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DEVELOPMENT OF GEOTECHNICAL ENGINEERING IN CIVIL CONSTRUCTION

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DEVELOPMENT OF GEOTECHNICAL ENGINEERING IN CIVIL CONSTRUCTION

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SAMBUTAN KETUA UMUM
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Pertama-tama kami mengucapkan selamat datang di kota Denpasar, Bali.

Seperti di tahun sebelumnya, pada tahun 2009 ini kita kembali menyelenggarakan Pertemuan Ilmiah Tahunan (PIT), yang kecuali menjadi ajang temu ilmiah dan saling tukar-menukar informasi juga menjadi forum untuk membicarakan peningkatan kinerja asosiasi yang kita cintai ini. Dari segi pengembangan organisasi, terlaksananya Pertemuan Ilmiah Tahunan (PIT) ini di Denpasar, Bali mempunyai arti yang sangat penting. Mengapa? Karena pada tahun-tahun sebelumnya PIT HATTI selalu dilaksanakan di pulau Jawa; seolah-olah kita tidak mampu menyelenggarakannya di luar pulau Jawa. Pelaksanaan PIT di Denpasar, Bali ini, membuktikan bahwa Komisariat Daerah HATTI Bali sudah cukup berkembang, dan bahwa kehadiran ahli geoteknik di pulau Bali telah diakui. Semoga aktualisasi ini mendapat respons yang positif dari pemerintah/perguruan tinggi setempat dengan cara meningkatkan partisipasi para ahli geoteknik Indonesia dalam membangun daerah masing-masing. Terimakasih kami ucapkan pada Fakultas Teknik Universitas Udayana, Bali atas kerjasamanya dalam pelaksanaan PIT ini.

Pertemuan Ilmiah Tahun ini mengambil tema "Development of Geotechnical Engineering in Civil Construction". Untuk menopang tema tersebut maka panitia PIT tahun ini telah berhasil mendatangkan pembicara tidak hanya dari Indonesia, tetapi juga dari luar Indonesia dengan topik yang cukup bervariasi yang meliputi : pembangunan infrastruktur, perbaikan tanah, penentuan parameter tanah, sistim fondasi, kegempaan dll. Mengingat semakin seringnya terjadi gempa di negara kita, maka pada PIT tahun ini diadakan panel diskusi mengenai masalah kegempaan. Kita tidak tahu kapan gempa itu akan terjadi, tetapi kita harus tahu dan harus bisa mengurangi kerusakan yang akan timbul akibat gempa. Disinilah peran kita sebagai angota HATTI diperlukan.

Kepada para pembicara yang telah bersedia datang dan memaparkan makalahnya, para peserta pameran, para sponsor dan pihak-pihak lain yang telah membantu terselenggaranya kegiatan PIT ini kami ucapkan terimakasih. Semoga kerjasama kita berlanjut diwaktu-waktu yang akan datang Ungkapan penghargaan yang setinggi-tingginya kami sampaikan kepada para panitia yang telah bekerja keras tanpa pamrih demi terselenggaranya acara ini dan tentu saja demi HATTI kita tercinta.

Akhir kata, kami ucapkan Selamat ber-Seminar dan sampai jumpa lagi pada PIT yang akan datang.

Denpasar, November 2009

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Daftar Isi

Dynamic Equilibrium Analysis of Earthquake Resistant Retaining Walls

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ABSTRAK: The dynamic analysis of retaining walls subjected to earthquake load is presented in this paper. Number of retaining wall models subjected to dynamic loading have been tested in the laboratory. The movements of the soil particle of the systems were recorded during the tests. The displacement of the points are then investigated to carry out the failure pattern of the system. The dynamic equilibrium formulation then was derived based on the forces acting on the retaining wall system. The forces are assumed to be in equilibrium state and act in the centre of gravities and the shear contacts. Every force are derived into its horizontal and vertical components. The shear and overturning resistant of the structure then can be calculated based. The safety factors of the stability are estimated based on the ratio of the resistant forces compared to the driving forces. It is concluded that the proposed method can be used to estimate the stability of retaining wall due to earthquake loading.

Keywords : Retaining walls, dynamic analysis

1. INTRODUCTION

Recently, dynamic lateral loads has been attacking retaining walls and caused several major damages. The dynamic lateral loads can be resulted by an earthquake motion. The increase of lateral pressure during motion can produce additional sliding and/or tilting to the retaining wall structures. Theories to estimate stability of retaining structures due to dynamic lateral pressure have been described by Das (1983).

The study of dynamic lateral earth pressure also has been given by Nazarian and Hadjan (1979) in the past. The study divided the theories of dynamic analysis into three categories, that are:

1. Fully plastic analysis
2. Solutions based on elastic wave theory
3. Non-linear and elastoplastic solutions

Based on Coulomb active pressure behind a wall, the classic analysis of Mononobe-Okabe has been derived (Mononobe, 1929 and Okabe 1926). The analysis is based on the assumptions:

1. The failure of the soil behind the wall formed in a stright-plane.
2. The wall moved in such way to produced minimum active pressure.
3. The shear strength of the dry back-fill is following Mohr-Coulomb theory.
4. On the failure plane, the full shear strength is mobilized.
5. The soil behind the wall behaves as a rigid body.

The more recently solutions of dynamic problems of retaining walls usually calculated based on numerical analyses (Vidya, 2007). However, the results gave number of interpretation depend on the data involved into the input of the analysis.

2. PROPOSED METHOD

Here, a new method to estimate the stability of a retaining wall due to dynamic pressure is proposed. The proposed method is based on the static equivalent analysis. However the forces acting on the wall are analyses based on the dynamic equilibrium. Then the lateral forces due to dynamic acceleration are included in the analysis.

The method introduced number of assumptions that are:

1. The failure of the backfill behind the wall is a straight-plane and follows the Rankine's active condition.
2. The active pressure behind the wall is fully generated.
3. The shear strength of back-fill is following Mohr-Coulomb theory.
4. On the failure plane, the full shear strength is mobilized.
5. The failure zone of the soil behind the wall behaves as a rigid body.

6. The forces acting on the wall are in equilibrium state.
7. The forces are generated due to gravity and the acceleration of the earthquake motion.
8. The forces act in their centre of gravities and the shear contact.
9. There is no movement on the system which is assumed to be stable.
10. The passive resistant on the toe of the wall is ignored.
11. Every force can be derived into its horizontal and vertical component.
12. The moment on the structure point is produced by the force components.

Based on those assumptions, the forces acting on the wall then can be drown in the Figure 1.

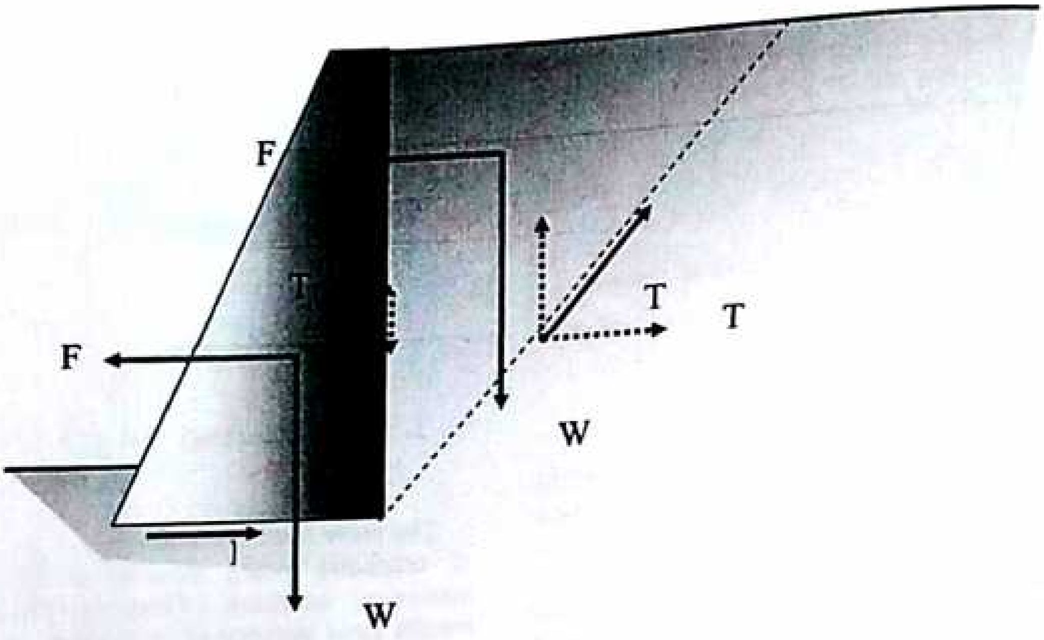

Figure 1. The dynamic forces acting on the wall system

Then, the stability of the retaining wall system due to the acting forces can be written as:

a. Overturning Stability:
The overturning stability of the wall is represented by the ratio of the sum of resistant moments respect to the toe and the sum of overturning moments on the same point in terms of the factor of safety:

$$FS_{ov} = \frac{\sum M_R}{\sum M_{ov}}$$

The forces which derive the overturning moment are T_N, F_{e1} and F_{e2} . Meanwhile, the force defend against the overturning of the wall is W_1.

b. Sliding Stability:

The sliding stability then is represented by the ratio of the resistant forces on the base on the wall and driving forces in terms of the factor of safety:

$$FS_{sl} = \frac{\sum F_R}{\sum F_{sl}}$$

The forces which slide the wall are T_N, F_{e1} and F_{e2} . Meanwhile, the force defend against the wall sliding is F.

3. CASE STUDY

The stability of a wall with the height of 9m and the base-width of 4 m is analyzed. The width of the wall-top is 1.5 m which made of reinforced concrete material with the unit weight of 2.4 t/m^3. The backfill soil is dry sand with the internal shear angle of 35 degree and the unit weight of 1.79 t/m^3. The forces act on the wall system the calculated as shown in the table 1.

The stability of the retaining wall system due to the acting forces then can be calculated as:

Overturning Stability:

a. By ignoring the active pressure of the soil.

$$FS_{ov} = \frac{252.45}{67.47} = 3.74$$

b. By involving the active pressure of the soil.

$$FS_{ov} = \frac{252.45}{126.18} = 2.00$$

Table 1. Forces acting on the wall

Component	Force (ton)	toe dist. (m)	M_{ov} (t.m)	M_R (t.m)	Remarks
W_1	59.40	4.25	-	252.45	weight od the wall
T_N	15.44	2.86	44.16	-	weight of the backfill
F_{e1}	2.97	3.82	11.35	-	due to the eq. of the wall
F_{e2}	1.89	6.33	11.93	-	due to the eq. of the backfill
P_a	19.57	3.00	58.72	-	active pressure of the backfill
T_c	5.63	-	-	-	shear on the failure plane
F	41.59	-	-	-	shear resistant on the base

The stability of the retaining wall system due to the acting forces then can be calculated as:

Overturning Stability:

a. By ignoring the active pressure of the soil.

$$FS_{ov} = \frac{252.45}{67.47} = 3.74$$

b. By involving the active pressure of the soil.

$$FS_{ov} = \frac{252.45}{126.18} = 2.00$$

Sliding Stability:

a. By ignoring the active pressure of the soil, the forces resist the sliding is T_c and F meanwhile the diving forces are T_N, F_{e1} and F_{e2}.

$$FS_{sl} = \frac{47.22}{20.30} = 2.33$$

b. By involving the active pressure of the soil which is act driving the wall.

$$FS_{sl} = \frac{47.22}{39.87} = 1.18$$

The minimum safety factor of the retaining wall due to the dynamic forces can be adopted as 1.2.

CONCLUSIONS

It has been shown that the proposed method can be used easily to estimate the stability of the wall due to the earthquake load. The proposed method is based on dynamic equilibrium of forces acting an the retaining wall system when an earthquake attacks. The forces are assumed to be in equilibrium state and act in their centre of gravities and the shear contact. The stability of the wall is calculated in the same way that is in the static analysis with number of dynamic component of the forces. Then, practically the proposed method can be used to estimate the stability of retaining wall due to earthquake loading.

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