Abstract - Now a day’s construction field facing many problems, one of them is scarcity of water. Proper curing is not practically possible in most of the cases. So, the concept self curing distributes the extra curing water (uniformly) throughout the entire 3-D concrete microstructure. Self curing agent is more readily available to maintain the saturation of the cement paste during hydration and reducing the autogenous shrinkage. The aim of the project is to investigate the strength characteristics i.e compressive strength, split tensile strength and flexural strength of self curing concrete with silica fume using sodium polyacrylate and to eliminate the shrinkage effect. The grade of the concrete selected was M30. Self curing agent used is sodium polyacrylate (0.2, 0.3% and 0.4%) relative to cement mass. Partial replacement of cement with silica fumes 10% to increase the pozzolanic properties of the concrete. The optimum mix ratio is taken for the casting of beam and the flexural strength characteristics was studied and compared with the control mix.

Key words: Self curing, Sodium polyacrylate, Silica fume, flexural strength.

I. INTRODUCTION

In recent years, the concept of self curing or internal curing of concrete has been undergoing rapid developments because of water scarcity. Nearly one third of water is used for construction field. According to ACI 308 committee [1] “internal curing refers to the process by which hydration of cement occurs because of availability of additional internal water that is not part of mixing water. Advantage of self curing are numerous mainly increase hydration process, reduce self desiccation and autogeneous shrinkage and increase the durability of concrete [2] [3]. In this paper self curing is made use of sodium polyacrylate, it is one of the type of super absorbent polymer (SAP). From the study previous literature and by reference of IS 456 codal provision [4] [5], silica fume is added as pozzolanic additive 10% of cement weight. Silica fume will increase the mechanical properties of the concrete.

II. RESEARCH SIGNIFICANCE

Self curing concrete is made using by Sodium polyacrylate. There are many self curing agents are available polyethylene glycol, calatropis gigantia, propylene glycol, bagasse ash etc. From this
Sodium polyacrylate has high water retention capacity. So that cost of construction is reduced by minimizing the amount of water used for construction. Autogeneous shrinkage is reduced by using sodium polyacrylate as an internal curing agent, it act as a reservoir for concrete curing it supplies water to the concrete for hydration reaction from inside to outside. The importance of this project is to provide sufficient data for the researcher and engineer's than concerns in using sodium polyacrylate in the water scarcity area, which the concrete curing process are difficult.

III. MATERIAL USED

A. Cement
The cement used in all mixture was commercially available Ordinary Portland Cement (OPC) of 53 graded confirmed to IS 12269-1987 [6]. The initial and final setting times were found as 32 & 130 minutes respectively. Specific gravity of cement is 3.164

B. Fine Aggregate
Locally available Natural River sand of size below 4.75 mm conforming to Zone II of IS 383-1970 is used as fine aggregate [7]. Specific gravity of fine aggregate is 2.63

C. Coarse Aggregate
Coarse aggregate used in this study consist of size 20 mm. Laboratory tests were conducted on coarse aggregate to determine the different physical properties as per IS: 383-1970 [7]. Specific gravity of coarse aggregate is 2.68.

D. Reinforcement
High Yield Strength Deformed bars of 8 mm and 10 mm diameter were used for the study. 10 mm bars were used as longitudinal reinforcement an 8 mm bars were used for lateral ties [4].

E. Silica Fume
Silica fume (very non crystalline silicon dioxide) is a byproduct of the manufacture of silicon, ferrosilicon etc. According to IS: 456 silica fume is usually used in proportion of 5 to 10 percent of the cement content of a mix. In this study commercially available silica fume is used (Enfiq Civil Innovative Chemicals & Systems, Tirunelveli). Specific gravity of silica fume is 2.2.

F. Sodium Polyacrylate
Super absorbent polymer is also called slush powder, which can absorb 100 to 300 times of its own weight and convert into a hydro gel. In this study commercially available sodium polyacrylate is used (chemzest enterprises, Chennai) for self curing agent shown in figure 1. This sodium polyacrylate SAP is used for internal curing purpose for concrete.

- Chemical Formula \([-\text{CH}_2-\text{CH}(_2\text{Na})\text{]}_n\]
- Sodium polyacrylate (SP), also known as water lock
- SAP act as self curing agent in concrete.
- Sodium Polyacrylate crystallizes as white powder. It takes up water as much as 400 to 500 times its dry size and swells to form a polymeric gel.

- Particle Size 85-50 mesh
- pH Value 6.0-7.0
- % of moisture \(\leq 5\)

Mechanism:
Sodium Polyacrylate polymer can retain large amount of water because of the osmotic pressure (i.e. movement of water through a semi permeable membrane). Osmotic pressure induced by the high...
water content concentration. Outside a sodium polyacrylate molecule brought the water into the center of the molecule. Sodium polyacrylate continuously absorb the water until there is an equal pressure of water inside and outside the sodium polyacrylate molecule.

**Water Absorption Test For Sap**

To determine the water retaining capacity for SAP. Water absorption test is done and details given in table 1.

### Table 1 Water Absorption for SAP

<table>
<thead>
<tr>
<th>S No</th>
<th>Material</th>
<th>Dry weight (gms)</th>
<th>Saturated weight (gms)</th>
<th>Water absorption</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SAP</td>
<td>25</td>
<td>2755</td>
<td>110 times</td>
</tr>
</tbody>
</table>

**Figure 1. Sodium polyacrylate**

G. Concrete Mix Design For M<sub>30</sub>

One of the ultimate aims of studying the various properties of the materials of concrete, plastic concrete and hardened concrete is to enable a concrete technologist to design a concrete mix for a particular strength and durability. Mix design can be defined as the process of selecting suitable ingredients of concrete and determining their relative proportions with the object of producing concrete of certain minimum strength and durability as economically as possible. The purpose of designing as can be seen is to achieve the stipulated strength and durability. W/C ratio 0.45 mix proportion for M30 is shown in table 2. Silica fume is added about 10% of cement mass.

### Table 2 Total quantities of ingredients and mix proportion

<table>
<thead>
<tr>
<th>Mix</th>
<th>Cement (kg/m³)</th>
<th>Fine Aggregate (kg/m³)</th>
<th>Coarse Aggregate (kg/m³)</th>
<th>Water (ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M&lt;sub&gt;30&lt;/sub&gt;</td>
<td>437.77</td>
<td>757.29</td>
<td>1010.50</td>
<td>197</td>
</tr>
</tbody>
</table>

M30 Grade (1:1.72:2.31)
IV. EXPERIMENTAL WORK

A. Compressive Strength

The most common of all tests on hardened concrete is the compressive strength test. Compressive strength tests on specimens treated in a standard manner which includes full compaction and wet curing for a specified period given results representing the potential quality of the concrete. The age at which specimens are tested is governed by the information required, the standard specimen are tested at prescribed ages, generally 7 and 28 days. Cubes sizes of 150 mm x 150 mm x 150 mm were tested for compressive strength after 7 and 28 days of self-curing. Compressive strength result shown in table 3. Compressive strength is done using CTM shown in figure 2.

![Compression testing machine and self curing concrete specimen in room temperature](image)

**Figure 2. Compression testing machine and self curing concrete specimen in room temperature**

**Table 3. Compressive strength of concrete**

<table>
<thead>
<tr>
<th>Material</th>
<th>Percentage</th>
<th>Compressive strength N/mm²</th>
<th>7 days</th>
<th>28 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional concrete</td>
<td>-</td>
<td></td>
<td>20.56</td>
<td>32.05</td>
</tr>
<tr>
<td>Sodium polyacrylate with silica fume 10%</td>
<td>0.2</td>
<td></td>
<td>19.96</td>
<td>29.87</td>
</tr>
<tr>
<td></td>
<td>0.3</td>
<td></td>
<td>21.12</td>
<td>33.14</td>
</tr>
<tr>
<td></td>
<td>0.4</td>
<td></td>
<td>21.05</td>
<td>31.75</td>
</tr>
</tbody>
</table>

B. Split Tensile Strength

Split tensile strength is used to determine the tensile strength of the concrete indirectly. It is done using a cylinder specimen of diameter 150mm and height 300mm. The specimen is placed horizontally in the compression testing machine and loaded. Split tensile strength of concrete is done using UTM shown in figure 3.
Figure 3. Split tensile strength using UTM

The split tensile strength test is performed for 7 and 28 days is shown in table 4.

Table 4. Split tensile strength of concrete

<table>
<thead>
<tr>
<th>Material</th>
<th>Percentage</th>
<th>Split tensile strength N/mm²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>7 days</td>
</tr>
<tr>
<td>Conventional concrete</td>
<td>-</td>
<td>2.332</td>
</tr>
<tr>
<td>Self curing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sodium polyacrylate with silica fume 10%</td>
<td>0.2</td>
<td>2.056</td>
</tr>
<tr>
<td></td>
<td>0.3</td>
<td>2.543</td>
</tr>
<tr>
<td></td>
<td>0.4</td>
<td>2.284</td>
</tr>
</tbody>
</table>

C. Flexural strength of beam

The flexural behaviour of the beam specimens are carried out at 28 days curing and the results are tabulated in Table 4. *RC Beam for M₃₀ Grade Beam Specification*

- Length of the member = 1200 mm
- Breadth of the member = 150 mm
- Depth of the member = 200 mm
- $f_{ck} = 30 \text{ N/mm}^2$
- $f_y = 415 \text{ N/mm}^2$
- $A_{st} = 314.159 \text{mm}^2$

Provide 4 nos of 10 mm diameter bars as main reinforcement and Provide 8 mm diameter vertical stirrups with 150 mm c/c spacing. Flexural behaviour is studied for both conventional beam and self curing concrete beam. Beam testing is done under two point loading setup for conventional and self curing beam is shown in figure 4 and 5. The ultimate load carrying capacity of conventional and self curing beam is shown in table 5.
V. CONCLUSION

Based on the results of this investigation the following conclusion is drawn.

- By using self curing agent sodium polyacrylate we can reduce the autogenous shrinkage and evaporation loss in concrete. Because it have good water retention capacity and improve hydration process, increase the strength compares conventional concrete.
- Compressive strength results shows, using silica fume 10% with sodium polyacrylate 0.3% increase the strength compare to conventional concrete. silica fume increase the pozzolanic reaction catalyst the hydration process CSH gel formation gives early strength to concrete.

<table>
<thead>
<tr>
<th>S No.</th>
<th>Beam specimen</th>
<th>Initial crack load (kN)</th>
<th>Ultimate load (kN)</th>
<th>Flexural strength (N/mm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Conventional beam</td>
<td>31.4</td>
<td>48.4</td>
<td>25.81</td>
</tr>
<tr>
<td>2</td>
<td>Self curing Beam</td>
<td>36.2</td>
<td>55.6</td>
<td>29.65</td>
</tr>
</tbody>
</table>
The self curing concrete with sodium polyacrylate shows high split tensile strength compare to normal concrete.

RC beam for M30 grade using silica fume 10% with sodium polyacrylate 0.3% has good ultimate load carrying capacity.

By using internal curing method we can reduce the external water usage for curing. This method is mainly suitable for water scarcity region.

References


