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Analysis and design of spread/wall footing

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Abstract

Lower base of a structure is a very supreme part as it links the main body superstructure to the earth. That lower base is known as Foundation. In this paper we are going to discuss about the types of foundations used in construction industry, there design and also which alternative materials we can utilize as foundation material which can make it more firm, durable and ecofriendly. When it comes to build a structure it is very crucial to construct a firm base which holds the superstructure in all climatic conditions without collapsing or decaying. It is very important to know which type of foundation is essential to use in a particular superstructure, which materials are more suitable, which designs should be used. If any inappropriate material is used for foundation of structure, then high risk is involved of collapsing of the structure. Different types of foundation base are utilized in different types of structures, each one of them has a unique design and specific configuration which makes a particular structure more durable and firm. A different foundation type is used in bungalows and in high rise buildings. In short this study presents the foundation types, (mainly **spread footing**) which type is used for which superstructure, which design is suitable and more precisely we will be discussing about how we can make the foundation base ecofriendly, cost efficient and more durable and strong to withstand the natural calamities.

Keywords: foundation, superstructure, design, durable, ecofriendly, base, collapsing

Introduction

Construction of any structure starts with the built up of foundation base which holds the weight of all beams, columns, walls, slab, and other household materials. Hence having a strong and solid base is must. Foundation is basically classified into two major categories which is further sub divided into number of categories based on the type of structure to be implemented. For low rise houses and bungalows shallow foundation is used and for high rise building and houses deep foundation is used. The classification diagram is shown below for better understanding of the types of foundation. Every foundation has different type of footing. Not only on ground but underground foundation is also existing which has a total different type of construction methodology. Each foundation type has a unique equation which helps us to design the foundation on field. For some foundation the underground depth is 3m while for some the underground depth is 10m and more as it depends upon the height of the structure. Also a thorough understanding of ground and soil condition is must for construction of foundation as it plays a major role in understanding the behavior of the structure, which materials should be used and also will the structure stand firm for longer time or not. So before constructing any foundation it is very important to study the soil type of the ground and also to check if the area is an earthquake prone zone or not.

1. **Shallow foundation**
- Individual footing or isolated footing
- Combined footing
- Strip/Spread/wall foundation
- Raft or mat foundation

2. **Deep Foundation**
- Pile foundation
- Drilled Shafts or caissons

Individual footing or an isolated footing: is the most common type of foundation used for building construction. This foundation is constructed for a single column and also called a pad foundation. The shape of individual footing is square or rectangle and is used when loads from the structure is carried by the columns. Size is calculated based on the load on the column and the safe bearing capacity of soil.

Combined footing: is constructed when two or more columns are close enough and their isolated footings overlap each other. It is a combination of isolated footings, but their structural design differs. The shape of this footing is a rectangle and is used when loads from the structure is carried by the columns.

Spread footing: is generally used in residential building, has a wider bottom portion as compared to the load bearing foundation walls it supports. This wider bottom portion spreads the weight of the structure over more area to achieve more stability. The layout and design of the spread footing foundation is controlled by some factors, such as the weight of the superstructure it must support, penetration of soft near surface layers and penetration through near surface layers which are likely to change volume due to shrink swell or frost heave. This type of footing is basically used to construct basements in residential buildings. Spread footing behaves like an inverted cantilever with load applied in the upward direction. Builders and civil engineers prefer spread footing as it beneficial, as it helps transfer the load to the ground surface making it an excellent solution for stabilizing weak soil. Benefits of spread footing are it reduces the cracking caused by settlement, cost efficient in design, construction and quality control, and stabilize the soil around the structural base, less complicated procedure.

Raft or mat foundations: are the types of foundation which are spread across the entire area of the building to support heavy structural loads from columns and walls. The use of mat foundation is for columns and walls foundations where the loads from the structure on columns and walls are very high. This is used to prevent differential settlement of individual footings, thus designed as a single mat (or combined footing) of all the load-bearing elements of the structure.

Pile foundation: is a type of deep foundation which is used to transfer heavy loads from the structure to a hard rock strata much deep below the ground level. Pile foundations are used to transfer heavy loads of structures through columns to hard soil strata which is much below ground level where shallow foundations such as spread footings and mat footings cannot be used. This is also used to prevent uplift of the structure due to lateral loads such as earthquake and wind forces.

Drilled shafts, also called as caissons: is a type of deep foundation and has an action similar to pile foundations discussed above, but are high capacity cast-in-situ foundations. It resists loads from structure through shaft resistance, toe resistance and/or combination of both of these. The construction of drilled shafts or caissons are done using an auger.

3. Proposed Algorithm

The eccentric footing is a spread or wall footing that must resist a moment in addition to the axial column load and it has the shape of the shoe. The eccentric footing is designed in such a way that the C.G (center of gravity) of the superimposed load coincides with the C.G of the base area so, resulting in uniform bearing pressure this footing is subjected to concentric loading. In one of an ongoing project of Ananda imperial extension, eccentric/wall footing is designed as one of the wall is common to another hall so there is no space for pad footing.

4. Experiment and conclusion

The design of footing is based on the safe bearing capacity and density of soil. After soil testing the result is

NET SBC = 170KN/sqm
SOIL DENSITY = 18 KN/cum

The footing is designed by equivalent method and by using STAAD-foundation advanced. The design values are considered according to IS code 456-2000. The values for design of footing is considered as

Footing Depth = 4m
Water Table = 1m
Clear Cover = 0.075mm
Live Load Reduction = 50%
Concrete Grade = M25
Steel Grade = FE500

Reinforcement Area

Minimum Depth = 3m
Minimum Top = 0.06%
Minimum Bottom = 0.12%
Maximum Top = 1.5%
Maximum Bottom = 1.5%
Face Reinforcement = 0.05%

The nonlinear finite elements are applied in the analysis of concrete footing-soil seismic interaction mechanism. The concrete footing is built up with two different shapes and equal volume. The simulated near-fault ground motions have been applied to each configuration. In the present study, the following aims have been achieved.

1. It has been found that the concrete footing-soil interaction and morphology of differential settlement have been changed with respect to the shape of the concrete footing.
2. The local geotechnical conditions have been modified ground-shaking characteristics. The anomalous damage distributions may not derive with the select appropriate shape of a concrete footing, considering local site conditions.
3. The morphology of concrete footing affects the seismic energy travel paths, and meaningful relationships have been observed between simulated near-fault ground-shaking and energy dissipation mechanism. The strain energy has more been dissipated with artistic concrete footing design.

4. The shape of concrete footing governs hysteretic soil damping and inertial interaction; these processes have occurred based on kinematic interaction of concrete footing-soil foundation characteristics.
5. The higher strain energy concentration has been observed at the base of the configuration-1, with respect to the magnitude and shape of the seismic loading response. The differential settlement is significantly minimized in configuration-2.
6. The cyclic strain causes plastic cyclic deformation, with respect to the shape of concrete footing and related to increment of stress. According to the numerical results, this approach supports in forecasting the seismic stability of concrete footing.

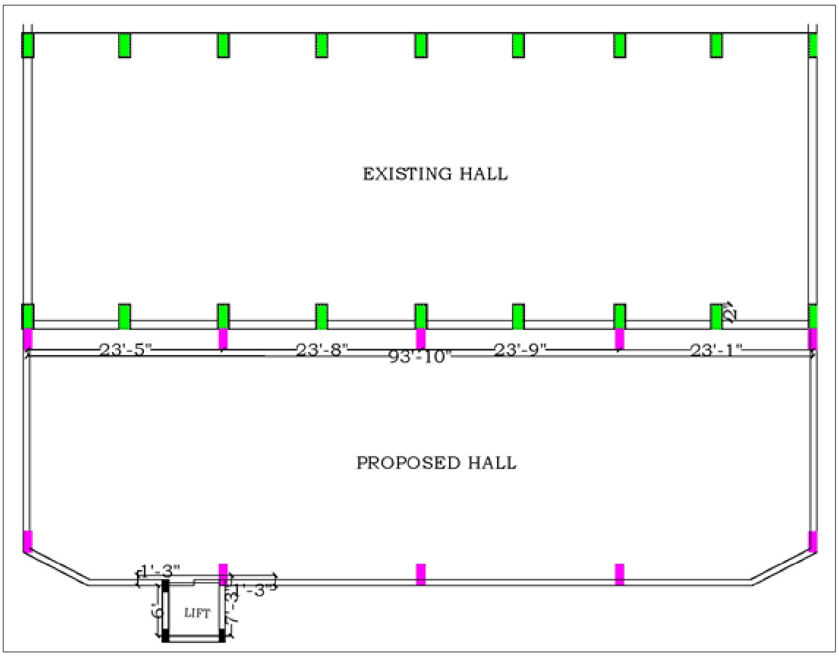

Fig1: Existing and proposed hall

Design result

After design procedure, footing size are differing for different columns. In this project there are 13 numbers of column including columns for lift. Let us consider one of the eccentric footing designed for column size 300x750.

This footing is designed as stepped eccentric footing resulting in the upper pad size 3600x2350x500 and lower pad size 4400x3950x425. The result for upper pad reinforcement mesh 10T@300 throughout and for lower pad reinforcement 12t@150.

In addition, when footings are subjected to an axial load "P" and bending moment "M" or lateral force "H", the footing will experience unbalanced stress distributions along the base of the footing which results in buckling and bond stresses in columns. To resist these failures, two inclined bars are designed for eccentric footing resulting 8x20T reinforcement for each face of column.

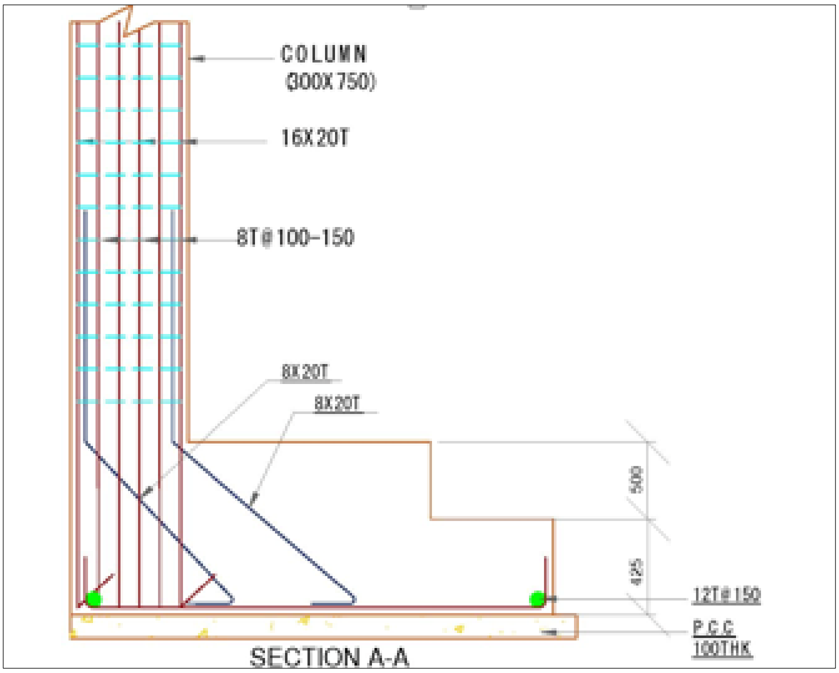

Fig 2: Section A-A

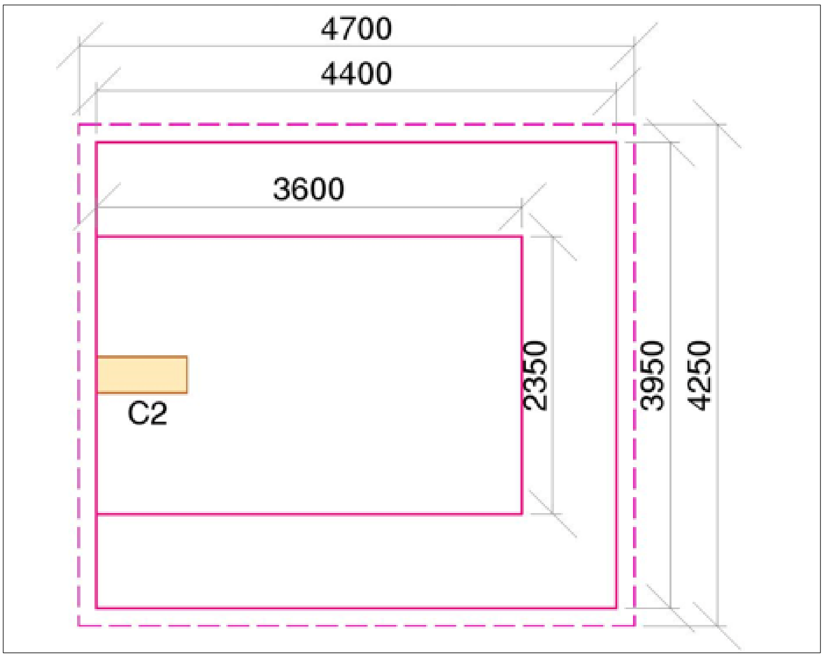

Fig 3: Detail of footing FC2, FC3, FC4

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