# Strength and Characteristics of Cylindrical Shell Using High Performance Concrete

[1]R.OMPRAKASH, [2]SS.CHANDRAN, [3]Ms.P.SARANYA
[12]Department of Civil Engineering,IFET College of Engineering, villupuram, Tamilnadu
[3]Assistant professor, Department of Civil Engineering, IFET College of Engineering, villupuram, Tamilnadu.

***Abstract*—** *The objective of this project is to increase the structural flexibility and durability of concrete structure using high performance concrete in cylindrical shell. It is designed of economical and heavy loads with minimum thickness of the concrete structures. Usage of high performance concrete of containment structures such as structural integrity, compressive strength, controlled deformation and durability are achieved by added silica fume by cement and hyper plasticizer is improve the workability in concrete. The cylindrical shell with the specimen of size 1m x 1m.The specimen are curing 28 days after testing the uniformly distributed load over the shell is applied and measured the deflection and load carrying capacity.*

**Keywords;** *High performance concrete, cylindrical shell, silica fume, hyper plasticizer, deflection and shell structure*.

## I.INTRODUCTION

Shell forms in nature such as egg shell, walnut and turtle's hood have their shape to protect and resist against the crack or break. These inquests led to the development of shell structures by mankind. Shell structures have been present in nature since ancient times. High performance concrete is development and scope of the shells led to the invention of the development of shell structures and shell theories.

Theory of shells and the shell dimensions were limited to a certain ratio in the earlier times. Advancements and recent trends in civil engineering have made the thin shell structures to be revisited. The advancement brought about the shells to be viewed as potential precast building roofs. Conventional Ordinary Portland Cement Concrete which is designed on the basis of compressive strength does not meet many functional requirements as it is found deficit in aggressive environments, time of construction, energy absorption capacity, repair and retrofitting jobs etc. and loses its tensile resistance after the formation of multiple cracks. So, there is a need to design High Performance Concrete which is far superior to Conventional Concrete, as the Ingredients of High Performance Concrete contribute most efficiently to the various requirements. The attribute "High Performance" implies an optimized combination of structural properties such as strength, toughness, energy absorption capacity, stiffness, durability, multiple cracking and corrosion resistance.

## II. RESEARCH OBJECTIVES

The following are the objective of this study

- To reduce the cement content for concrete and utilize the industrial by-products on concrete.
- To increase the structural flexibility in concrete structures.
- To increase the compressive strength of concrete by using silica fume.
- To minimize the overall environmental effects of cement production using these resources as partial replacement of cement.
- To determine the performance of concrete by partial replacement of cement by silica fume is 5%,7.5%,10%,12.5%and 15% variants.
- To determine the most optimized mix of silica fume based concrete.
- To study the physical and chemical properties of structural design and are the ingredients in concrete.
- To provide economical construction material for all construction projects.
- To provide safeguard to the environment by utilizing industrial wastes properly.

## III. MATERIAL PROPERTIES

**MINERAL ADMIXTURE:**

Chemical composition finding the role of Mineral Admixtures in enhancing properties of concrete. Different materials with Pozzolanic properties such as Fly Ash (FA),Ground Granulated Blast Furnace Slag (GGBS), Silica fume(SF), High Reactivity Metakaolin (HRM), Rice Husk Ash (RHA), Copper Slag, have been widely used by cementitious materials in the production of High Performance Concrete. Fly Ash (FA) and Silica fume (SF) act as Pozzolanic materials as well as fine fillers the microstructure of the hardened cement matrix

becomes denser and stronger. The use of Silica fume fills the space between cement particles and aggregate and cement particles. It does not impart any strength but acts as a rapid catalyst to gain the early age strength. Such applications as not only help to improve the strength and durability characteristics of High Performance Concrete but it also help to dispose more of the industrial by-products which utilize the concrete.

**CHEMICAL ADMIXTURE:**

Chemical admixtures (Super plasticizers) are extensively used in development of High Performance Concrete, as they increase the efficiency of cement paste by improving workability of the mix and thereby resulting in considerable decrease of water requirement. Super Plasticizers help to disperse the cement particles in the mix and promote mobility of the concrete mix. Retarders help in reduction of initial rate of hydration of cement so that fresh concrete retains its workability for a longer time. Air entraining agents artificially introduce air bubbles that increase workability of the mix and enhance the resistance to deterioration due to freezing and thawing actions. Its type of super plasticizer is high range water reducers are powerful as dispersing agents. It plasticizer is poly carboxylate (Master glenium sky 8700) based super plasticizer for high performance concrete.

**HIGH PERFORMANCE CONCRETE**

High performance concrete is known as high tech construction material, providing to be very cost effective, reliable and having long term durability in natural environment. The definition of HPC is based on establishing value of workability, strength and durability. The concrete of containment structures are mainly radiological protection, structural integrity, controlled deformation, leak tightness, durability etc.

**Properties:**

1) A high strength and high early strength
2) Concrete with uniform density and minimum void
3) Moderately high strength
4) Good split tensile strength
5) High abrasion resistance
6) Volume stability

**CYLINDRICAL SHELL**

A cylindrical shell may be thought of as a surface generated by a straight line moving a plane curve. The straight line generating the surface is known as the generator and the plane curve that guides it is known as directrix. The directrices usually employed are the arc of the circle, the semi ellipse, the parabola, the cycloid and the catenary. A cylindrical shell may or may not be provided with an edge beam or edge member. The supporting members at the two ends of the shell are known as traverses. The traverse may be a solid diaphragm, a tied arch, a trussed arch, or a rigid frame. It is usually assumed that the shell is simply supported on the traverses. A further assumption is that the traverse are rigid in their own planes but flexible out of their planes so that they cannot receive any loads applied normally to them. The distance between the adjacent traverses is known as the span of the shell. The projection of the arc of the shell is generally known as its chord width. The shell to be casted is a thin cylindrical shell of 25mm thickness in which the edge members are reinforced with ring beam of 8mm dia bars as seen in figure Along the length of the shell, 8mm dia bars are tied with the providing the support while lifting the shell. Wire mesh is provided in the shell with a cover of 5mm on the top surface. The total thickness of the shell is 25mm. The top of the shell is finished by hand and the curvature of the shell and the height of the edge ribs.

**SILICA FUME:**

Silica fume as micro silica, is another material that is used as an artificial pozzolanic admixture. It is a product resulting from reduction of high purity with coal in an electric arc furnace in the manufacture of silicon or ferrosilicon alloy.

| COMPONENETS | COMPOSITION |
|---|---|
| Cao | 0.2% |
| Sio2 | 97.7% |
| Al2o3 | 0.3% |
| Fe2o3 | 0.1% |
| Mgo | 0.2% |

Properties:

1) Mean particle size between 0.1 and 0.2 micron.
2) Minimum specific surface area is 15,000 m2\kg
3) Spherical particle shape
4) pH value is 4.7
5) Micro silica is 48-52%

IV. RESEARCH METHODOLOGY

From the study of literatures, shell structure used in various shape and normal concrete structure, decided to thin shell like cylindrical shell used minimum thickness to distribute load, so its use high performance concrete due improve again strength and durability of concrete structure. High performance concrete using silica fume its improve strength but low workability, its avoided use hyper plasticizer. Its improve cylindrical shell strength and durability.

Compression test: It is the most recognized test conducted as it is an easy test to perform on hardened cement mortar and also mostof theenviable characteristic properties of cement mortar are qualitatively associated to its compressive potency.

The compression test is experimented out on cubical specimens of the size 150 × 150 × 150 mm. The test is carried out in the following steps: Firstly the mould made up of cast iron, is used to make the specimen of size 150 × 150 × 150 mm. At the time of placing concrete in the moulds it is well compacted with the tamping bar with not less than 35 strokes per layer. After 24 hours the specimens are carefully removed from the moulds and instantly stored in clean fresh water. After 14 and 27 days the specimens are made to test under the load in a compression testing setup.

## V. RESULTS AND DISCUSSIONS

**Prepared on Cubes**

Moulds were arranged and oil was applied for easy demoulding of specimens. Materials were weighed according to the mix ratio. Materials were dropped at the tray in the order of coarse aggregate, fine aggregate. After thorough mixing, the concrete mix was brought near to the cube moulds were kept for casting cubes. Concrete was placed in three layers and each layer was tamped for 25 times. Finally the specimen are curing 14 and 28 days in fresh water.

Cubes were placed one after the other properly in the compression testing machine in such a way that load will be applied uniformly over the cubes. Loading was given at the rate of 2kN/sec and the readings at the failures were taken. The failure pattern is shown below and the obtained data is tabulated.

There are parameters needed to describe the plastic properties of concrete. From the above results, the ultimate compressive strength of concrete is found as 40 N/mm2. As per IS 456:2000 clause 6.2.3.1, the modulus of elasticity of concrete can be assumed as follows:

$$E_c = 5000\sqrt{f_{ck}}$$

**Compressive Strength of concrete cubes**

The below table, the concrete mix design is 12.5% silica fume is good compressive strength compare to other propogations.

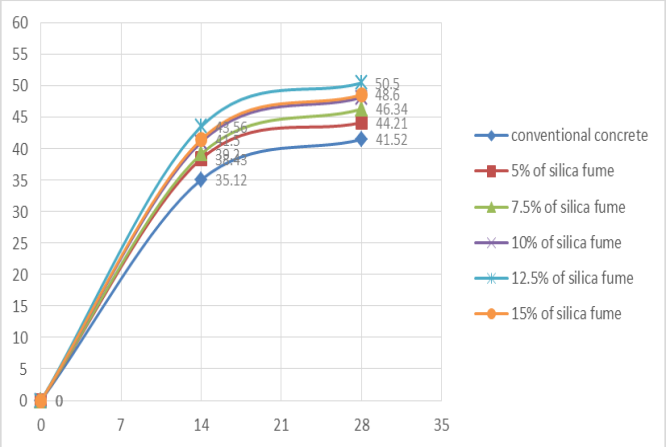
Where,

$E_c$ is the short term static modulus of elasticity in $N/mm^2$

Therefore, in the material model, 27386 $N/mm^2$ for young's modulus, 0.18 for poisons ratio and the concrete damaged plasticity model are used to incorporate the plastic behaviour of concrete. The concrete damaged plasticity model has capability to model plain or reinforced concrete in many applications including monotonic, cyclic and dynamic loading. The plasticity of model is defined by 34 degree for dilation angle, 0.667 for the ratio between second stress invariant on the tensile meridian to second stress invariant on the compressive meridian and 1.16 for the ratio between equi-biaxial compressive stresses to uni-axial compressive stress. The tension stiffening option is used to define the concrete's post failure behaviour. The tested plot values between the compressive stress and plastic strain is included to define the concrete in compression.

Its mixing was found mineral admixture and hyper plasticizer in increased the cohesiveness and stability of the segregatable mixtures. When silica fume was added at 5% and 7.5% its just cohesive while that with 12.5% silica fume was very cohesive. The 15% addition made highly cohesive very low workability. Finally 12.5% is good workability its added 0.5% of hyper plasticizer. It occur slump cone loss as 75mm.

| SI.NO | PERCENTAGE OF SILICA FUME | NUMBER 0F CUBES | COMPRESSIVE STRENGTH($N/mm^2$) ( 14 days ) | COMPRESSIVE STRENGTH($N/mm^2$) ( 28 days ) |
|---|---|---|---|---|
| 1 | 0% | 3 | 35.12 | 41.52 |
| 2 | 5% | 3 | 38.43 | 44.21 |
| 3 | 7.5 % | 3 | 39.2 | 46.34 |
| 4 | 10% | 3 | 41.09 | 48.2 |
| 5 | 12.5% | 3 | 43.56 | 50.5 |
| 6 | 15% | 3 | 41.5 | 48 .6 |




From the above graph, 12.5% of silica flume will give high compressive strength.

TESTING

Load testing was done by placing weighed sand bags contain about 40 to 90 kg sand on the top surface of shell. As the specimen is deformed, the soil is also deformed. And corresponding strain on the strain gauge and deflection on dial gauges are taken print out from data logger connected to the gauges at the various stages of loaded. The cylindrical shell corresponding to withstand the maximum load respectively. Here the failure has occurred suddenly without any warning. And the failure pattern is seems to be a pure structural failure by means of reverse buckling which otherwise known as snap through buckling.

FIG.1 LOAD APPLIED ON SHELL

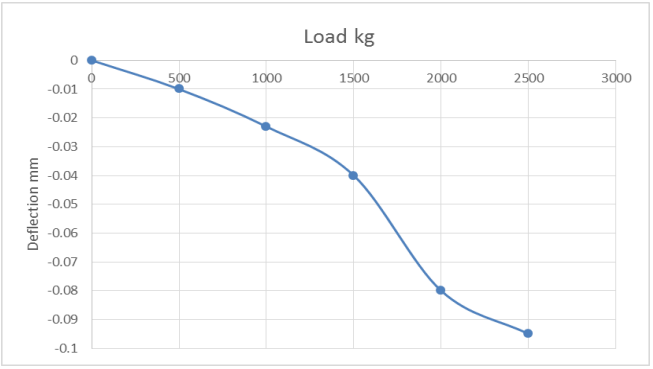



FIG.2 DEFLECTION GRAPH

## CONCLUSION

Finally the casted shells are tested by using sand bags. Under this uniformly distributed load applied on shells give results. The shell of thickness 25mm is carry 2400 kg until small crack. By these high performance using in cylindrical shell thickness give more strength to the shell.

- The high performance concrete is using silica fume 12.5% it achieved higher compressive strength.
- The results from the present study inferred that for better high performance concrete of cylindrical shell, to increase the load carrying capacity in minimum thickness of shell.
- Membrane stresses decreases with the increase in thickness of concrete cylindrical shell.
- The cylindrical shells are exhibited good performance in one-way slab action. This infers that the cylindrical shells are well suitable for one-way slab arrangements.

Analytical results has not close agreement with the experimental results and few results were not promising each other due to the error in the material model observe from the experiment.

## *References*


1. . Indian Standard – Criteria for Design of Reinforced Concrete Shell Structures and Folded Plates (IS 2210-1988).
2. 2. Practical design of Cylindrical Shell Roofs – V.K. CHAVAN.
3. 3. Design and Construction of Shell Roofs –G.S. RAMASWAMY
4. 4. Buckling stability of thin walled cylindrical shells under axial compression – Himayat Ullah and Sagheer Ahmad, Failure of Engineering Materials &Structures, pg 205, vol 2, 2007.
5. 5. Computer Aided Analysis of Multiple Cylindrical Shell Structure Using Different Parameters- Ravindra Rai, Dr.Umesh Pendharkar, international Journal of Engineering Research and Technology, Vol1, issue 2, May 2012.
6. 6. A Numerical and Experimental Study of buckling of Cylindrical Panels Subjected to Compressive Axial Load – Mahmoud Shariati, Mehdi Sedidhi- Journal of Mechanical Engineering, UDC 669.14:539.4
7. 7. Analysis of Thin Concrete Shells Revisited: Opportunities due to Innovation in Materials and Analysis Methods- Prof.dr.ir.J.C.Walraven, Ir.W.J.M. Peperkamp, Faculty of Civil Engineering, Delft University Of Technology, Netherlands.
8. 8. Thin-Shell Concrete From Fabric Moulds – C.A.S.T., University of Manitoba, Canada.
9. 9. Experimental investigations on buckling of cylindrical shells under axial compression and transverse shear, Sandana, Vol. 29, Part 1, February 2004, pp. 93–115
10. 10. Design aids for fixed support reinforced concrete cylindrical shells under uniformly distributed loads, International Journal of Engineering, Science and Technology, Vol. 1, No. 1, 2009, pp. 148-171.