



INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X

Impact factor: 4.295

(Volume 5, Issue 2)

Available online at: www.ijariit.com

Review on multi storey building foundation strength against various soil properties and seismic force

Sangitika Nandi

sangitika2011@gmail.com

Lovely Professional University, Phagwara, Punjab

Anshul Garg

anshul.18374@lpu.co.in

Lovely Professional University, Phagwara, Punjab

ABSTRACT

The foundation stability for different types of multi-storied building is becoming one of the most important areas of study since last few years. But unfortunately, there are many factors associated with the stability of the foundation are yet to be discovered. However it has been seen that many have attempted to establish the correlation between different coefficients and factors associated with beams and column failure, but only a few research works have been considered the failure against seismic force. There are only a few numbers of research evidence available which indicate that the analysis of the stability against seismic force is one the most important parameter in this regard. In this work, a detailed study related to the different factors associated with the building foundation as well as their effect and correlation with the seismic forces has been done. From the study, it has been found that the deep foundation provides better resistance than the shallow foundation against seismic force.

Keywords—Pile foundation, Shallow foundation, Load bearing capacity, Soil properties, Seismic force

1. INTRODUCTION

Building development is an ancient human activity. Since that time the foundation is being used but with the progress of building technology research against building a more efficient foundation is getting the highest priority. It has been seen that the strength of the foundation mainly depends upon the type, shape, and number of foundation [1]. It has also been reported that the soil types also play an extensively crucial role in foundation design [2]. Soil bearing capacity in this regard is considered to be the most important parameter. It has been reported that the soil bearing capacity changes with respect to different types of soil found in the different geographic region [3]. After an extensive literature survey it has been found that load-bearing capacity of pile foundation and shallow foundation can be estimated in respect to in-situ laboratory testing, codal provision [4], [5] and static formula [6], [7]. Superstructures, for example, pillars, sections, pieces, and staircase and so on, are put over the ground level that is., at the highest point of the establishment and establishment are assigned as substructure as it is put beneath the ground level. Establishment assumes a crucial job in each auxiliary structure. Assorted types load of the superstructure is exchanged to substructure that is., establishment and establishment exchanged it to soil and shake which help an establishment to give support proficiently to the superstructure. A wide range of soil can get compacted and encourages structure to settle. Presently multi-day, before building an establishment we should check the dirt capacity, water level and generally it is checked in which seismic zone it lies. In seismic zone 5, establishment ought to be taken uncommon consideration with legitimate soil testing and plan [8]. As per cl.34.1 of IS 456 [9], the most requirement of the foundation is given below:

- The structures of the establishment should have the capacity to withstand the connected burdens, minutes, powers and initiated responses denied over the dirt-safe bearing limit.
- The structures settlement should be as uniform as conceivable which can be inside the middle of as far as possible. The structured settlement is likewise known from the basic examination that disparity settlement of backings causes extra minutes in statically uncertain structures. That is the reason; the differential settlement should dodge. This is considered as strengthening imperative than keeping up a uniform finish settlement of the establishment structure.

2. LITERATURE REVIEW

Aleksandar Sedmak Vesić has displayed a cutting-edge viewpoint of the issue of bearing limit of shallow establishments. They have demonstrated that the best inadequacy of accessible hypotheses lies in their open suspicion of incompressibility of the establishment soil. In this paper, an endeavour is made to figure out of the blue sane compressibility criteria for soils exposed to establishment loads. A concise thought of the impacts of bearing limit of an anomaly and vertical profile of establishment base, ground-water table, nearness of neighbouring footings and rate of stacking has been acquired from this exploration work [9]. S. K. Sarma et al. have considered the Seismic increasing speed is following up on the structure as it were. The seismic bearing limit

factors (that is. N_q , N_c and N_r), are controlled by utilizing the breaking point symmetry procedure of slant steadiness examination with slanted cuts. Their examination demonstrated that the factor. V_q is subject to the idleness of the extra charge stack. In this examination, the connection between various seismic bearing limit factors has appeared. This paper demonstrated that a similar connection that has been appeared in changed writing is not right in a considerable lot of the cases and need to retest [10]. Antonio Bobet et al. recorded worldwide for the execution of profound establishments amid past quakes is utilized to distinguish the causes and the instrument of heap harm. Distortions forced to the heap by the reaction of the encompassing soil and fit to deliver harm particularly in instances of soil layers with substantial contrasts in solidness. Splitting watches out for the concentrated close to the heap head and at the interfaces among delicate and hardened soil layers. In this exploration, ground increasing speeds and liquefaction, the potential is evaluated for nine chosen locales by one-dimensional proliferation investigation utilizing shake. Steel throwing enhances the seismic execution of solid heaps even in instances of broad liquefaction and parallel spreading. Steel heap establishments are more averse to endure harm amid quakes [11].

E. C. Shin et al. established that a definitive bearing limit of a strip establishment upheld by sand with different layers of geogrid fortification the consequences of little-scale research centre model tests have been selected. The creators have directed the test just with one sort of geogrid and sand compacted to one relative thickness. They fluctuated the installation proportion of the establishment from 0 to 0.6. The advantage they got from this examination is found for the given support profundity proportion as for extreme load increments with the installation. The connection between the bearing limit proportion at extreme load and at constrained dimensions of settlement (not exactly or equivalent to 5% of establishment width) has additionally been considered. In particular, it has been accounted for that the bearing limit proportion at constrained dimensions of settlement is littler than the incentive at extreme load [12]. H. B. Nagaraj et al. have examined the Indian Seismic codes are: 1893 (Part-1): 2002 [13] in points of interest. They see that table 1 of IS: 1893 [13] demonstrates that passable bearing weight increments. The dirt is appropriated in three sorts for comprising establishment is named as Type I-Rock or Hard soil; Type II-Medium Soil; Type III-Soft soil. The previously mentioned order is made on IS1498-1970 [14], which pays prefixes and additions to group the sort and subgroup as condensed in table 2 and table 3. It is seen that the heaps ought to be gotten ready for horizontal burdens ignoring parallel opposition of soil layers dependable to dissolve. They registered from IS1888 [15], the estimations of N (redressed values) are at the establishment level and the suitable bearing weight can be resolved [16]:

Seismic Zone level (in meters)	Depth below ground	N-values	Remark
III, IV and V	≤ 5	15	For values of depths between 5 m and 10 m, linear interpolation is recommended
	≥ 10	25	
II (for important structures only)	≤ 5	15	
	≥ 10	20	

Akira Komatsu et al. has done model tests utilizing the aluminium bar-laminar, it was discovered that the idea of compelling width relying upon load capriciousness can be utilized to assess the bearing limit of assembled heaps in the same way as the count strategy for shallow establishment. In this exploration, the horizontal bearing limit condition of battered heaps was inferred by utilizing the permissible speed field strategy and the proposed condition gave palatable concurrence with the aftereffects of research facility tests [17]. K.S. Subba Rao et al. has assumed that the seismic earth weight coefficients by utilizing the utmost harmony with the assistance of pseudo-static strategy for seismic powers. The prior investigations have utilized this sort of examination mostly for sands, yet in this exploration, the creators have additionally considered the seismic latent earth weight coefficients and relate with the impacts of attachment, supplement and its own weight. The minimum seismic dormant power was acquired by including the individual slightest estimations of these parts and the legitimacy of the rule of superposition was reviewed. The advantages creator got from this exploration is that the seismic earth weight coefficients were found, and they have demonstrated that they are exceedingly touchy to the seismic quickening coefficients in both the level and vertical ways. Correlations with accessible hypotheses of the proposed strategy if there should be an occurrence of seismic are additionally exhibited [18]. M. Yanger Walling et al. has picked the propelling zone for the significant quakes which are in charge of the impression of prior accessible maps. The seismic zone guide of India has likewise been set up by different free workers by interfacing diverse strategies to accomplish the motivation behind the zonation. The advantage of this exploration is seismic small-scale zonation work has been done in India. They have taken some fundamental user urban communities and modern locales which are developing that can give the capability of getting harmed from future tremor as it has been uncovered previously. They presumed that the small-scale zonation outline, not the last yield delineate it tends to be refreshed at a later stage with more information; it provides a more practical picture on the site correct seismic peril [19].

Adarsh Sankaran et al. figured two techniques, bolster vector machines (SVMs) and Hereditary Programming (GP) to foresee a definitive bearing limit under shallow establishment. To foresee extreme bearing limit of the dirt, they have taken width of balance (B), profundity of balance (D), the length-to-width proportion (L/B) of footings, thickness of soil (γ), point of inside rubbing (Φ), and so on the outcomes demonstrates that statically examination is superior to the hypothetical methodologies. It is seen that GP models is effective while foreseeing a definitive bearing limit cohesion less soil when it is contrasted and different models [20]. Valverde-Palacios et al. have done powerful entrance tests, coordinate shear and combination test over circulated tests. The fundamental programmed properties of the dirt under static circumstances and it is resolved that the highlights are associated with bearing limit and establishment structure. To investigate the proportional unique geotechnical parameters through utilizing different observational relationships of static and dynamic parameters. They discovered the implications or phrasing and standards about bearing limit under seismic conditions with the assistance of Spanish and European specialized codes. They gotten results from their undertaking are that they proposed new kinds of establishment, which would be fit for withstanding the capability of seismic activity. These enhanced establishments can have a superior load stream and higher solidness that is., strip balance is of strengthened solid plates and wherever required profound heaping is finished. After the entirety of their examination

work, they discovered that profound establishment will be more helpful to continue capability of seismic activity [21]. Franc esco Castelli et al. has improved the situation a given seismic inclined region, these elements contain however it isn't limited to:

- The blame of burst plane from relative separation;
- Construction type and it's quality;
- Local soil condition (that is. quality/firmness of soil establishment, profundity to bedrock, impedance contrasts, topography);
- Topography (topographic and bowl impacts);
- Near blame impacts (break directivity, filling step, running divider impact, extremity impacts and so forth.).

These incorporate new ideas of the plan, for example, execution based plan (PBD) and new proportions of the auxiliary introduction dependent on vitality ideas and harm lists. In this examination, the structure of establishments in seismic inclined zones needs exceptional treatment than the static case. The specialists are persuaded to re-examine existing strategies and to grow new techniques for seismic unaffected structure because of as of late happened quakes. The pivotal point for the assessment of the seismic reaction of the structure is dirt structure communication [22].

Behzad Kalantari described different types of foundation design which are built in the expansive soil. It has been observed that these foundations undergo different structural damage because the soil swells when they are subjected to moisture and shrink when they lose moisture. In this work, the author has attempted to present some common technique to determine the swelling potential. The author has observed that if the particle size is less than 0.002 mm, then there is always a chance of an increase in swelling potential. It has been suggested that for swelling soil the structure on the ground is not recommended as well as the topsoil layer should be replaced by a soil which is non-expansive in nature [23]. Mahmoud Ghazavi et al. go for vertical and slanted heaps as a result of angled symphonies vibration stack on it. They can't perceive still for firmly dispersed battered heaps on the heaped soil - collaboration. They utilized a straightforward expository strategy, which made on the elasto-dynamic hypothesis by Novak and his associates, is utilized in this examination to portray vertical and slanted detached round and hollow heaps exposed to slanted symphonies vibrations. While doing the examination they discovered that the correspondence factor between two battered heaps and they completed an investigation to manage the impact of the nearness of a nearby heap (recipient) while the primary heap (source) is stacked. By this, they discovered that source heap's head diminished while collector heap is available. They discovered every one of the impacts conceivable because of heap separate, the geometry of gathering, the length of the heaps, and the slanted plot for every, they gave relating results add to that [24]. Rolf Katzenbach et al. have explained a way to optimize geotechnical structure which does not compromise with safety and serviceability. The importance of in situ load test in order to optimize deep foundation system has been explained [25].

Taiye W. Adejumo et al. have explored the heap incremental impact on the disfigurement of mud under pivotally stacked displayed wooden roundabout heaps in the dirt. They have watched a straight relationship among heap pivotal limit, heap uprooting and stack incremental rate. From this work, the creators have presumed that the parallel relocations in the model tests displayed generally comparative patterns to those by and large saw in the field [26]. B.N. Basak et al. have worked at the site of Palatana, Agartala. They have done field investigation with a number of bored piles following standard codes. They conducted pressure meter tests at the two sites of the location using Menard Pressure Meter. They have done testing of both disturbed and undisturbed samples that are collected from bored piles and obtained results as per codal provisions. Later, bearing capacity of different types of shallow and deep (pile) foundations are obtained as per standard codes using different laboratory tests. Bearing capacities of those shallow foundations and safe bearing capacities of those piles are further estimated using Pressure meter parameters. A contrast between the bearing capacities of footings and pile capacities under compression obtained from Pressuremeter test and they obtained bore log data and laboratory test results as per standard codes. From shallow and pile foundation, pile capacity arrives more as compared to shallow foundations [27]. Bogumil Warna considers the principle issue emerging because of heap limit figuring. He primarily investigates the fundamental standards of figuring of heap limit which is made reference to in Euro code 7 and different process with appropriate depictions. For the most part, two strategies are thought of one as: is α -technique which is utilized to compute for here and now stack limit of heaps in strong soils and another is β -strategy which is utilized to figure for long haul stack limit of heaps in both firm and cohesionless soils. He discovered cone CPTU results and heap limit issues dependent on static tests [28].

A. K. Dey et al. determined that bearing capacity of foundations resting over a slope which is subjected to dynamic and static loads. They tested models in the laboratory also. They have maintained the slope of 30° with 50% of relative density. A square plate of 10cm is used as their model in this research. The results have seen that if load-settlement behaviour and ultimate bearing capacity is increased then edge distance is also increased. One dimensional shaker is been used to check the load-settlement behaviour. At last, the failure on the slope is analysed and the dynamic bearing capacity was determined [29]. Zhibao Cheng et al. has put one multi-storey casing structure and the perception is done intermittently. A 6-story RC outline structure for the seismic reaction is dissected in the event field. To break down the dynamic properties of designing structures is known as occasional structure hypothesis. They have finished with both hypothetically and numerically on multi-storey casing building structure of the wave scattering properties is set up. They have done symphonies investigation and time history examinations are directed. The advantages from this exploration, the creator discovered that when outside excitations of the principal event locale fall into the passing groups, numerical outcomes are gotten as extensive in unique reactions for the multi-storey edge building structure reactions of the decrease zones, and for the multi-storey casing building seismic reactions are little [30]. Shrikant M. Harle has done plan and examination in the multi-story building utilizing staadpro and Matlab. An examination can likewise be finished with the assistance of C+, Java programming and so forth. Be that as it may, Matlab is abnormal state programming devices for some confounded projects. Here in this paper, he utilized standard for structuring and examination reason. He analyzed the structure according to seismic conduct. Utilizing standard, the creator discovered the shear constrain, twisting minute, avoidances are determined and by Matlab, he found the plan of piece, bar, segment, and balance. The primary point was to locate the auxiliary

component utilizing programming dialects [31]. Jyothi Lakshmi R has discovered shell establishment is less expensive than plain establishments if there should be an occurrence of heaps of overwhelming superstructure is transmitted to more fragile soil. It is less expensive on the grounds that it's sparing the rates of material and work. Here, they utilized funnel-shaped shell strip balance which is being useful for water tanks and tower-like structures. The absolute burden limits of shell establishments on earth are found from lab testing. In their investigation, they gathered the dirt from the Edathva area of Alappuzha region, Kerala. They did lab testing so as to decide building properties of soil. They utilized Plaxis programming to confirm the consequences of model testing. They understood that heap bearing limit of shell strip balance with support is higher than both the shell strip balance without fortification and level strip balance lastly they reasoned that shell strip balance with support has most minimal settlement and greatest bearing limit [32].

D. Ramya has informed that Structural Analysis is a branch which includes in the assurance of conduct of structures so as to anticipate the reactions of genuine structures, for example, structures, spans, brackets and so forth. The aftereffects of investigation are utilized to confirm the structure qualification for use. PC programming is additionally being utilized for the figuring of powers, bowing minute, stress, strain and deformation or redirection for a complex auxiliary framework. The similar examination on structure and investigation of multi-storeyed structure (G+10) is done in STAAD.Pro and ETABS software. STAAD. Pro was one of the main programmings for the plan of structures. In this task they had examined the G+10 working for finding the shear powers, bowing minutes, avoidances and fortification subtleties for the auxiliary parts of the structure, (for example, Beams, sections and chunks) to build up the monetary plan. ETABS is additionally driving plan programming in present days utilized by numerous auxiliary originators. Here they had likewise broken down a similar structure utilizing ETABS programming as well. At long last, we will make an endeavour to decide the affordable area of G+10 multi-storeyed structure utilizing both STAAD. Pro and ETABS. Entidhar Al-Taie has found in Iraq that dirt is named Quaternary stores, particularly in the Mesopotamian plain and tributaries of the River Tigris. Soil changes from north to south of Iraq. These distinctions in soil influenced the procedure to choose the reasonable sort of establishment. Here, in their examination work, the impact of bearing limit on shallow establishments in various areas of Iraq is contemplated. They gathered 79 tests from 23 boreholes at 3 distinct destinations. The examples were gathered at different profundity between 1 to 24 m. They were done these testicles: Atterberg points of confinement, sifter and hydrometers, combination, direct shear, unconfined pressure and the recorded (SPT test). The estimations of the bearing limit parameters were acquired from the above tests. The outcomes acquired were utilized in the use of the general condition of the bearing limit. At that point, they utilized staadpro, to plan the model of the structure. The outcome they acquired that for the 3 distinctive area shallow establishments is material however for the greater part of the zones profound establishment is reasonable [3].

Amit Srivastava has seen that many buildings are constructing in such areas soil has insufficient soil properties; due to lack of space buildings are constructed in such areas where the bearing capacity of the soil is not so much sufficient to carry the load of the superstructure. As in the top layer of the soil, foundation lies if the soil properties changes then it cannot withstand the load of the building. Different types of foundation failure have been shown by him in his paper:

- Drag down and heave
- Lateral movements
- Load transfer failures
- Vibrating effects
- Water level changes
- Design and Construction errors
- Earthquakes
- Uplift forces
- Slope uncertainty/landslide

Foundation failure can be stopped by using through various ground improvement techniques which improve the properties and bearing capacity of the soil [34].

3. CONCLUSION

The paper reviewed and discussed the effect of soil properties towards the foundation. As previously foundation design isn't taken into consideration so much, but now due to failure of the foundation is occurring so soil properties on which foundation are constructed is taken to be more precisely. Earthquake is another shock that foundation gets while it occurs. So, to make safe structure precautions and remedies are taken into consideration.

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