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EXPERIMENTAL STUDY ON CONICAL SHELL FOOTING

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ABSTRACT:

The development of shells as a structural form is a gift to construction field. Shell foundations outperform conventional flat footings and are reputable performers especially when heavy super-structural loads are to be transmitted to weak bearing soil. This project deals with the study of the structural performance of conical shell footing in low load bearing capacity soil. The main aim of this project is to find out the ultimate load carrying capacity of conical shall footing. Mixes were prepared for M30 grade concrete. Cubes of sizes 150 mm were casted for compression test. All the specimens were water cured and tested subsequently. The conical shell footings were designed for two different shell angles i.e. 126.88^o and 90^o with constant thickness. Tests were conducted for 3, 7 and 28 days.

Keywords: Grade, Shell foundations, Bearing Soil.

1. INTRODUCTION

A foundation is the lower part of structure which transmits entire load from superstructure to the soil beneath. Therefore a foundation is used to support a building or structure and transmits loads directly to the underlying soil or rock. Also foundation is the first structural elements which undergo any structural failure. So selection of type of foundation as well as design must be an important one in any design. It must satisfy two fundamental requirements. Firstly, it must provide an adequate factor of safety against failure of the supporting strata. Secondly, any resulting settlement and in particular differential settlement should not be detrimental or interfere with the function of the structure. The main purpose of the foundation is to distribute the structural load over a large bearing area without causing bearing capacity failure and excessive settlement to obtain a level and hard strata or bed for building operations to increase the stability of the structure as a whole. A concrete support under a foundation that rests on solid ground and is wider than the structure supported is known as footing. Footings distribute the weight of the structure over the ground. A footing is typically concrete and typically reinforced with steel. Different types of footings are available and day-to-day changes overcome in that in a better manner. Shell footing is one among them. The concept of shell footing is not new in foundation design, considering past constructions using inverted brick arch foundation. The use of inverted brick arches as foundation or footing has been in practice in many parts of the world for a long time. Shells in modern foundation engineering are however relatively new. Shell footings are economic alternatives to plain foundations in situations involving heavy super structural loads to be transmitted to weaker soils. Shell footings have been found to be economical foundations in areas having high material to labour cost ratio. Shell footing has greater load carrying capacity compared with flat shallow foundations. Moreover, shells are essentially thin structures, thus structurally more efficient that flat structures. This is an advantage in situations involving heavy super structural loads to be transmitted to weaker soils.

2. LITERATURE REVIEW

Abang Ali et al. (2007), studied on the performance of triangular shell footings using finite element and field model test. Two shapes of triangular shells were studied, namely the upright triangular and inverted triangular shell. A parametric study was also carried out to examine the effect of shell thickness and shell angle on the load carrying capacity of the shell footing. Field tests comprising three types of footings, namely a conventional flat footing, an upright triangular shell and an inverted triangular shell footing were carried out. The model footings were monitored using load and pressure cells. Each footing was 1 m by 1 m in plan area. The 2 and 3 D finite element modelling was done by using the computer software LUSAS. The Finite Element analysis showed that the inverted triangular shell footings had higher load carrying capacity compared with other strip footings. The load carrying capacity of the inverted triangular shell footing was about 15% and 28% higher than the upright triangular shell footing and conventional flat footing respectively.

Esmaili and **Hataf (2008),** studied the ultimate load carrying capacities of conical and pyramidal shell foundations on unreinforced and reinforced sand by laboratory model tests and numerical analysis. To examine the effect of the shell thickness on the ultimate load capacity, three types of conical and pyramidal model shell foundations have been made and tested. Two types of flat foundations, i.e. circular and square foundations were also made and tested for comparison. A cylindrical tank of 1.00 meter in diameter and 1.00 meter in height was built for testing the conical and circular foundation models. A box of 1.00×1.00×1.00 meter was built for testing the pyramidal model shell and square flat foundations. Displacements were measured using the dial gauges. A total of 32 loading tests were performed on the cited shallow footing models.

Pusadkar Sunil Shaligram (2011), studied behaviour of triangular shell strip footing on georeinforced layered sand. Tests were conducted on five models of triangular strip footings with peak angles $\theta = 180^0$, 150^0, 120^0, 90^0 and 60^0. All models have same width B = 100 mm and length L = 130 mm. Three holes of 25 mm diameter each were provided on the top of all footings for filling sand under side of footing. The sand used in present experimental work is local sand having blackish colour, rounded quartz crystal particles. Reinforcement was provided in the form of woven geosynthetic of polypropylene. An experimental tank of 600 mm x 500 mm x 130 mm internal dimensions was fabricated for model testing. The sides of the tank were made of Perspex transparent sheet to allow visual observations and base was made of steel sheet.

3. METHODOLOGY

This chapter briefly explains the methodologies adopted in phase I and phase II of this project. In the first phase, the literature related to the conical shell footing were collected and studied, then the preliminary tests were conducted to find out the properties of materials used in construction and using these properties, the proportions of ingredients of the control concrete of grade M30 was determined by using IS code for mix design. In the second phase, conical shell footing will be cast and test to find out the ultimate load carrying capacity of the footing. All the materials tests were conducted in the laboratory as per relevant Indian Standard codes. Basic tests were conducted on fine aggregate, coarse aggregate, and cement to check their suitability for concrete making. The study aims to investigate the strength related properties of concrete of M30 grade. The proportions of ingredients of

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the control concrete for grade M30 had determined by mix design as per IS code. Then the cubes were casted and cured. Then the cubes were tested in compression testing machine to found out its strength.

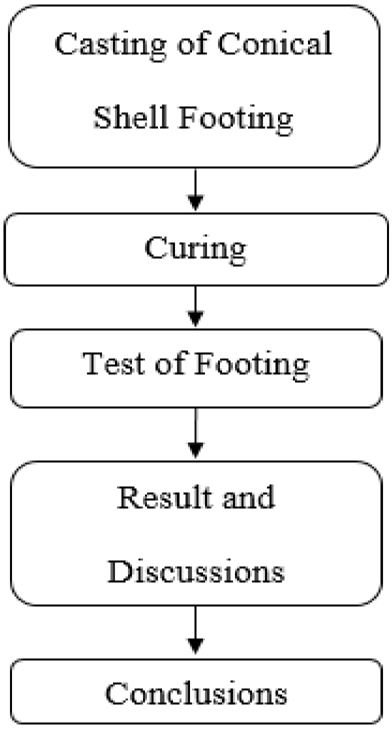

Fig.1.Flow Chart of Methodology

4. PRELIMINARY TESTS

Fig.2. Slump cone apparatus

Cement when mixed with water forms paste which gradually becomes less plastic and finally a hard mass is obtained. This process of setting stage is termed as setting time. In actual construction dealing with cement paste, mortar or concrete certain time is required for mixing, transporting, placing, compacting and finishing. The time is reckoned from the instant when water is added to the cement. The setting time is divided into two parts namely, the initial setting time and the final setting time.

The time taken to reach the stage when the paste then becomes a hard mass is known as the final setting time. Lowering the needle gently and bring it in contact with the surface of the test block and quickly released. In the beginning, the needles will completely pears through the test block. But after sometime when the paste starts loosing its plasticity, the needle may penetrate only to a depth of 33-35 mm from the top. The period elapse between the time when water is added to the cement and the time at which the needle penetrates the test block to a depth 33-35 mm from the top is taken as initial setting time. The sample was brought to an air-dry condition before weighing and sieving. This was achieved either by drying at room temperature or heating at a temperature of 1000^0C to 1100^0C. Then 1 Kg of air-dry sample was taken and sieved successively on the appropriate sieves starting with the largest size sieve as stated in the table. Sieving was carried out on a machine not less than 10 minutes required for each test.

5. ANALYSIS

Fig.3. Experimental Setup for Compressive Strength Test

The compressive strength test for cubes was conducted in compression testing machine as per IS 516 : 1964. The bearing surface of machine was wiped off clean and the surface of the specimen was cleaned. The specimen was placed in machine in such a manner, load was applied to opposite sides of the cubes such that casted side of specimen was not top and bottom. The axis of the specimen was carefully aligned at the centre of loading frame. The load applied was increased continuously at a constant rate until the resistance of the specimen to the increasing load breaks down and no longer can be sustained. Maximum load applied on specimen was recorded. The strength of concrete was expressed as N/mm^2. The three specimens were tested for compressive strength for 3, 7 and 28 days respectively.

CONCLUSION

The various factors which affect the behaviour of conical shell footing had thoroughly studied from reputed journals for initiating the phase I work. It was learned that half shell angle influence much in the load carrying capacity of the shell footings.The preliminary investigations had done for basic ingredients in concrete. Various initial tests were done for cement, coarse aggregate and fine aggregate.From the material property results, mix proportions were arrived for controlled concrete of M30. Compressive strength test for controlled specimen concrete was carried out for 3, 7 and 28 days. The results were obtained for compressive strength of concrete as 36.48 N/mm^2 which is close to the target strength of 38.25 N/mm^2. Conical shell footings with two different angles with constant thickness were designed to cast footings in the next phase.

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