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ANALYTICAL STUDY ON GEOPOLYMER CONCRETE BEAM WITH HOLLOW SPACE BELOW NEUTRAL AXIS

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Abstract — *In this paper, a detailed study was carried out on strength behaviour of flyash based geopolymer concrete with hollow space below neutral axis . Use of hollow space at and near the neutral axis will reduce the selfweight and saves concrete materials. This paper focuses on material minimization by introducing hollow space using pvc pipe in tension zone of beams. By this method, we can reduce the dead loads which contribute to seismic effect in high rise structures. Geopolymer concrete shall be produced without using any amount of ordinary Portland cement. Alkaline solution produced aluminosilicate gel that acts as the binding material for the concrete. Thus many efforts are being made to reduce the usage of opc which responsible for carbondioxide emission. M30 grade concrete is used for ordinary and geopolymer concrete. Analysis was done by ANSYS software.*

Keywords *Fly ash, alkaline solution, opc , pvc.*

I. INTRODUCTION

The global warming is an environmental problem caused due to the emission of greenhouse gases, such as carbon dioxide (CO2), to the atmosphere. As the demand for concrete increases in construction field, the demand for Portland cement also increases . Cement industry is held responsible for some of the CO2 emissions. Thus many efforts are being made to reduce the usage of cement. The concrete just above neutral axis is less stressed whereas the concrete below the neutral axis acts as a shear transmitting media. Sustainability can be achieved by replacing the partially useful concrete ,by saving concrete, which reduces the demand for material and cost. So new technology materials like geopolymers offer waste utilization and emissions reduction, in which fly ash is used as a base material instead of OPC in geopolymer concrete. Geopolymer concrete is an innovative construction material which is produced by the chemical action of inorganic molecules. Fly Ash, a by- product of coal obtained from the thermal power plant is available in plenty worldwide. Flyash is rich in silica and alumina reacted and an excellent alternative construction material to the existing plain cement concrete .In this work flyash based geopolmer is used. Flyash is a waste product generated from thermal power plant. Hence we can protect water bodies from contamination due to flyash disposal and by creating hollow space at tension zone by inserting the pvc pipe we can reduce the quantity of concrete and cost can be reduced. The electrical conduits, air conditioning small ducts etc .also been taken through these hollow beams.

II.OBJECTIVE

The main objectives of the present study is

- The main aim of this study is to find the structural behaviour of hollow GPC beam.
- To study the flexure behaviour of hollow pliain geopolymer concrete beam at different diameter pvc pipe.
- To determine the flexural strength.
- To determine the load carrying capacity of hollow concrete beams.

III. RCC BEAM ANALYSIS

The model used in this study is a simply supported Reinforced geopolymer beam .Size of pcc beam is 150x300x1000mm with a hollow space below neutral axis using pvc pipe with two diameter. Material properties of both pvc pipe and geopolymer is briefed below

Fck = 30N/mm2
Ec = 22360N/mm2(GPC),
Poisson’s ratio = {0.224(GPC), 0.4(Pipe),0.3(steel)}
Fy = 415N/mm2,
Ec = 4.7Gpa(pipe)

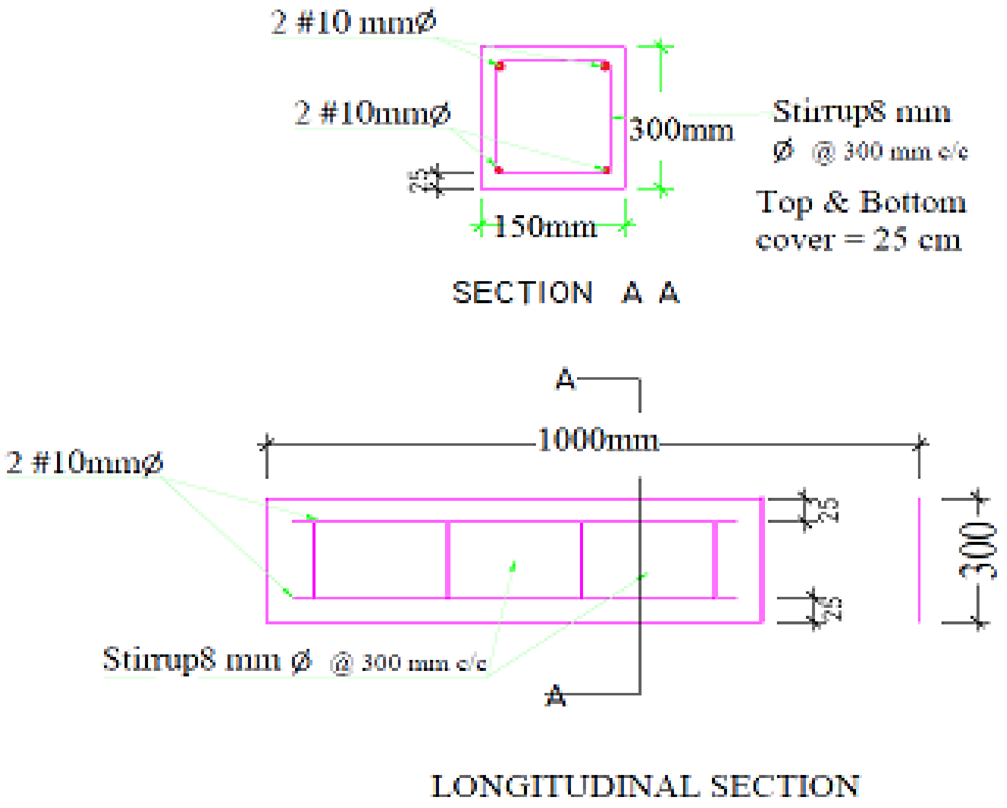

Fig 1 Reinforcement details

IV. LOADING CONDITIONS

Specimen was tested as simply supported beam with a span of 1000 mm. . Then static structural test was conducted. Failure load is obtained from software.

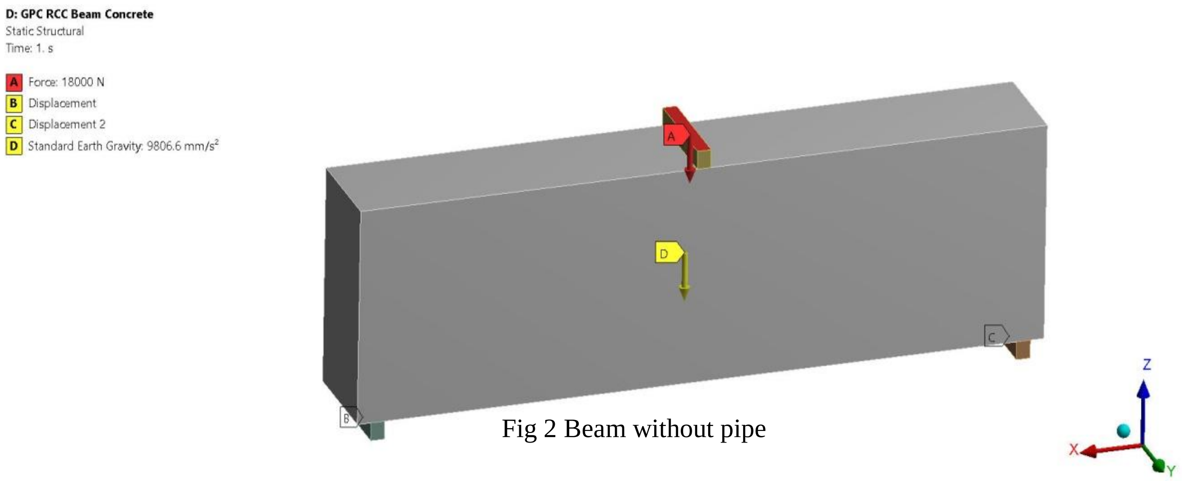

Fig 2 Beam without pipe

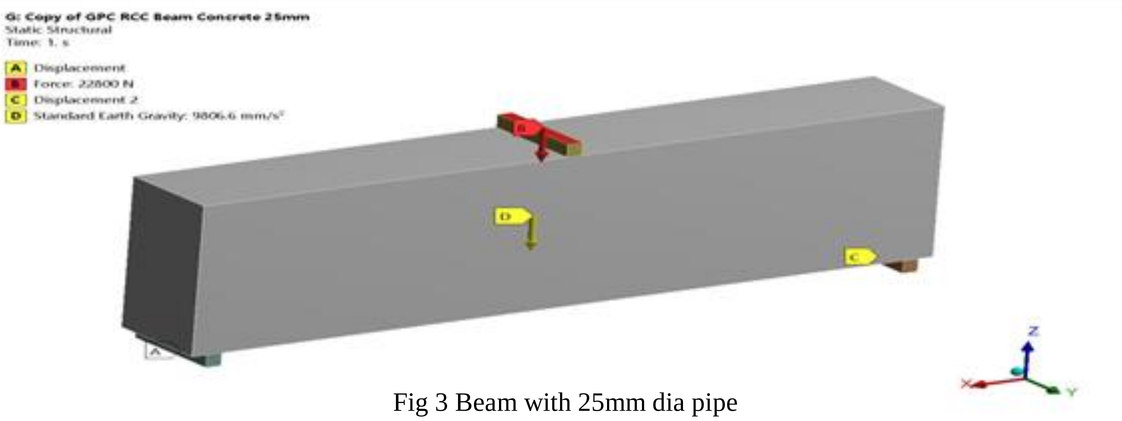

Fig 3 Beam with 25mm dia pipe

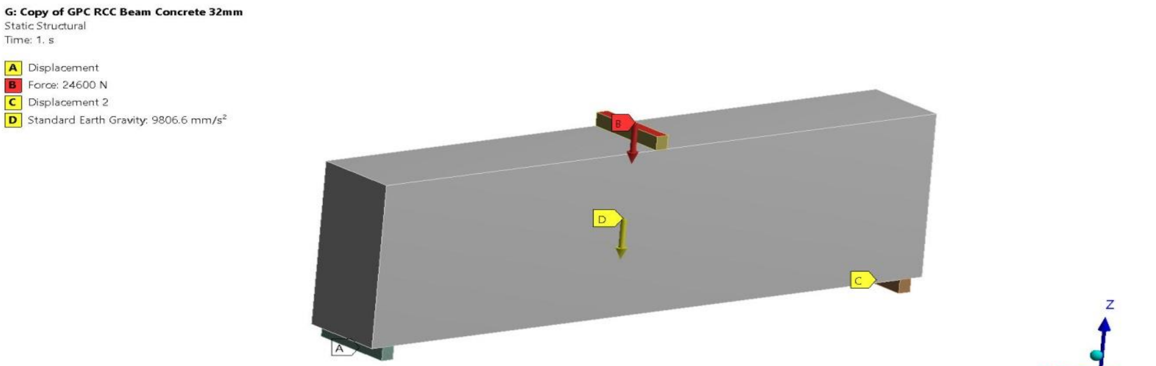

Fig 4 Beam with 32mm dia pipe

V.GEOMETRY

Figure shows the geometry of RC beam. All model had dimensions of 150x300x1000mm. The reinforcement for the specimens was 2 nos. of 10mmϕ at tension zone and 8mm stirrup at 300mm c/c spacing. The PVC pipe of 25mmϕ and 32mmϕ is placed 160mm from the top concrete surface. The length of the pipe inside the beam neutral axis is 900mm and an anchorage length of 50mm on each side is provided for the transfer of load

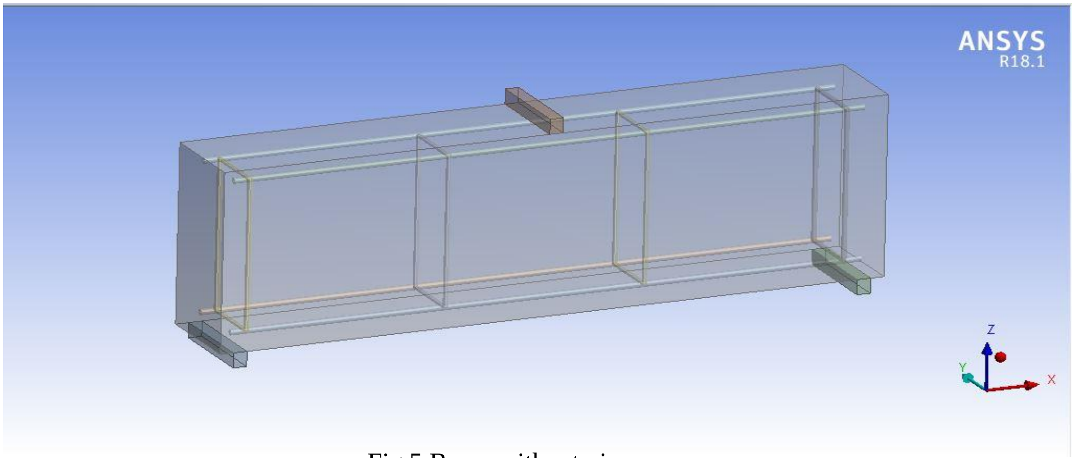

Fig 5 Beam without pipe

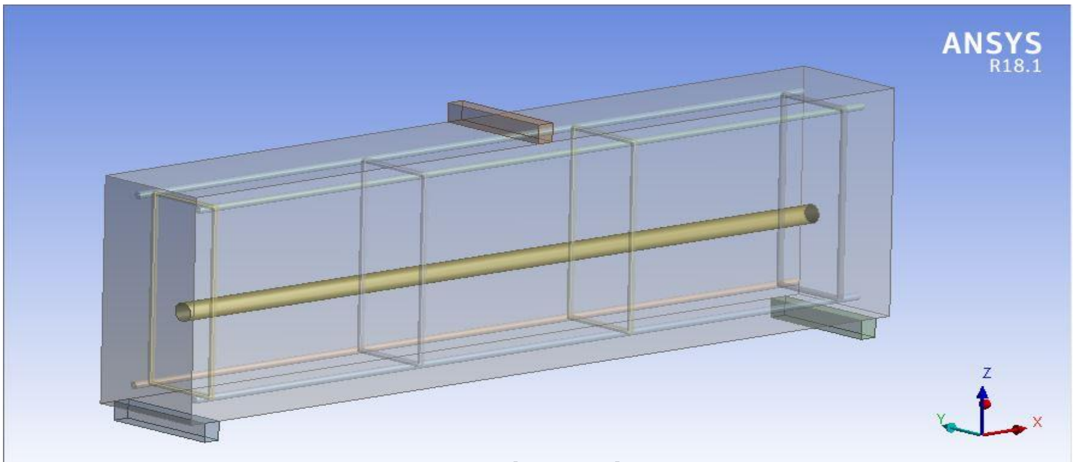

Fig 6 Beam with 25mm dia pipe

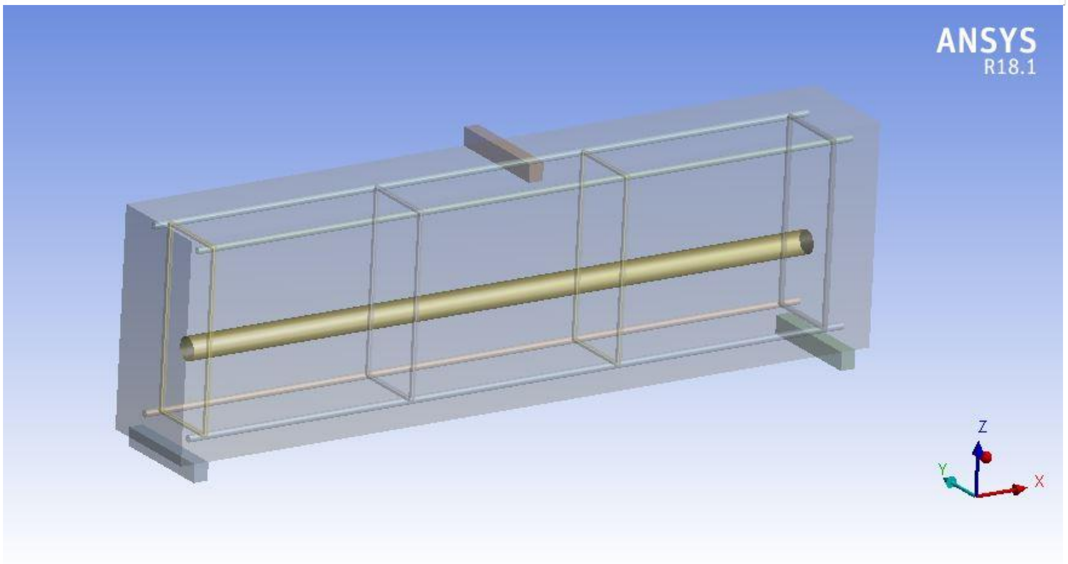

Fig 7 Beam with 32mm dia pipe

VI DISCUSSION OF RESULTS OF RCC BEAM

6.1 TOTAL DEFORMATION

6.1.1.Total Deformation Of Concrete

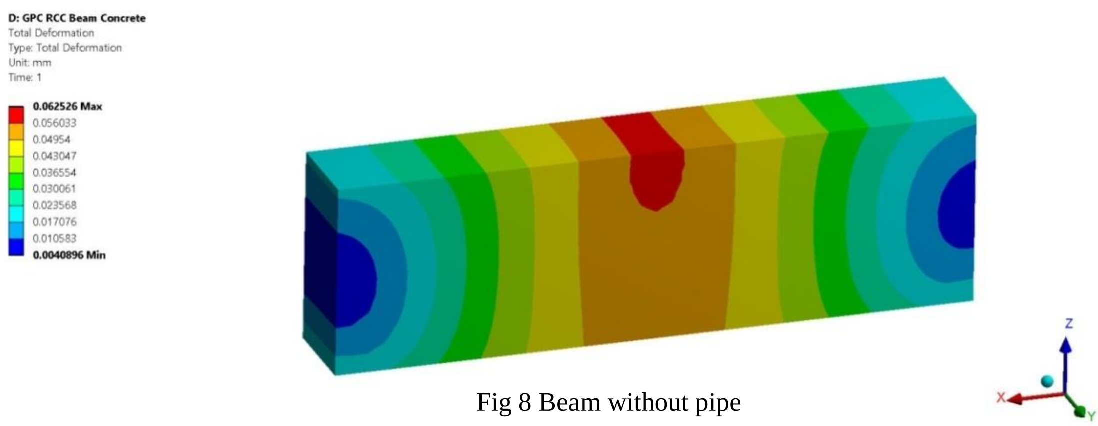

Fig 8 Beam without pipe

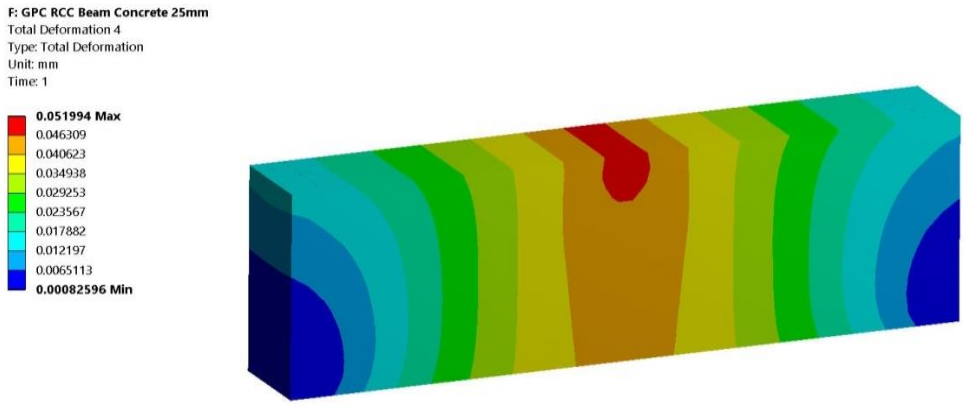

Fig 9 Beam with 25mm dia pipe

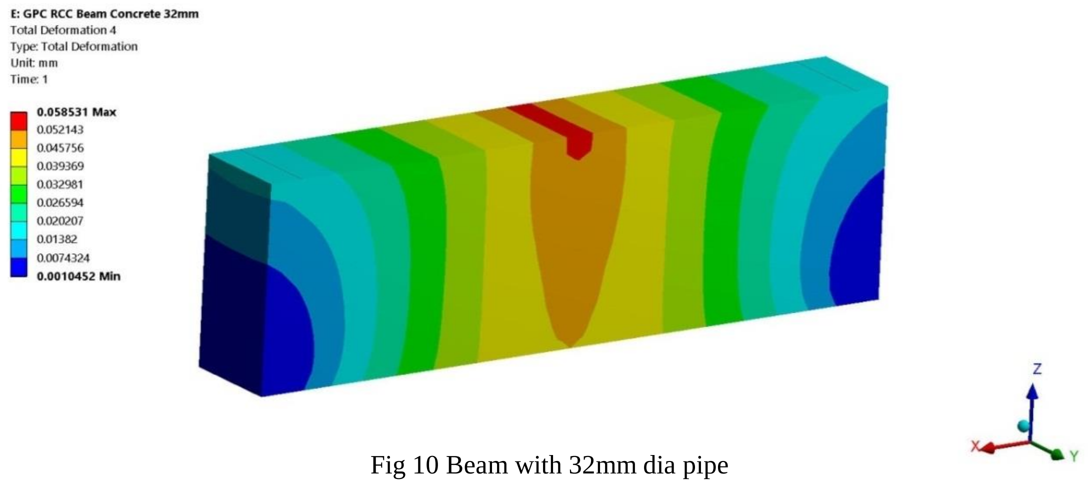

Fig 10 Beam with 32mm dia pipe

6.1.2.Total Deformation Of Pipe

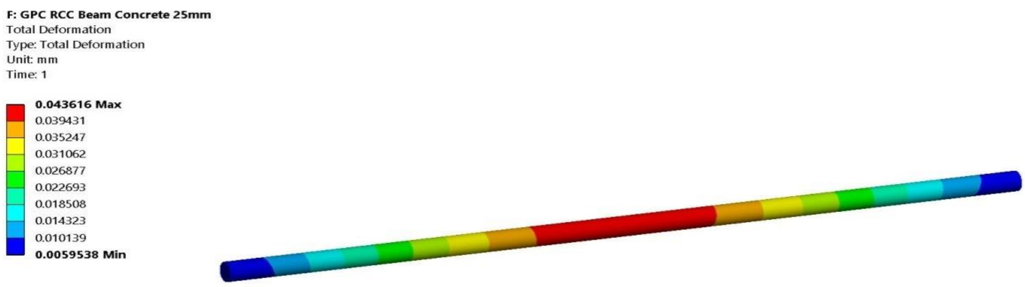

Fig 11 Beam with 32mm dia pipe

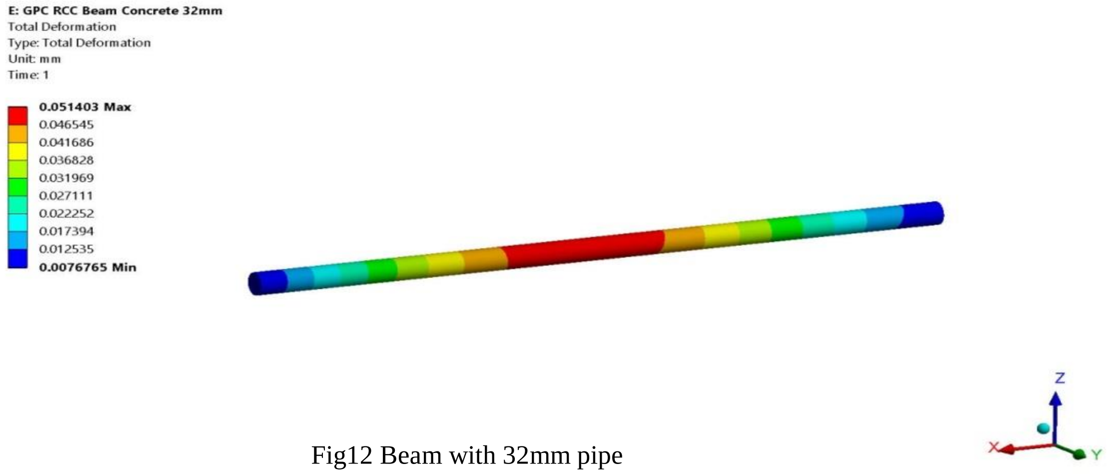

Fig12 Beam with 32mm pipe

6.1.3. Reinforcement Deformation

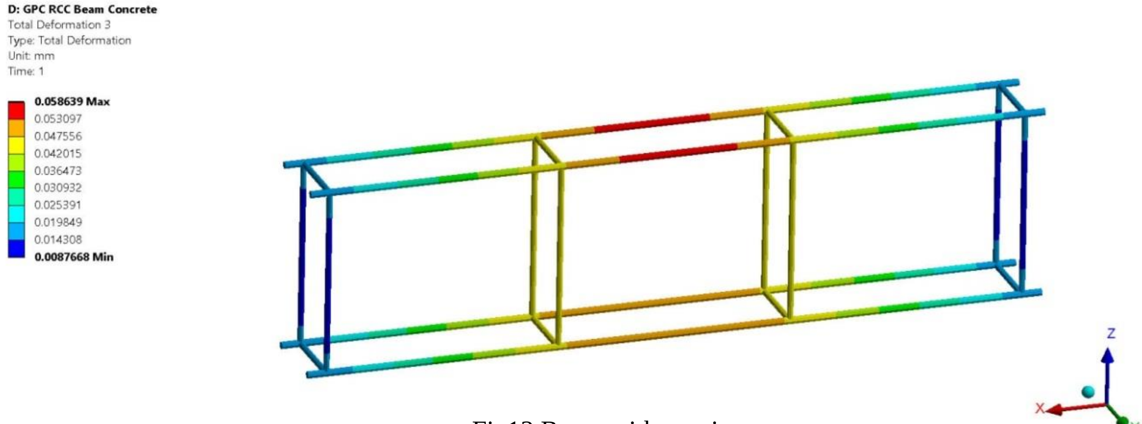

Fig13 Beam without pipe

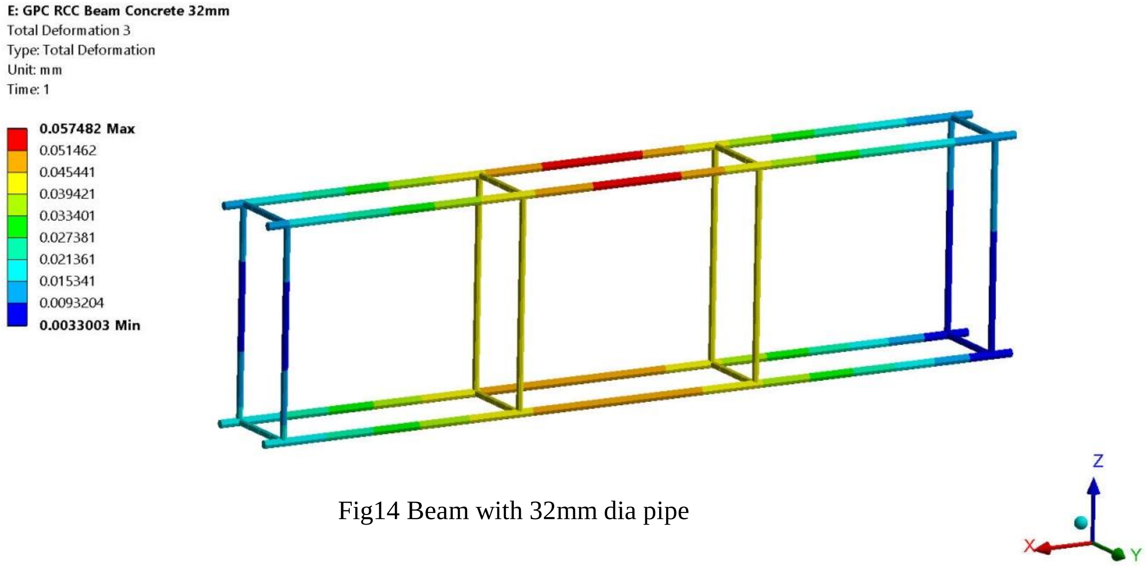

Fig14 Beam with 32mm dia pipe

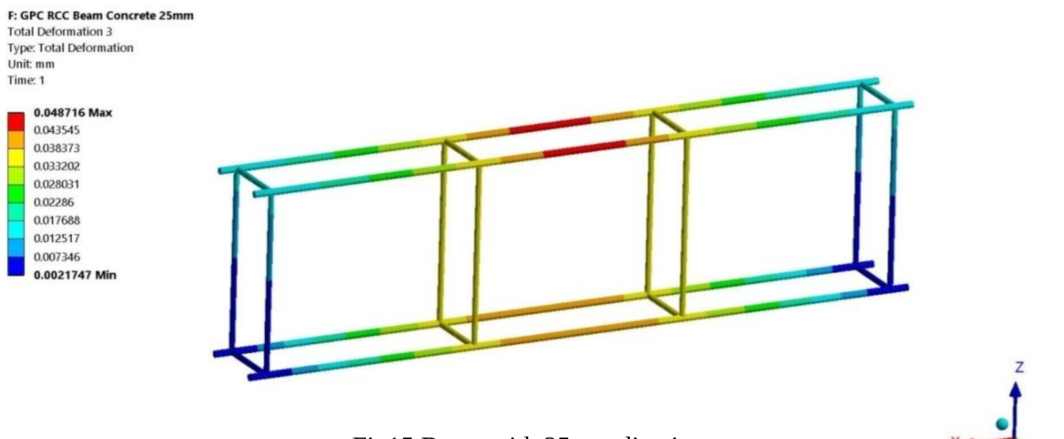

Fig15 Beam with 25mm dia pipe

6.1.4 Equivalent Stress

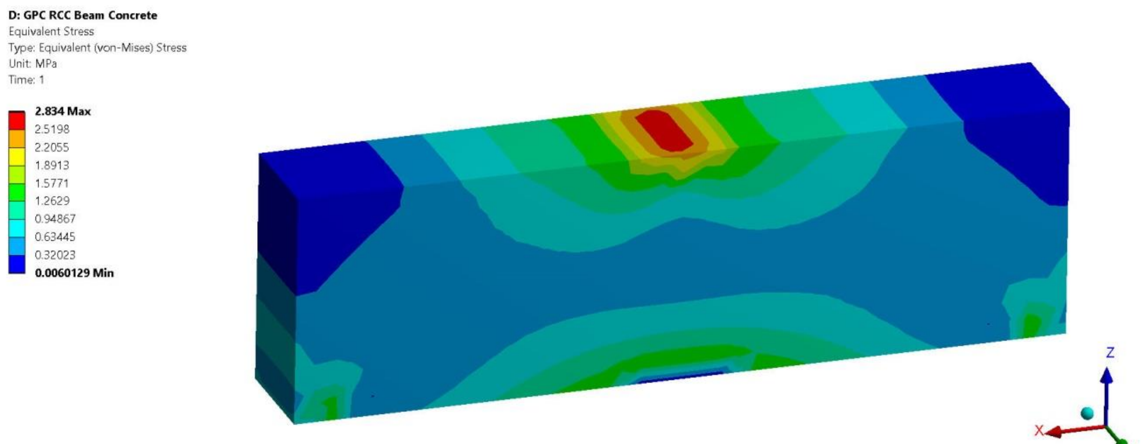

Fig16 Beam without pipe

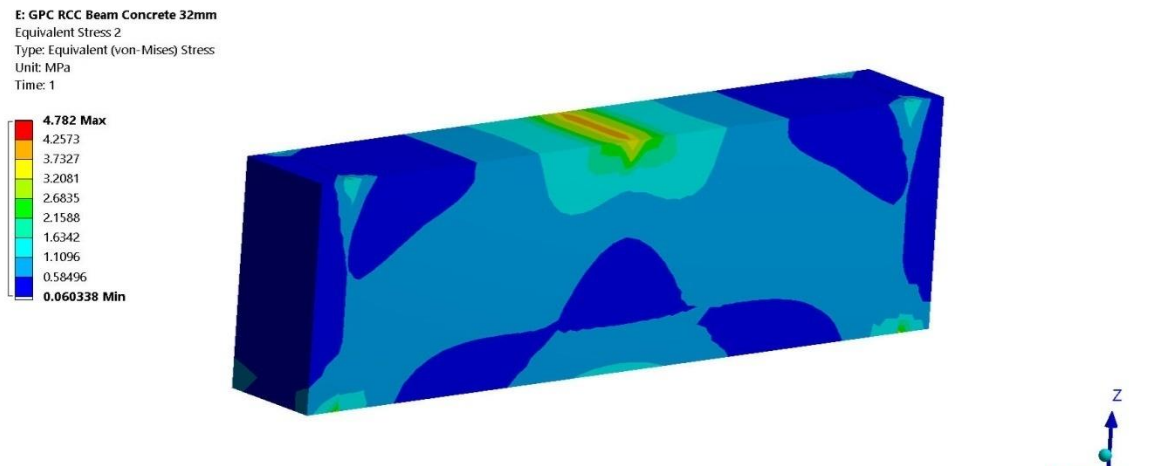

Fig18 Beam with 32mm dia pipe

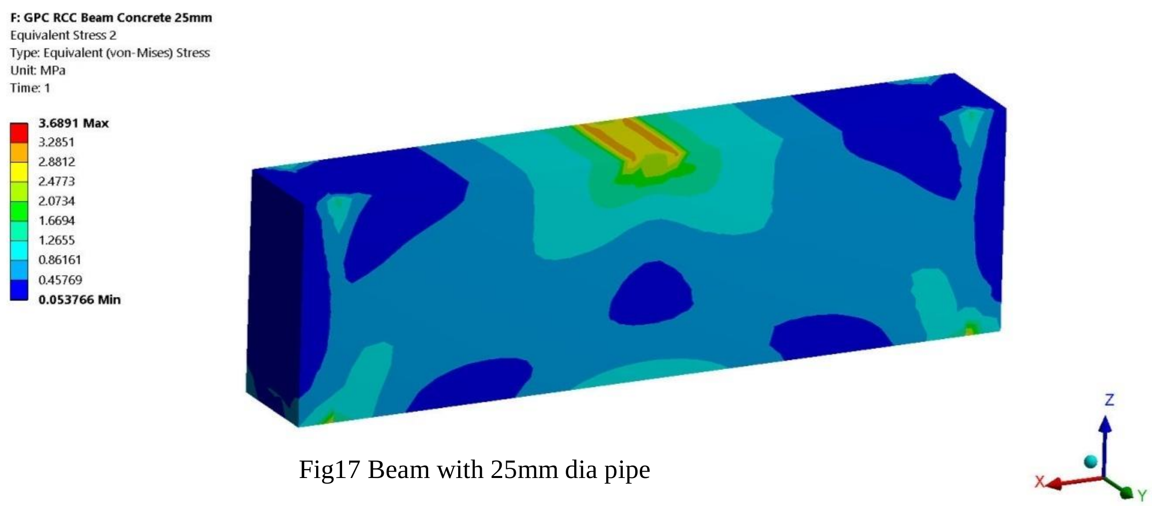

Fig17 Beam with 25mm dia pipe

6.1.5 Equivalent Elastic Strain

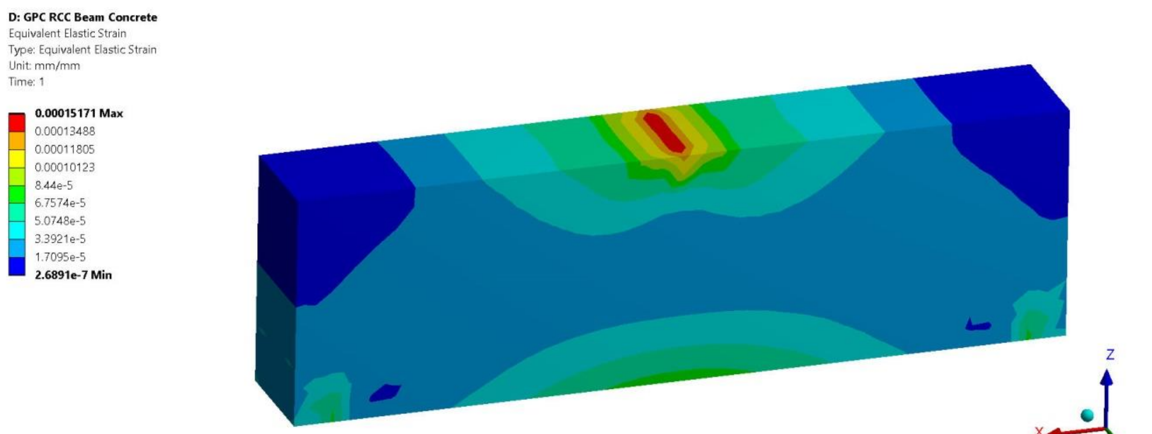

Fig19 Beam without pipe

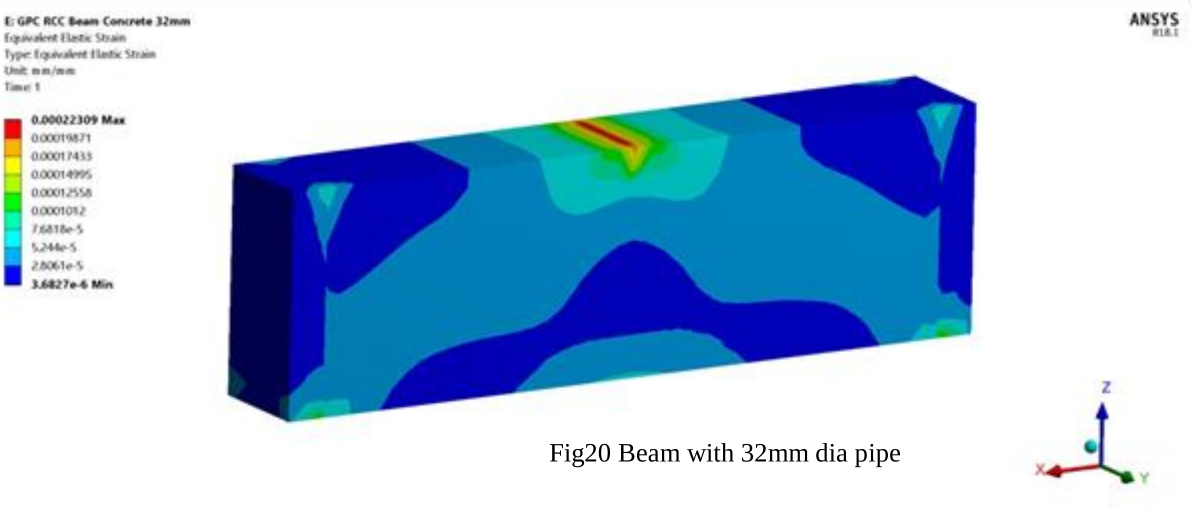

Fig20 Beam with 32mm dia pipe

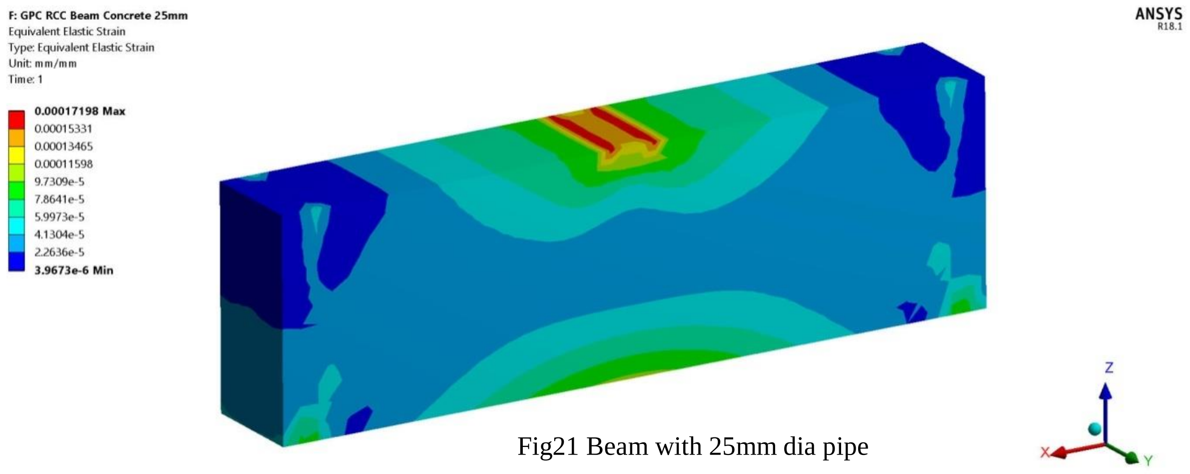

Fig21 Beam with 25mm dia pipe

6.1.6 Reaction Force

Details of "Force Reaction"	
Definition	
Type	Force Reaction
Location Method	Boundary Condition
Boundary Condition	Displacement
Orientation	Global Coordinate System
Suppressed	No
Options	
Result Selection	All
Display Time	End Time
Results	
Maximum Value Over Time	
X Axis	0. N
Y Axis	0. N
Z Axis	9540.5 N
Total	9540.5 N

Fig22 Beam without pipe

Details of "Force Reaction"	
Definition	
Type	Force Reaction
Location Method	Boundary Condition
Boundary Condition	Displacement
Orientation	Global Coordinate System
Suppressed	No
Options	
Result Selection	All
Display Time	End Time
Results	
Maximum Value Over Time	
X Axis	0. N
Y Axis	0. N
Z Axis	13055 N
Total	13055 N

Fig 23 Beam with 25mm dia pipe

Details of "Force Reaction 2"	
Definition	
Type	Force Reaction
Location Method	Boundary Condition
Boundary Condition	Displacement 2
Orientation	Global Coordinate System
Suppressed	No
Options	
Result Selection	All
Display Time	End Time
Results	
Maximum Value Over Time	
X Axis	0. N
Y Axis	0. N
Z Axis	14080 N
Total	14080 N

Fig 24 Beam with 32mm dia pipe

VII RESULTS AND DISCUSSION

7.1.Comaprison of reinforced geopolymer concrete with and without pipe

The result of the experimental investigation on the reinforced GPC with and without hollow beams were discussed. The comparison of test results is given in the below table. The terms are ultimate load carrying capacity, total deflection, bending stress, strain, shear force.it is observed that the reinforced geopolymer concrete with hollow space have more strength behaviour than solid reinforcement geopolymer concrete beam.

Parameter	Solid GPC	GPC with 25mm dia	GPC with 32mm dia
Load	18000N	22800N	24600N
Deflection	0.061526mm	0.05199mm	0.058531mm
Bending Stress	2.83N/mm²	3.68N/mm²	4.78N/mm²
Strain	0.000151	0.00017198	0.00022309
Shear force	9540KN	13055KN	14080KN

9.4.2.Concrete Saving
Concrete is one of the most versatile building materials. Material cost is a main component to be considered while construction. Therefore, in order to control the cost, it is necessary to pay maximum attention for controlling the material cost. It should be made sure that the right quantities of materials are consumed with less wastage. This issue can be minimized by avoiding concrete below the neutral axis without bearing significant strength.

9.4.3.Labour Reduction
Labours are one of the major resources in construction industries. From the study it is clear that the total volume saving inconcrete is directly proportional to the percentage reduction in labour. When the volume of concreting works reduce, the need for labour also get decreased simultaneously, which in turn minimize the production cost.

9.4.4. Cost Reduction
In current days the entire field is filled with competition, and it is necessary that a business concern should have utmost efficiency and minimum possible wastages to reduce the cost of production. From the study conducted, we can conclude that by partial replacement below neutral axis in beams, significant amount of concrete can be saved without affecting the strength.

9.4.5. Decrease in self weight
Dead load shall include weight of all structural and
Architectural components which are permanent in nature. It includes self-weight of the structure. The unit weight of concrete is 24kN/m3. If we can reduce the volume of concrete then the self-weight of the beam also get reduced.
Weight of 1 m3 concrete = 2400 kg
Weight of beam, W1 =12 kg

Weight of concrete replaced by pipe, W2 = 0.83 kg
Weight of hollow beam = W1- W2 = 11.4 kg
Since we have assumed a small beam, the self-weight reduction is also small. When we assume this for a larger section, the weight reduction will be larger.

VIII CONCLUSION

1. GPC has almost same properties as that of OPC.
2. From the above results, it is concluded that Hollow beam of 25mm and 32mm diameter provides higher strength and better performance and hence it is used for structure in effective way as electrical conduits, when compared to the solid conventional beam
3. Mode of failure is flexural in hollow beam of 25mm and flexure in solid and hollow (32mm)
4. It is seen that there is not much difference in the flexural strength of control beams and that of beams with low grade concrete near neutral axis zone and hollow neutral axis.
5. It can also be seen that with the increase in size of pipe replaced at neutral axis, there is no large difference in flexural strength
6. Thus in the overall study, it can be concluded that behaviour of PGC beams with hollow neutral axis behaves almost in the same manner as that of conventional concrete. \

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