ABSTRACT-
Fly ash is one of the major residues generated during combustion of coal in thermal power plants. Fly ash brick technology is the process of converting industrial waste material into quality building material. Glass waste is the problematic threat to the environment and also to the developing countries. Fly ash, Lime, Gypsum and Crusher dust are used to manufacture the fly ash brick. In this study glass powder is used as a replacement material for fly ash. The first type Boron glass powder in Fly ash bricks and another type Soda lime glass lime were cast in Fly ash bricks. The prepared bricks are cured for 7days and 28days dried in regular temperature. The tests results show the compressive strength of the brick with 20% replacement of boron and soda lime glass powder revealed 6.723N/mm², 6.150 N/mm² provokes the excellent performance in compare to the Indian Standards. The water absorption, bulk density, hardness, efflorescence, initial rate of absorption and sorptivity of the brick are experimented as per IS code. The study was aimed to reduce the waste glass dumping in the earth to protect the environment from hazardous and also increment of low cost brick towards the construction industry for the sustainable development.

KEYWORDS-Waste Glass, Boron glass powder, Soda lime glass powder, Fly Ash.

INTRODUCTION
Waste is the common environmental threat to India as well as to the developing countries. Most municipalities dumping 95% waste in the land and remaining 5% waste used for alternative method. Especially the glass wastes are increasing in terms of 2% to 4% tones per year. Glass is an amorphous (non-crystalline) solid material. Glass also a non degradable component in which provides the hazardous properties to the landfill. But those materials provide glass transformations states it helps the reversible transformation in amorphous materials from a hard and relatively brittle state into a molten state. Glass are in strong demand to utilize the waste glass to the alternative materials. The most familiar types of glass are based on the chemical compound of silica (silicon oxide) which is the primary constituent of sand. Glass waste are collected and disposed in the landfill. This will create an environmental issues on global network. In today’s environment the main aim is to manufacture the building materials without any impact on environment. In this situation it is necessary to concentrate on recycle and reuse of waste materials. At the same time the waste material should not affect the strength and should have low cost. The properties of material, which are used for this investigation containing of class F ash containing the 70%(Silicon dioxide+ aluminum oxide+ iron oxide) of chemical composition that are required for binding.

Paki Turgut (et al.,2007) stated that the masonry blocks produced with waste lime stone dust and glass powder . It revealed the replacement of 25%, 50% and 75% glass powder enhances the compressive strength of 6.2%, 11.6% and 21.1% higher than that of controlled specimen. The flexural strength of the masonry block are revealed as 18.6%, 41.2%,7.3% higher than the conventional blocks. This study shows the mechanical and physical characteristics of the blocks are efficient in feasible manner.

M.N. Akhtar, J.N. Akhtar (et al.,2013) stated that the reinforced fly ash lime stone dust bricks with glass powder revealed that the mechanical properties of brick are enhanced by addition of fibre, lime and glass powder. The compressive strength of lime stone dust bricks results the increase of 25% as compared to the controlled specimens. P.Chindapasir, K.Pimraka (et al.,2007) stated that the study of the fly ash lime granule unfired bricks containing the compressive strength are excellent between 47.0-62.5 MPa. The rate of water absorption is under 16%-19% in weight and also shows that the increased strength by adding the fineness of fly ash with the large amount. The bulk density of the brick in the range of 1.60- 1.66kg/m³. TayfunCiciek,Mehmet Tanriverdi (et al.,2006) stated that the lime based steam autoclaved fly ash bricks containing mixture of sand and hydrated lime in an autoclaving pressure produces the compressive strength of 10.25MPa are excellent compare to the conditional bricks. The unit volume weight of the fly ash brick containing the respective mixture is 1.15g/cm³. The water absorption of the bricks ranges from 30% to 40% as compared to the controlled specimen. The thermal conductivity of the bricks is efficient in construction and cooling costs of the buildings.

In this study glass powder is used for preparing the bricks as a replacement material for fly ash and also to compare the result of glass powdered brick with ordinary fly ash brick. This study helps the improvement in reduction of glass waste in the earth.

2. MATERIALS AND METHODS
2.1 Fly Ash
The flyash material under the category of Class F, containing $SiO_2$, $Al_2O_3$, Iron Oxide on total amount of 70% in composition. This Class F contains mostly pozzolanic materials with lower calcium oxide content. Meanwhile those materials are free from the power stations. They are remained to bury in to the ground. The available residual material FA is used in the brick. The corresponding Class F fly ash materials are collected from the Mettur thermal power station, Tamilnadu, India.

2.2 Glass Powders
The Boron Glass Powder and Soda Lime Glass Powder are collected from the Madurai based recycling company, Tamilnadu, India. Boron glass powder are the classification of window panels and glass containers etc., and Soda Lime glass powders are under the classification of Reagent bottles, Medical devices and optical etc., The chemical composition of the Class F Fly Ash, Boron Powder.
and Soda Lime Powder are obtained from the SONASTRACH –(Sona Science center for Testing and Applied Research) Sona College of Technology –Salem as given in the Table No.1. Those glasspowders passing less than 75µm is used in the production of brick.

2.3 Crusher Dust And Lime Powder
Locally available crusher dust passing through IS 4.75mm was used in this study containing 25% of crusher dust is used in total mass of the specimen. Gypsum materials are also assorted in the mixture to under the non-influence of the setting time for about 5% gypsum used in total mass of the specimen are used.

Table 1 Chemical Composition of Class F Ash, Boron Powder and Soda Lime Powder

<table>
<thead>
<tr>
<th>Constituents</th>
<th>Class F Fly ash Percentage</th>
<th>Boron Glass Powder Percentage</th>
<th>Soda lime Glass Powder Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>SiO₂</td>
<td>48.09</td>
<td>81.25</td>
<td>78.78</td>
</tr>
<tr>
<td>Al₂O₃</td>
<td>23.2</td>
<td>1.06</td>
<td>1.23</td>
</tr>
<tr>
<td>Fe₂O₃</td>
<td>11</td>
<td>0.91</td>
<td>0.78</td>
</tr>
<tr>
<td>SO₃</td>
<td>2.9</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CaO</td>
<td>13.37</td>
<td>1.98</td>
<td>6.56</td>
</tr>
<tr>
<td>MgO</td>
<td>-</td>
<td>0.23</td>
<td>1.63</td>
</tr>
<tr>
<td>Na₂O</td>
<td>-</td>
<td>4.69</td>
<td>12.15</td>
</tr>
<tr>
<td>K₂O</td>
<td>-</td>
<td>1.39</td>
<td>1.95</td>
</tr>
</tbody>
</table>

3. MIX PROPORTIONING
This study consists of six different mixtures for two types of bricks were prepared and casted. The dimension of the non-modular brick are chosen according to the Indian Standard (IS12894:2002)-230mmX100mmX80mm. In the first type only fly ash used to prepare the brick. In the second type, fly ash is partially replaced with Soda-Lime glass powder and in the third type, fly ash is partially replaced with Boron glass powder for the preparation of brick. Throughout the project, the both the glass powders (Soda lime glass powder and Boron glass powder) is replaced instead of fly ash with various percentages i.e. 5%, 10%, 15%, 20%, 25%, and 30%.

4. BLOCK PRODUCTION
The production of fly ash Brick containing partially replacement of boron powder and partially containing replacement of soda lime powder in manufacture of Bricks. The production of the brick was done in brick plant by using High Pressure Hydraulic Machine. The Production stage for the preparation of the block as follows

1. Mixing the Raw Material-Mix the Fly Ash, Glass Powder, Crusher Dust, Gypsum, is manually fed into a pan mixer as according to the controlled proportion. A some amount of water to the mixer for the initiate the mixing.
2. Allow the mixture to pass through the conveyor to transfer raw material from mixer to feeding hopper hydraulic press.
3. The corresponding mixture is over fill the mould cavity containing the dimension of 230mmx100mmx80mm.
4. After Pressing, the Bricks are demolded & the Pallet with Bricks is pushed out of the Press. After that the Pallet is stacked to the stacking area.
5. The Bricks are air dried for 24 hours until it gets hard.
6. The prepared bricks are cured for 7days and 28days and dried in regular temperature. The curing of bricks is done by covering it with Gunny Bags. The moisture in the gunny bag is maintained regularly for the better curing.

5. TEST METHODS
A series of test are done according to IS 3495:1992-Methods of testing of burnt clay building bricks. The glass powders at the respective rate of 5%, 10%, 15%, 20%, 25%, 30% replacement in fly ash bricks with the dimension of 230x100x80mm are used to find the compressive strength of brick, water absorption, efflorescence test, bulk density test, initial rate of absorption and Sorptivity Test.

6. RESULTS AND DISCUSSION
The tested results of the samples containing fly ash replaced Boron and Soda lime glass powders at the respective rate of 5%, 10%, 15%, 20%, 25%, 30% with the dimension of brick-230x100x80mm. The compressive strength of the brick is done to find the amount of stress that the brick can withstand their respective area cross section by using the universal testing machine. The result shows that the percentage of 20% replacement of boron powder samples with 7th and 28th day curing, provokes the compressive strength of about 2.923,6.723 N/mm². Hence, 20% of the boron powder replacement in fly ash containing bricks increased the compressive strength of the bricks in comparison to ordinary fly ash bricks.

![Fig 1. Compressive strength of Boron glass replaced Specimen](image-url)

The figure No. 1 & 2 shows the result Compressive strength of Soda Lime glass powder & Boron Glass Powder in fly ash bricks. The results of Fly ash replaced 20% Soda lime glass powder containing bricks compressive strength are in 2.732N/mm², 6.284N/mm² of 7th day and 28th day strength. The maximum compressive strength was attained in replacement of 20% Soda lime glass powder in fly ash containing bricks shows the feasible compressive strength as compare to normal fly ash brick. Thus, the Glass powder particles have the inherent capacity to relate the fly ash particles and also increasing the strength to the bricks.

**WATER ABSORPTION TEST**

The samples are tested for the water absorption as shown in the Table No.2. The result shows the water absorption in terms of percentage of 3.028% for 30% replaced boron replaced specimen. The soda lime replaced samples are tested values for water absorption test as shown in the table No.2 the result shows the water absorption rate of 2.857% for a 30% replaced soda lime powder in the bricks. The water absorption result shows the greater possibility of water penetrating capabilities are reduced and its efficiency in building plays a great role in the building as compare to the conventional fly ash brick. The respective values provoke the low water absorption rate as stated in IS12894:2002 code of fly ash bricks in accordance of not more than 20% of mass.

**BULK DENSITY TEST**

The calculated bulk density values of the respective specimen in terms of percentage as shown in the Table No.3. The value shows the 30% replaced both boron and soda lime specimens provoke the bulk density of 1583.69 kg/m³, 1640.03 kg/m³. The density of bricks is lower in comparable to ordinary fly ash bricks. The respective values of the two type prepared specimen are satisfied the bulk density values of fly ash bricks. Thus, the both the specimen bricks are can be utilized in the construction industry.

**EFFLORESCENCE TEST**

After the samples are examined their presence of salts or any other powdery substances provokes only 10% area of specimen is discovered with alkalis. The presence of soluble salts is very low in fly ash brick. The prepared specimens of both boron and soda lime powder bricks are under in slight appearance of white deposit over the surface as per in the code of IS 12894:2002.

**INITIAL RATE OF ABSORPTION**

The test results shows that the percentage of Boron glass powder and soda lime powder replaced specimens have the feasible and efficient initial rate of absorption in bricks. The respective value of 0.092 kg/cm²/min, 0.082 kg/cm²/min for 30% replaced...
boron powder in the brick on aspect of initial rate of absorption as shown in Table No. 4. An initial rate of absorption provides the good values as compared to the ordinary fly ash bricks. The efficiency is great in aspect of two boron and soda lime powdered specimen. This shows the decreased rate of absorption by increasing the percentage of glass powders makes the specimens in to the sterling brick.

SORPTIVITY
The sorptivity results stated that the capillary absorption in brick are decreased and feasible as compare to the test on fly ash bricks. The percentage of boron glass powder and soda lime powder replaced fly ash brick their amount of initial rate of absorption vs percentage of glass powders are shown in the following Fig. No.3. The results showing percolation of water with respect to time leads to the rate of increase of water are greater in boron glass powder replaced fly ash bricks compare to the soda lime glass powder replaced fly ash bricks.

<table>
<thead>
<tr>
<th>Percentage of Glass powder replaced</th>
<th>Initial rate of absorption (Kg/cm²/min)</th>
<th>Percentage of Soda Lime glass powder replaced</th>
<th>Initial rate of absorption (Kg/cm²/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td>0.165</td>
<td>0%</td>
<td>0.165</td>
</tr>
<tr>
<td>5%</td>
<td>0.143</td>
<td>5%</td>
<td>0.157</td>
</tr>
<tr>
<td>10%</td>
<td>0.130</td>
<td>10%</td>
<td>0.132</td>
</tr>
<tr>
<td>15%</td>
<td>0.120</td>
<td>15%</td>
<td>0.129</td>
</tr>
<tr>
<td>20%</td>
<td>0.119</td>
<td>20%</td>
<td>0.117</td>
</tr>
<tr>
<td>25%</td>
<td>0.107</td>
<td>25%</td>
<td>0.097</td>
</tr>
<tr>
<td>30%</td>
<td>0.092</td>
<td>30%</td>
<td>0.082</td>
</tr>
</tbody>
</table>

Fig 3. Sorptivity for Soda lime glass powder and Boron glass powder replaced fly ash bricks

<table>
<thead>
<tr>
<th>Percentage of Glass powders</th>
<th>0%</th>
<th>5%</th>
<th>10%</th>
<th>15%</th>
<th>20%</th>
<th>25%</th>
<th>30%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soda-Lime Glass Powder</td>
<td>0.2985</td>
<td>0.326</td>
<td>0.283</td>
<td>0.3744</td>
<td>0.3104</td>
<td>0.5117</td>
<td>0.3173</td>
</tr>
<tr>
<td>Boron Glass Powder</td>
<td>0.3049</td>
<td>0.2737</td>
<td>0.5927</td>
<td>0.6309</td>
<td>0.6216</td>
<td>0.5659</td>
<td>0.6043</td>
</tr>
</tbody>
</table>

7. CONCLUSION
Based on the experimental investigations carried on Fly ash-Glass powdered bricks the following are concluded. When compared to the ordinary fly ash bricks the cost of bricks are reduced by 25%. The compressive strength of Boron replaced and soda lime glass powder 20% replaced fly ash bricks provide optimum values of 6.723 (N/mm²) & 6.280 (N/mm²). So it can be used for up to two stories of building. The efflorescence test on both types of bricks provides slight. The water absorption on both types of bricks which provides less than 10% absorption of water. The bulk density of boron glass powder 30% replaced fly ash bricks provide lesser density on compare to ordinary fly ash bricks and Soda lime glass powder 30% replaced fly ash bricks gives slightly increased in density comparable to fly ash bricks. Initial rate of absorption are satisfying the common conditions of fly ash brick. Thus, Glass powders can inhibit the inherent capacity to relate with the fly ash properties and increasing the strength of the bricks. Thus, the fly ash-glass powdered bricks can reduce the production cost as well as feasible for the construction industry.

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REFERENCE