reinforced Concrete, Conventional Concrete

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INTRODUCTION
Concrete is widely recognized as a cost-effective, versatile construction material. But it is also covered with a number of drawbacks that are inherent to its composition. By generally accepted engineering standards, concrete is relatively brittle and lacks flexural strength. Intertwined with these problems is concrete’s propensity to crack in both its plastic (early-age) and hardened (long-term) state. Early-age cracks are microscopic fissures caused by the intrinsic stresses created when the concrete settles and shrinks over the first 24 hours after being placed. Long-term cracking is in part caused by the shrinkage that transpires over the months, perhaps years, of drying that follow. In either case, these cracks can jeopardize the overall integrity of the concrete and not allow it to maintain or possibly ever attain its maximum performance capability. The demand for high strength, crack resistant and lighter concrete
resulted in development of fiber reinforced concrete. Recron3S Fiber Reinforcement Systems can provide a solution to most of these problems.

Recron 3S is an secondary reinforcement product for construction developed in house by Reliance Industries Limited at State of Art R&D facility at Patalganga. The uniqueness of Recron 3S fiber is its triangular shape, which give better anchoring with concrete, which is not found in most of the fibers available worldwide.

Recron 3S Fibers act as an internal support system, facilitating the retention of a homogenous concrete mix. Fibers randomly oriented in the concrete matrix provide a unique bridging mechanism by virtue of which intrinsic cracks formed are intercepted and bridges by the fiber right at the micro level. Fiber parameters which govern the crack control and failure inhibition action include:

- High Fiber Area
- High Bond Strength
- Balanced Fiber Pull-Out & Rupture Strengths
- High Fiber Aspect Ration (L/D)

Recron 3S Fibers not only retards crack initiation but also reduces the crack width expansion caused by long term thermal gradient exposures & induced stress due to dynamic & static loading on the structure.

Recron 3S Fibers exhibits better ductile characteristics & is found to sustain more load after peak before brittle failure.

According to the Environmental Protection Agency [EPA], 27 percent of municipal solid waste (MSW) is comprised of paper waste. About 100 million kg of toxic pollutants are released every year from the paper industry.

Environmental problems regarding the paper industry are not limited to high water consumption. Solid wastes including sludge generated from wastewater treatment plants and air emissions cause further problems, thus an effective disposal and treatment approach is essential.

Hypo sludge is produced in a large amount as a by-product of paper industry and is usually used in concrete production as partial replacement of cement. It contains low calcium, magnesium and minimum amount of silica and due to presence of silica and magnesium properties, it behaves like cement. Use of hypo sludge in concrete can save the paper industry disposal costs and also produces a sustainable concrete for construction.

**REVIEW OF LITERATURE**

**Literature Review on Hypo sludge**

**Dr. L. B. Zala, et al (2012)**

The authors reported that:

(a) Compressive strength reduces when replacement of hypo sludge percentage increases when compare to traditional concrete.

(b) Replacement of cement with hypo sludge provides maximum compressive strength at 10% replacement but it is lesser than traditional concrete.

(c) Flexural strength of beam reduces when replacement of hypo sludge percentage increases when compare to traditional concrete.
Dharani.N et al. (2013)
The authors found that:
- The optimal replacement percentage of cement with hyposludge is found to be 30% when Recron 3s fibers are not added.
- On addition of Recron 3s fiber with cement matrix, the compressive strength and split tensile strength decrease with increase in fiber content, however the flexural strength increases with increase in fiber content.
- When hyposludge and Recron 3s fiber are added, the optimum dosage of Hyposludge is 20% and optimum Fiber content is 0.4%.
- Usage of Recron 3s fibers will reduce the segregation, cost of maintenance by reducing the micro cracks and permeability and hence the durability will increase.

Mr.R.Balamurugan, et.al (2014)
The authors noticed that:
- The compressive strength increased up to 10% addition of hypo sludge and further increase in hypo sludge reduces the strengths gradually.
- If silica is added the strength will be considerably increased, because of lack of silica in hypo sludge, considerably this type of Concrete, will be used for road works effectively with less consumption of cement.

The authors indicated that:
- 10% replacement of cement with Hyposludge and 50% replacement of fine aggregate with Copper slag show increase in compressive strength and flexural strength compared to other combinations.
- 10% replacement of cement with Hyposludge and 40% replacement of fine aggregate with Copper slag show increase in split tensile strength compared to conventional mix.
- With increase in curing days 30% replacement of cement with hypo sludge shows decrease in split tensile strength when compared to other combinations.

The authors noticed that:
- The industrial waste materials were found to be performing better than normal concrete, in properties such as workability, durability, permeability and compressive strength.
- Utilization of these wastes in concrete will not only provide economy but also help in reducing disposal problems.

B. Literature Review on Recron 3s

S. C. Patodi, C. V. Kulkarni (2012)
The authors found that matrix having 0.3% of recron and 0.7% of steel fiber volume fraction was found:
- More balanced in terms of strength and post – peak ductility.
- Best resistance against impact and maximum toughness.
- For overall better performance.
- Advantages in improving concrete properties.

Zoran J. Grdic et al. (2012)
The authors concluded that:
- Abrasive resistance of concrete is reduced with the increase of water/cement ratio from 0.5 to 0.7 which is reflected in the increase of the value of abrasion resistance rate.
A Review on Fiber Reinforced Concrete

- The addition of fibers increases tensile strength across the entire range of water/cement factors from 0.5 to 0.7 in respect to the benchmark concrete.
- The concretes with high compressive and tensile strength (at bending) have higher abrasive resistance, so these parameters may serve as indicators of the abrasive–erosive resistance of concrete.
- The polypropylene fibrillated fibers proved better in respect to the monofilament fibers in terms of abrasive–erosive resistance of concrete.

S. Sharmila et al. (2013)
The authors indicated that:
- The effect of adding hybrid fibres influence the behavior of beams by increasing the ductility characteristics by 80% and energy absorption characteristics by more than 160%.
- Instead of adding single fibre, the combination of different types of fibres (Hybrid fibres) increases the energy absorption capacity substantially.

Gurunathan k et al. (2014)
The authors discussed that the addition of polypropylene fibers, recron3s fibers, fly ash and silica fume in different concrete mixes marginally improve the compressive strength at 28 days. The minimum percentage of fly ash and silica fume were added in concrete so that the performance of the concrete increases. There is an increase from 3% to 9% in split tensile strength for all fiber mixes when compared with that of control mix. Then from the test results the authors concluded that the volume fraction of hybrid fiber concrete mix gives better strength values on par with control mix.

T. Sandeep (2015)
The authors reported that:
- Both grades of concrete attained maximum value at 25-30% of flyash replacement in the 28 days compressive test.
- Compressive strength gets increased by 12% with addition of flyash when compared to plain concrete.

CONSTITUENTS OF MATERIALS
The materials to be used are Cement, Fine aggregate, Coarse aggregate, Recron3s fiber, Hypo sludge and Water.

SPECIFICATIONS OF RECRON 3S:

**Specifications of Recron 3s**

<table>
<thead>
<tr>
<th>S.No</th>
<th>Specifications</th>
<th>Unit</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Chemical Composition</td>
<td></td>
<td>Modified Polyester</td>
</tr>
<tr>
<td>2.</td>
<td>Cross - Section</td>
<td></td>
<td>Triangular</td>
</tr>
<tr>
<td>3.</td>
<td>Diameter</td>
<td>Micron</td>
<td>30 – 40</td>
</tr>
<tr>
<td>4.</td>
<td>Elongation</td>
<td>%</td>
<td>&gt;100</td>
</tr>
<tr>
<td>5.</td>
<td>Cut Length</td>
<td>mm</td>
<td>6,12&amp;18</td>
</tr>
<tr>
<td>6.</td>
<td>Moisture Flat</td>
<td>%</td>
<td>&lt;1.0</td>
</tr>
<tr>
<td>7.</td>
<td>Melting Point</td>
<td>ºC</td>
<td>240 – 260</td>
</tr>
<tr>
<td>8.</td>
<td>Softening Point</td>
<td>ºC</td>
<td>220</td>
</tr>
<tr>
<td>9.</td>
<td>Specific Gravity</td>
<td>cc/g</td>
<td>1.34 – 1.40</td>
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CONSTITUENTS OF HYPO SLUDGE

Constituents of Hypo Sludge

<table>
<thead>
<tr>
<th>S.No</th>
<th>Constituent</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Moisture</td>
<td>56.8</td>
</tr>
<tr>
<td>2.</td>
<td>Magnesium oxide (MgO)</td>
<td>3.3</td>
</tr>
<tr>
<td>3.</td>
<td>Calcium oxide (CaO)</td>
<td>46.2</td>
</tr>
<tr>
<td>4.</td>
<td>Loss on ignescent</td>
<td>27.00</td>
</tr>
<tr>
<td>5.</td>
<td>Acid insoluble</td>
<td>11.1</td>
</tr>
<tr>
<td>6.</td>
<td>Silica (SiO$_2$)</td>
<td>9.0</td>
</tr>
<tr>
<td>7.</td>
<td>R$_2$O$_3$</td>
<td>3.6</td>
</tr>
</tbody>
</table>

ADVANTAGES

Recron 3s Fibers
- Improves homogeneity of the concrete by reducing segregation of aggregates.
- Reduces shrinkage cracks/micro cracks.
- Increases abrasion resistance by more than 25%.
- Increases impact and shatter resistance by 100%.
- Increases ductility, compressive, flexural and tensile strength.
- Reduces water permeability which helps prevent corrosion of primary steel.

Hypo Sludge
- Hypo Sludge is used as a replacement of cement hence cost of production is less.
- Save the paper industry disposal costs.
- Produces a sustainable concrete for construction.

APPLICATIONS

Recron 3s fibers are applied in the following cases:
- Floorings,
- Grade Slabs,
- Foundations,
- Retaining Walls,
- Shotcrete,

RESULTS AND DISCUSSIONS

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**Gurunathan k et al. (2014)**

The authors concluded that the volume fraction of hybrid fiber concrete mix gives better strength values on par with control mix.

**T.Sandeep (2015)**

The authors reported that these fibers are causing 30% of increase in the 28-days compressive strength in the presence of 0.25% recron and 25% flyash substitution.

**RELATED WORKS**

Since the use of concrete is limited due to certain deficiencies like brittleness, poor tensile strength and poor resistance to impact strength, fatigue, low ductility and low durability, Recron 3s fibers shall be added to develop the requisite characteristics of concrete. Hypo sludge produced in a large amount as by product of paper industry and is usually used in concrete production as partial replacement of cement. In order to study the use of Recron 3s fibers and Hypo sludge in concrete, investigations shall be carried out on M30 grade of concrete. The specimens like cubes, cylinders and beams shall be cast and shall be subjected to curing for 7 days and 28 days. After curing, the tests like Compressive strength test, Split tensile strength
test, Flexural strength test, Capillary test and Porosity test shall be carried out. Hypo sludge shall be added at a dosage of 25%, 50% and recron 3s fibers shall be added at a dosage of 0.5%, 1% by weight of cement. Finally, the results shall be compared with the conventional concrete specimens.

CONCLUSION
The addition of Recon 3s fibres into concrete mixes improves the Compressive strength, Split tensile strength and Flexural strength at 28 days for fibre mixes when compared with that of control mix. The volume fraction of fibre concrete mix gives better strength values on par with control mix. The capillary absorption coefficient and porosity increases with addition of fibres. Industrial waste materials were found to be performing better than normal concrete, in properties such as workability, durability, permeability and compressive strength. Utilization of these wastes in concrete will not only provide economy but also help in reducing disposal problems.

REFERENCES


