POST DISASTER MANAGEMENT TO DISPOSE BUILDING DEBRIS BY RECYCLING TO FABRICATE INTO SHELL ROOFING

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ABSTRACT

In a developing country like India prone to many disasters like earthquakes and cyclones, the disposal the building debris of buildings collapsed remain as a major issue. The authors have found an interesting method to recycle the building debris. The coarse aggregates derived out of broken glass and broken ceramics are used to pre fabricate funicular shell units to have alternate roofing. This method not only eliminates the debris but also remain as a cost effective technique to arrive at roofing elements for low cost building projects. The authors make a sincere attempt in conducting experimental research on pre-cast FUNICULAR SHELLS with a linear scale factor of 1:2 with the help of model study and arrived at valid findings. In order to minimize the cost, the authors used novel idea of introducing recycled waste materials as coarse aggregates like broken glass pieces and broken ceramic aggregates found as bio non degradable industrial solid waste. The results achieved were quite useful to the construction industry as valid addition to its knowledge base.

Keywords: Funicular Shells, Glass Aggregates, Ceramic Aggregates, Mass Housing, Seismic Resistant Design.

INTRODUCTION

Housing scenario: More than one billion people have shelter unfit for habitation and this number will expand dramatically unless determined measures are taken. The United Nations Centre for Human Settlements (UNCHS) launched a global strategy for shelter to the year 2000 in order to improve the urban and rural shelters living condition. The main objective of the global strategy is to facilitate adequate shelter for all by the year 2025. In view of rising cost of land, building material, labour, lack of resources to mitigate housing problem and the fact that unless shelters solutions are provided at affordable level for the people at large, the housing problem will be accentuated; it became still more urgent to fasten the research work in this area. HUDCO studies have indicated the cost variation upto 2 to 3 times may occur between an efficient and inefficient physical design.

Shell structures: Shells can be defined as curved structures capable of transmitting loads in more than two directions to supports. Loads applied to shell surfaces are carried to the ground by the development of compressive, tensile and shear stresses acting in the in-plane direction of the surface. Thin shell structures are uniquely suited to carrying distributed loads and find wide application as roof structures in building. They are, however, unsuitable for carrying concentrated loads.

Types of shells

1. Shells by translation
2. Shells by revolution
3. Shells by ruled surface

Funicular shells: The word funicular is derived from Latin word funiculas, a thin rope or cord, which I related to funis, a rope. Funicular shells are doubly curved shell under the action of uniformly distributed loads and hence they are ideally suited for concrete construction. The shells can be cast using simple masonry moulds. The weight of the funicular shell of 1m x 1m size is about 650N and can be handled by manual labour.

Theory of funicular shells: The ordinates for the surface of a funicular shell can be obtained from the equation. A computer programme is available for obtaining co-ordinates of the funicular shells of rectangular or other plan forms. The following simple approximation of the equation can be used for obtaining ordinates of the surface.

$$Z = (z_{max} / a_2 \times b_2) \, ((a_2 - x_2) (b_2 - y_2))$$

Where

Z = Vertical ordinates at point(x, y)

z = Maximum central rise which may be taken as L/10 to L/15

(L = Size of the shell)

a = Half the length of the shell

b = Half the width of the shell

x, y = The co-ordinates to the grid point from the origin, which is taken as the centre of the shell unit.

Salient features: A doubly curved structure on the edge beam

1. Compressive structure able to span square, rectangular, triangular or orthogonal spaces.
2. An attractive alternative to RCC slab for small to medium span.
3. Ensures optimal utilization of steel and cement.

Journal of Chemical and Pharmaceutical Sciences www.jchps.com ISSN: 0974-2115

METHODOLOGY

The authors prepared model funicular shell with a linear scale factor of 3. These models were cast, cured and tested in the Universal Testing Machine. There were totally 12 samples constructed for different rises and material parameters. Then the load, longitudinal deformation and lateral deformation are all been tabulated and there corresponding deformation graph is drawn.

Advantages of funicular shells:

1. The saving in steel up to 25%.
2. Saving in total cost upto 20%
3. Saving in time of construction.
4. Reduction in the use of shuttering.
5. Plastering on the ceiling normally done in-situ is eliminated.

Specimens cast:

SP 1.75mm Rise Mould (C.A.)
SP 2.75mm Rise Glass
SP 3.75mm Rise Porcelain
SP 4.75mm Rise Canvas
SP 5.100mm Rise Mould (C.A.)
SP 6.100mm Rise Glass
SP 7.100mm Rise Porcelain
SP 8.100mm Rise Canvas
SP 9.125mm Rise Mould (C.A.)
SP 10.125mm Rise Glass
SP 11.125mm Rise Porcelain

Fig.1.Construction of funicular Shell

Fig.3.Porcelain used as coarse aggregate

SP 1.75mm Rise Mould (C.A.):

Table.1.75mm Rise Mould (C.A.)

Load **KN**	Longitudinal Deformation **mm**	Lateral deformation **mm**
0	0	0
5	0.5	0.002
10	0.73	0.086
15	0.82	0.196
20	0.93	0.234
25	1.0	0.266
30	1.1	0.376
35	1.6	0.476
40	2.14	0.508
45	3.32	0.944

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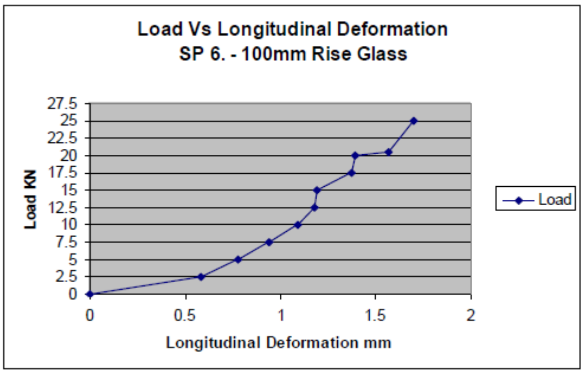
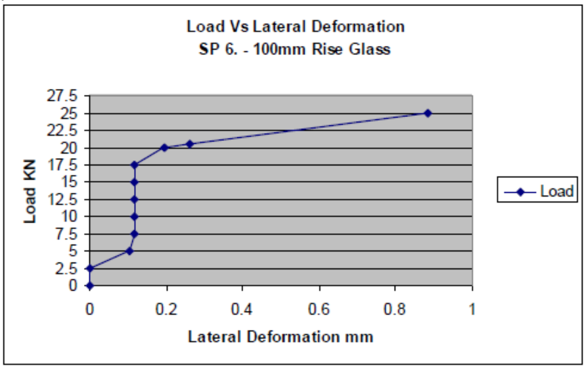


Graph.3.Sp6. Load Vs Longitudinal Deformation



Graph 4. Sp6. Load Vs Lateral Deformation

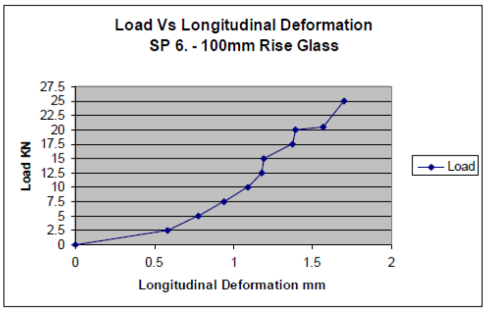
Fig.4. 75mm Rise Mould (C.A.)

Fig.5. Testing of 75mm Rise Mould (C.A.)

SP.6.100mm Rise Glass:

Table.2.100mm Rise Glass

Load KN	Longitudinal Deformation mm	Lateral deformation mm
0	0	0
2.5	0.58	0.001
5	0.78	0.105
7.5	0.94	0.115
10	1.09	0.115
12.5	1.18	0.115
15	1.19	0.115
17.5	1.37	0.115
20	1.39	0.196
20.5	1.57	0.26
25	1.7	0.885



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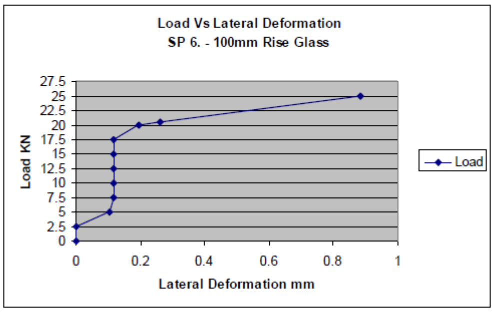

Graph 4. Sp6. Load Vs Lateral Deformation

Fig.6.100mm Rise Glass

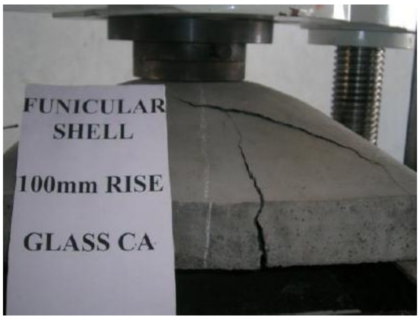

Fig.7.Testing of 100mm Rise Glass

CONCLUSIONS

We found out the optimum rise of the shell which has maximum load carrying capacity. We found out that the shell with a rise of 100mm has the maximum load carrying capacity. The shell thickness is kept as slender as 50mm. hence we have the option of using coarse aggregate of size 10mm and down grade. This reduction in size of coarse aggregate will result in lower load bearing capacity. Hence we made a sincere attempt to replace the conventional blue granite jelly with some other alternate material. We found that the estimated cost of funicular shell roofing is almost 50% less than that of the regular flat roofing. The shell structure is always subjected to compressive loading and thus it also acts as an effective solution to earthquake make the structure resistant toward the vulnerable seismic ground accelerations.

REFERENCES

Appropriate Technologies for Low-Cost Housing-A.G.Madhava Rao, D.S.Ramachandramurthy.

House for economically weaker sections, Structural Engineering Research Center, Madras 1977.

Proceedings of advanced course on 'Modern Trends In Housing',Structural Engineering Research Center, Madras, volumes 1and 2sept-1-11,1980.

Report of the development group on prefabrication and modular co-ordination in building, Min of works and housing, Government of India, 1978.

Proceedings of the UNCHS-SERC work shop on housing, Infra Structure and Services for Low-Income groups in Developing countries, 5(17), 1983.