GEOMETRICAL EFFECT ON THE BEHAVIOUR OF EMBANKMENT ON SOFT GROUND

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ABSTRAK

Kebanyakan tambakan yang di bina di atas tanah liat lembut terdedah kepada Kebanyakan benteng yang dibina di atas tanah lembut terdedah kepada kegagalan dan enapan besar disebabkan keadaan tanah mempunyai nilai kekuatan yang rendah. Geosintetik digunakan dengan berkesan sebagai bahan pemgukuh untuk meningkatkan kekuatan ricih, dan kekukuhan benteng bertetulang dan seterusnya, untuk mengurangkan enapan jumlah dan perbezaan. Dalam bahagian pertama kajian ini, empat kes benteng yang berbeza iaitu dengan dan tanpa menggunakan tetulang,yang dibina atas tanah dasar lembut dan tegar telah dikaji menggunakan model fizikal berskala kecil melalui ujian centrifuge dan model berangka menggunakan simulasi unsur terhingga. Perbandingan diantara keputusan menggunakan kedua-dua model unsur terhingga dan ujian centrifuge telah dijalankan untuk mengesahkan dan mengenal pasti kebolehpercayaan kaedah unsur terhingga. Dalam ujian centrifuge, skala model dengan pelbagai saiz telah disimulasikan kepada dimensi sebenar yang tetap menggunakan medan pecutan yang berbeza. Keputusan menunjukkan berlaku kelakuan ubah bentuk yang berlainan bagi kes-kes tambak yang berbeza dan menunjukkan kesan yang ketara terhadap tetulang geosyntheic di dalam peningkatan kestabilan benteng. Analisis perbandingan menunjukkan hubungan yang baik di antara keputusan kedua-dua kaedah. Ini mengesahkan penggunaan teknik unsur terhingga dalam analisis untuk kes benteng yang berbeza. Bahagian kedua kajian ini memberi tumpuan kepada kesan geometri terhadap tingkah laku dan kegagalan mekanisme benteng. Dua kes benteng berskala penuh di Malaysia dan Kanada, Benteng Percubaan Muar dan Benteng Lebuh Raya Vernon telah disahkan. Kesan tiga dimensi di Benteng Percubaan Muar dinilai dengan membandingkan hasil analisis dua dan tiga dimensi, dari segi anjakan, ramalan pergerakan sisi, tekanan liang berlebihan, faktor keselamatan, dan ketinggian kegagalan benteng. Selain itu, kajian ini telah menilai had sempadan yang sesuai untuk analisis dua dan tiga dimensi dengan menentukan konfigurasi geometri benteng yang sesuai dalam menggunakan analisis geoteknikal. Nisbah ketinggian kegagalan yang dikira menggunakan dua dan tiga dimensi analisis Unsur Terhingga ($H_{f.3D}$ / $H_{f,\ 2D}$) telah ditentukan melalui kes-kes banteng yang mempunyai nisbah yang berbeza untuk aspek asas panjang dan lebar (L / B). Dua persamaan faktor bentuk yang berkaitan dengan keupayaan galas asas dan faktor keselamatan benteng digunakan untuk mengambil kira kelakuan geometri benteng terhadap konfigurasi geometri itu. Keputusan analisis tiga dimensi mempunyai kesamaan yang lebih baik dengan ukuran sebenar di tapak. Ia menyimpulkan bahawa dengan mengabaikan kesan tiga dimensi, boleh mengelirukan reka bentuk benteng dalam beberapa keadaan. Kesimpulannya, adalah disyorkan bahawa untuk "benteng panjang" dengan nisbah panjang ke lebar lebih daripada dua (L / B> 2), ia boleh memperuntukkan untuk menggunakan dua analisis dimensi kerana faktor keselamatan tiga dimensi menumpu kepada faktor keselamatan dua dimensi. Untuk "benteng pendek" dengan panjang ke lebar nisbah kurang daripada dua (L / B <2), kesan tiga dimensi ke atas tingkah laku benteng menjadi agak besar dan boleh dianggap sebagai faktor penting dalam reka bentuk dan analisis benteng.

ABSTRACT

Many embankments constructed on soft ground are susceptible to failure and large settlements due to its low strength soil condition. Geosynthetics are used effectively as a reinforced material to increase the shear strength, and stiffness of the reinforced embankment and consequently, to reduce the total and differential settlements. In the first part of the study, four different cases of embankments with and without reinforcement, constructed on soft and stiff grounds were studied through small-scale physical modeling using centrifuge test and numerical modeling using finite element simulation. Comparison between the results using both finite element models and centrifuge tests was carried out to validate and identifies the reliability of the finite element method. In centrifuge test, a model scale with various sizes was simulated to a constant full-scale dimension using different acceleration fields. The results show the different deformation behavior for these different embankment cases and indicate the significant effect of the geosynthetics reinforcement on increasing the stability of embankment. The comparison analysis presents a good agreement between results of these two methods. It validated the finite element technique in analysis of different embankment cases. The second part of the study focus on the geometrical effects on the behavior and failure mechanism of embankments. Two full-scale case history embankments in Malaysia and Canada, the Muar trial embankment and Vernon highway embankment were verified. Three dimensional effects on Muar trial embankment were evaluated by comparing the results of two and three-dimensional analysis, in terms of predicted displacements, lateral movements, excess pore pressure, factor of safety, and failure height of the embankment fill. Moreover, this study attempt to evaluate the boundary limits for the applicability of two and three-dimensional analyses by determining the suitable geometry configuration of embankment in utilizing the geotechnical analysis. The ratio of the calculated failure height of three to two dimensional Finite Element analyses ($H_{f,3D}/H_{f,2D}$) has been determine for embankment cases with different base aspect ratio of the length to width (L/B). Two shape-factor equations related to the bearing capacity of spread footings and safety factor of embankments also utilized to account for the geometrical behavior of the embankment regards to its geometrical configuration. Results of three-dimensional analyses have better agreement with the actual field measurements. It is concluded that neglecting the three dimensional effects could mislead the design of the embankment in some condition. In conclusion, it is recommended that for "long embankment" with the length to width ratio more than two ($L/B > 2$), it may appropriate to use two-dimensional analysis as the three-dimensional safety factor converges to two dimensional safety factor. For "short embankment" with the length to width ratio less than two ($L/B < 2$), three dimensional effects on the embankment behavior becomes considerably great and should be considered as important factor in design and analysis of embankments.

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