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CHRONICAL AND MODERN DEVELOPMENTS IN GEO CELL REINFORCES FOUNDATION BEDS

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Abstract- Geo cells are engineered for protection and stabilization applications. They are usually wont to facilitate improve the performance of normal construction materials and erosion-control treatments. Geo cell items are three-dimensional, expandable boards produced using high-thickness polyethylene, polyester or another polymer material. Infill choice is basically administered by the nature and power of foreseen working anxieties, the accessibility and cost of applicant materials, and in a few cases the stylish prerequisites for a completely vegetated appearance. Essential geo cell infill types are totals, vegetated topsoil, and cement. This paper is a brief review about geo cell reinforced foundation beds.

Introduction

embankments are a necessary piece of streets, railroads, waterways and earth dams and other stockpiling utilities. Regularly dikes are developed over delicate soils.Here and now soundness is the significant overseeing model in the plan of dikes since the establishment soil picks up the quality with the time because of combination. By and large, ground change systems, for example, vibro stone sections are utilized to reinforce the bank bases in delicate soils. Be that as it may, the later pattern is to utilize the geo engineered fortifications eg. Geotextiles, geogrids. To upgrade the solidness of the embankments. Studies directed by numerous specialists have affirmed the reasonableness of geo engineered fortifications in such applications by and large, geo manufactured fortifications are given to upgrade the strain obstruction of the dirt. Frequently these strategies are combined with the wick channels and PVDs Wick channels facilitates the union procedure and expands the shear quality of the dirt. Geo cells are three dimensional expandable panels made up of high density polymers. Numerous analysts have announced the helpful impacts of geo cells Very constrained data is accessible in the writing about the geo cell upheld dikes. Jenner et al. (1988) proposed a philosophy in light of slip line hypothesis to plan the geo cell establishment framework for settling the base of a embankment. Krishna swamy et al. (2000) presented the beneficial effect of geo cell reinforcement in settling the base of a bank through the research facility 1-g demonstrate tests. Madhavi Latha (2000) proposed FEM based way to deal with outline of the geo cell fortified bank in view of the identical composite methodology. In this model, prompted obvious attachment in the geo cell-soil composite was identified with the augmentation in the keeping weight on the dirt because of the arrangement of the geo cell fortification. Further, build on the identical composite perspective, Madhavi Latha et al. in the year 2006 proposed the incline security based outline way to deal with plan the geo cell upheld dike. This methodology utilizes a broadly useful incline soundness program. Zhang et al. in the year 2010 proposed explanatory technique to locate the bearing limit of the geo cell fortified earth bed supporting a embankment. In this method, , increment in bearing limit was certify to the vertical pressure scattering impact and the film outcome. Most of the past research is arranged towards building up the plan strategies for the geo cell upheld dikes and featuring the valuable impacts of geo cells through experimental studies. In hate of the ongoing advancements, the utilization of geo cells to balance out the dike base has not sufficiently increased fame due to non-accessibility of demonstrated case chronicles. Additionally before, utilization of geo cells in balancing out the banks is limited just to street and rail dikes in the transportation areas. Cowland and Wong (1993) detailed a case history of a 10m more responsible option bank development on the geo cell establishment in delicate mud stores in Hong Kong. Geo cell system was combined with wick depletes in the detailed work. The present investigation draws out the imaginative field use of geo cells in balancing out the bank base in Aluminum mine following i.e. delicate settled red mud. The revealed work is first of its kind in India. Geotechnical issues of the site, the outline of the geo cell establishment in view of test examination and development arrangements of the geo cell establishment at the field are talked about in the paper. In light of the trial considers, a systematic strategy was additionally created to gauge the heap conveying limit of the delicate earth bed strengthened with geo cell and mix of geo cell and geogrid.

Fabrication of embankments over frail soils is a commonly encountered problem in many geotechnical applications like highway and airport runway ridge, flood protection levees, containment dikes, earth dams and berms. Among different adjustment procedures accessible for dikes on delicate soils, giving high quality geo manufactured support at the base of the dike is basic, quicker and savvy. Utilization of geo cells for strengthening the dikes over feeble soils has picked up parcel of notoriety as of years. Geo cells are three-dimensional type of geo engineered materials with interconnected cells loaded up with soil or total. The essential focal points of geo cell layer at the base of the embankment are:

- It acts as an on the spot operating platform for the development.
- It behave as a stiff rigid base to the embankment, stimulate uniform settlements.
- It minimizes construction time and eliminates excavation and replacement costs.
- It prevents bearing capability failure and minimizes excessive settlements and lateral deformations.
- It provides short and long run international stability to the mound.

Laboratory experiments

The primary aim of the laboratory study was to ascertain the suitability of the geo cell foundation in soft clays. To obtain the realistic comparison with the field, the clay bed was prepared with undrained cohesion of 10 kPa. Neoweb geo cells with effective pocket diameter 0.21 m and yield tensile strength 20 kN/m were used as the reinforcements. A biaxial geogrid (SS-20) with extreme elasticity 20 kN/m was additionally utilized in the test examination. The arranged development of the dike in plain strain condition was mimicked by applying the incremental load on the strip balance put along the width of the tank. The strip footing used was twenty metric linear unit thick, one hundred fifty metric linear unit wide and 750 metric linear unit long and was created from steel. Three quantities of stress controlled plate stack tests were led viz. unreinforced, geo cell fortified and geo cell strengthened with extra basal geogrid.
Late decades have encountered an enormous ascent popular for land inferable from fast industrialization and urbanization and consequently ensuing ascent in framework building. Nonetheless, the measure of land space on which development should be possible as it is restricted, in this manner, engineers have proceeded onward to build ashore masses that were viewed as unacceptable for development prior. It is a hazard to develop over such land because of high compressibility, uneven settlement and low bearing limit. Several sorts of ground change procedures including balancing out or strengthening the dirt are utilized to build the bearing limit and make these kind of soils appropriate for construction1-2. Among the different methods accessible for ground change, soil strengthening has been accentuated by numerous analysts as a viable method3-9. Historically, humankind has been utilizing strengthening systems for quite a while in the by making mud dividers fortified with bamboo or reed however the enthusiasm for the region was basically produced in the advanced occasions by crafted by Vidal10. In the ongoing decades, geo synthetics have been received by architects the world as a dirt strengthening technique due to their ease of construction and cost efficiency. Geo cell is the latest development in the field of geo synthetics and its benefits have been highlighted by several researchers11-18. Geo cell is three dimensional, polymeric, honeycomb like cell structure made by welding high force thermoplastic sheet. Geo cells are less demanding to work with as they can be collapsed for transportation purposes and stretch themselves when loaded up with concrete or stonee. They also give a sidelong imprisonment to the fill in this manner giving quality. Because of the previously mentioned simplicity of usefulness and workableness, geo cells are generally utilized in geotechnical designing for different applications by fortifying delicate soil strata and balancing out slants and embankments19. A geo cell restricts the dirt particles to its takes which keeps the parallel spreading of soil which permits the dirt layer to carry on as a firm sleeping cushion and consequently the heap is dispersed over a bigger area3. This examination is a survey of a portion of the ongoing test and numerical discoveries identified with works on geo cell-reinforced foundations.

Experimental studies

Krishna swamy et al. connected uniform extra charge weight on lab scale model of geo cell-fortified dikes upheld over delicate dirt establishments. Geo cell of various thickness were set over the delicate soil establishment and dikes were made over this layer of geocell20. They inferred that giving a geo cell base enhanced the execution of the bank in term of the most extreme additional charge stack and the misshapenings. The properties of the geo cell like its rigidity and viewpoint proportion affected the general working of the geo cell. The ideal estimation of viewpoint proportion was found to be 0.5. Dash et al. through display tests in research center to think about the bearing limit of strip balance in light of geo cell-strengthened sand21. They fluctuated a few parameters like cell measure, material, elasticity and stature and width of the geo cell for sand of various relative densities. what's more, the plot of bearing weight versus settlement for various tallness and width of the geo vcell. It can be seen from that weight settlement conduct is relatively direct for a settlement up to half of the establishment width and load up to eight times the bearing limit of establishment that isn't strengthened. The ideal tallness and width of the geo cell was resolved to be 2 and 4 times separately the width of the balance. They likewise presumed that cell size and introduction considerably affects the execution of geo cells. Dash et al. measured the working of geo cell-strengthened strip balance in sand when planar support is included alongside geocells11. They found that the arrangement of a planar geogrid underneath the geo cell sleeping cushion expanded the bearing limit of balance and settled it against turn. In any case, this impact was not all that significant for substantial stature of geo cell sleeping pad and an ideal estimation of 2 times the width of the establishment was accomplished. Dash et al. also studied round balance bolstered on geo cell fortified sand and found that geo cell enhanced the bearing limit of the balance and lessened its surface heaving3. They reasoned that the geo cell empowers the heap to be redistributed consistently over a more extensive region. According to another study on strip footings that were supported on geo cell-reinforced sand, it was found that the reinforcement effect of geo cell is maximum below the footing and much smaller in the end portions of the footing22. The end parts contribute by obtaining strength from the soil that comes by mobilizing soil nonviolence and resistance between geogrid-soil interfaces. The strain behavior within the geocell conjointly indicated that a geocell pad behaves sort of a subgrade supported composite beam underneath the footing load. An perception of the dislodging designs in the subgrade soil of the model establishment demonstrated that geo cell crossed the potential disappointment planes in soil beneath the establishment.

To think about the impact of relative thickness of soil on the working of geo cell-fortified sand establishments, Dashused stack tests on sand beds, both with and without geo cell reinforcements23. After doing tests for relative densities of 30% to 70%, he presumed that the geo cell fortification in sand establishments is successful for an expansive scope of relative thickness. He exhibited a chart of establishment settlement and weight for soil of various particular thickness. The settlement is same at a higher bearing weight for soil of higher relative thickness, it is prudent to thick establishment soil to higher thickness for acquiring better outcomes from geo cell reinforcement.

Numerical studies

Limited information was found in the literature regarding numerical studies to assess the working of geo cell with respect to bearing limit of fortified establishment. Such examinations were finished by Hegdeand Zhang and Sitharam et al. where they gave conditions to ascertain the bearing limit of establishment on delicate soil having a geo cell layer at the base of embankment29, 30.Sitharam and Hegde proposed a diagnostic model to figure the bearing limit of establishment on earth in which has a combination of geo cell and geogrid has been used as reinforcement29. They superimposed the values of bearing capability thanks to "lateral resistance effect", "vertical stress dispersion effect" and "membrane effect" to succeed into a final price of bearing capability. The results from the analytical model and experimental investigation were found to be in agreement with one another. Zhang et al. presented an equation to calculate the bearing capacity of a soft subgrade soil which contains a geo cell layer at the base of the embankment30. They included both the "vertical stress dispersion effect" and "membrane effect" of the geo cell in calculation of the overall bearing capacity. The results from the obtained equation were conjointly compared with experimental results and also the 2 values were found to be in shut conformity.

Existing design methods

Very few researchers have explored the methods for designing geocells. Some the working of geo cell with respect to bearing limit of fortified establishment. Such examinations were finished by Hegdeand Zhang and Sitharam et al. where they gave conditions to ascertain the bearing limit of establishment on delicate soil having a geo cell layer at the base of embankment29, 30.Sitharam and Hegde proposed a diagnostic model to figure the bearing limit of establishment on earth in which. The slip line is the first method method proposed by Jenner et al. in the year 1988. Based on slope stability analysis is the second method, by Madhavi Latha et al. in the year 2006.

- Method of Slip line
- Design on slope stability analysis
- Design proposed on finite element analysis

Slip line method

Jenner et al. (1988) recommended a technique for outlining geo cells for supporting dikes. In this outline, plastic bearing disappointment of the dirt was accepted rather than slip circle disappointment. This sort of disappointment was foresee for dikes, whose width is extra than four times the profundity of the establishment soil. The methodology developed by Mellor and Johnson in the year 1983 for the pressure of a square between two harsh, unbending plates was utilized for control the bearing limit of the delicate establishment soil. The delicate soil, which was comparable to the square, was expected to get compacted between the geo cell sleeping pad at the best and the hard stratum at the base. The idea of this plan is that the geo cell sleeping pad applies a level of limiting impact on the twisting component of the delicate soil, along these lines pivoting the bearing of main burdens. The course of most extreme shear pressure additionally turns correspondingly, pushing the disappointment surface profound into the establishment soil. A 15o slip line field was utilized to decide the bearing opposition of the delicate soil. The erection of slip line field and quadrate outline bearing weight are talked about in detail by Jenner et al. in the year 1988. Ordinary bearing limit chart for the geo cell upheld bank drawn in light of the slip line field.

Design based on slope stability analysis

The design of reinforcement for embankments supported slope stability analysis is developed by Madhavi Latha et al. (2006). This methodology uses an all-purpose slope stability program to style the geocell pad of needed strength for a hill. the pc program developed for directing slant steadiness examination of geocell bolstered banks takes the incline unadulterated arithmetic, tallness of geocell layer, profundity of establishment soil, shear quality parameters of slope soil and geocell layer, properties of establishment soil, pore weight coefficient and in this way the cost of uniform extra charge weight on the peak as info parameters. The program utilizes Bishop's methodology of slices for hard the issue of safety. The program mechanically searches for various trial slip circles and provides rock-bottom issue of safety and coordinates of the middle of the essential slip circle. The dependableness of the pc program was ensured by running some example issues. an issue of safety obtained from the program for these issues was in agreement with a rock-bottom issue of safety obtained from graphical methodology by drawing many trials slip circles and getting the issue of safety for every one of those circles mistreatment standard methodology of slices.

Proposed design based on finite element analysis

Using finite component technique for the soundness analysis of bolstered earth embankments was tried earlier by researchers like Roy et al. (2009).Based on the laboratory experiments, Madhavi Latha (2000) projected the identical composite model for geocell cased sand. Later Rajagopal et al. (2001) valid the equivalent composite model mistreatment experiments on geocell supported model embankments created over soft clay bed. during this model, the evoked cohesion within the soil is expounded to the rise within the confining pressure on the soil thanks to the geocell reinforcement through atomic weight. given within the previous section. The equivalent stiffness of geocell cased soil is expounded to the stiffness of unreinforced soil, secant modulus of geocell material and interaction parameter, that represents the interaction just in case of multiple cells. supported triaxial pressure tests on geocell cased sand, Madhavi Latha (2000) and Rajagopal et al. (2001) anticipated the consequent nonlinear experimental condition to particular the Young's modulus of geocell-strengthened sand (Eg) as far as the secant modulus of the geocell material and thusly the Young's modulus parameter of the unreinforced sand (Ku).

$$E_g = P_a[K_u + 200\,M^{0.16}]\left(\frac{\sigma_3}{P_a}\right)^{0.7}$$

MECHANISM OF GEOCELL REINFORCEMENT

Geocells, made from geosynthetics like geotextiles or geogrids, square measure thermally welded or automatically guaranteed interconnected pocket-structures, within the variety of pad, used with in-filled soil. General strengthening systems of geocell is keeping the in-fill soil from removing and determine mooring obstruction through the including soil against the connected load. Geocell dividers cut the potential disappointment planes (which would be the situation in unreinforced condition) and power it to travel deeper into the soil. The interconnected pocket
Provide all round restriction to the in-filled soil and opposes from crushing out under shear. Moreover, the geocell-dividers infer interfacial protections with encompassing soil through its openings and create jetty with the dirt to enhance the heap bearing limit of the reinforced-system. As a whole, the in-filled geocell-soil pad behaves sort of a semi-rigid block that spread the incoming load over wider space onto the underlying soil resulting in improved performance of the system with reduced stress intensity and therefore the associated settlements.

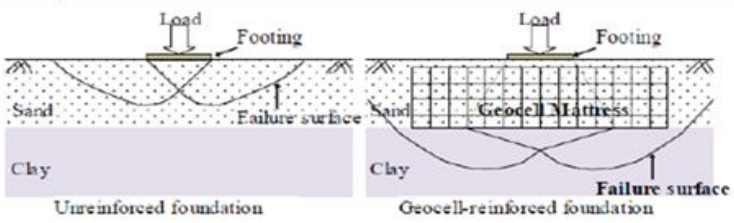

Fig. 1 Foundation behavior in different configurations

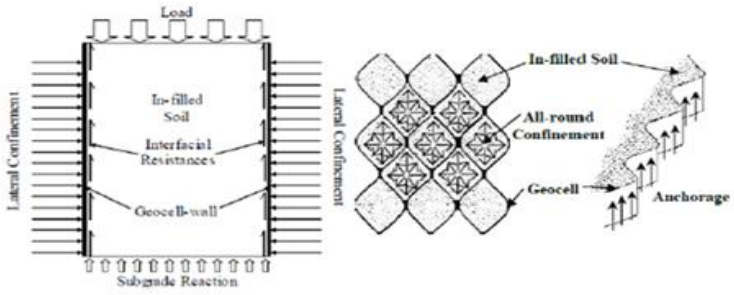

Fig. 2 Various mechanisms with geocell reinforcement

GEOCELL-REINFORCED FOUNDATION SYSTEM

A typical geocell-reinforced foundation system for a footing of diameter D. Two types of soils can be noticed. The soil-1 is the local soil underneath the strengthened soil and the geocell-fortified fill-soil is appeared as soil-2. To enhance the bearing limit of establishment soil, geocells are set straightforwardly over the local delicate ground and after that the pockets of geocell are loaded up with either utilizing local soil or utilizing better granular materials like sand or gravel. If it is filled by the local soil, at that point soil-1 and soil-2, are one and the equivalent (dirt earth or sand-sand). Be that as it may, according to general practice, the geocell-pockets are loaded up with granular materials, for example, sand or rock for its better interfacial properties. All things considered, the two soil medium will be extraordinary (sand/gravel-clay

STUDIES ON GEOCELL-REINFORCED SYSTEMS

Successful field applications impressed researchers for rigorous constant quantity study to use geocell additional effectively. Rajagopal et al. (1999) investigated the quality and solidness conduct of an individual geocell-sand framework through triaxial tests. Dash et al. (2001) supposed a detail consistent amount think about on development

example, geometry, and arrangement profundity, the solidness of the geocell material and thickness (ID) of the in-filled sand of geocell-sand establishment framework. Concerning eight overlap change in bearing capability with geocell was ascertained. Pokharel et al. (2010) investigated the impact of form, type, embedment depth of footing, the height of geocell and quality of in-filled material on geocell strengthened foundation bed and located that circular formed geocell pocket gave higher result than elliptical form.

According to general field conditions, many model studies have conjointly been meted out with geocell-sand pad over soft clay subgrade. Mandal and Gupta (1994) investigated responses of geocell-sand foundation pad over soft marine clay. Krishnaswamy et al. (2000) investigated behavior of a model footing untired on geocell-sand strengthened mound over soft clay. Emersleben and Meyer (2008) performed model and field trial with all-out traffic loading on a geocell-sand pad over soft clay subgrade. Zhang et al. (2010) planned bearing capability calculation technique of geocell strengthened foundation system considering "Lateral resistance effect", "Vertical stress dispersion effect" and "Membrane effect".

Few laboratory model investigations have conjointly been meted out with geocell-reinforced clay over clay subgrade. Sitharam et al. (2005 & 2007) investigated clay-filled geocell pad over soft clay subgrade. Concerning were will increase in bearing capability was achieved. it had been rumored concerning ninetieth reduction in settlement thanks to geocell-clay pad over soft clay subgrade.

Geogrid Properties

The stiffness of geogrid, an orientation of ribs and aperture gap size (da) additionally have nice influence in up the reinforcing impact of geocell (Rajagopal et al., 1999; Krishnaswamy et al., 2000; Dash et al., 2001, Dash, 2012). it's seen that having a larger gap size, the geogrid develops higher interlocking and anchorage with the soil particles than the solid walled or perforated walled geocells (geoweb) which supplies rise in up the performance. In alternative facet, geogrids having smaller gap sizes has higher improvement capability, because the confinement of in stuffed soil is best in smaller openings and per unit area for resistance and anchorage impact will increase. This produces a comparatively stiff geocell-sand mattress and redistributes the loads even better. The orientation of geogrid ribs is additionally vital in rising load bearing capability. The horizontal and vertical orientation of ribs (square or rectangular openings) provides higher resistance against loading than the inclined orientation (diamond openings).

Conclusion:

In this paper all the aspects regarding geo cell are discussed along with their properties and applications. During literature review for this review paper we came to know that these geo cells could be further improved to support civil engineering works as they are doing now**.**

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