EFFECT OF WALL MOVEMENT ON LATERAL EARTH PRESSURE

by

Swami Saran[1] and Shamsher Prakash[2]

SYNOPSIS

An analytical solution of lateral earth pressure distribution on retaining walls subjected to earthquake has been developed based on the philosophy of Dubrova (1963). Formulations have been done for a general case of inclined wall with inclined cohesionless backfill. Solutions have been obtained both in active and passive states for all the three possible modes of wall movement i.e. (i) Rotation about bottom, (ii) Translation and (iii) Rotation about top.

ANALYSIS

The analysis is developed for a retaining wall of height H inclined at an angle α with the vertical having cohesionless backfill inclined at an angle i with the horizontal. Expression for computing total earth pressure is given below (Mono-nobe -Okababe, 1963)

$$\left.\begin{matrix} P_A \\ P_p \end{matrix}\right\} = \frac{1}{2}\gamma H^2 \frac{(1 \pm \alpha_v)\cos^2(\phi - \lambda \mp \alpha)}{\cos\lambda . \cos^2\alpha . \cos(\delta \pm \alpha + \lambda)} \left[\frac{1}{1 \pm \left\{\dfrac{\sin(\phi+\delta)\sin(\phi \mp i - \lambda)}{\cos(\alpha - i)\cos(\delta \pm \alpha + \lambda)}\right\}^{\frac{1}{2}}}\right]^2 \quad ..(1)$$

where

P_A = Total active earth pressure taking upper sign of the expression.

P_p = Total passive earth pressure taking lower sign of the expression.

δ = Angle of wall friction

γ = Density of backfill

ϕ = Angle of internal friction

λ = $\tan^{-1}\alpha_h$

α_h = horizontal seismic coefficient

α_v = Vertical seismic coefficient.

Equation (1) is rewritten as follows by replacing ϕ and δ by Ψ and $m\Psi$ respectively, where Ψ is an angle which varies along the height of the wall depending on the type of wall movement and m is a factor less than unity as the mobilized wall friction angle will be less than mobilized angle of internal friction.

---

1. Reader in Civil Engg., University of Roorkee, Roorkee, India.
2. Professor in Civil Engg., University of Roorkee, Roorkee, India.

$$\left.\begin{matrix} P_A \\ P_p \end{matrix}\right\} = \frac{1}{2}\gamma Z^2 \frac{(1\pm\alpha_v)\cos^2(\Psi-\lambda\mp\alpha)}{\cos\lambda.\cos^2\alpha\cos(m\Psi\pm\alpha+\lambda)} \left[\frac{1}{1\pm\left\{\frac{\sin(\Psi+m\Psi)\sin(\Psi\mp i-\lambda)}{\cos(\alpha-i)\cos(m\Psi\pm\alpha+\lambda)}\right\}^{\frac{1}{2}}}\right]^2 \quad ...(2)$$

The variation of Ψ for different types of wall movement have been taken as follows :

Active case :

(i) Rotation about bottom

$$\Psi = \phi - (\phi - i - \lambda)Z/H \quad ...(3)$$

(ii) Rotation about top

$$\Psi = \left[(\phi - i - \lambda)Z/H\right] + (i+\lambda) \quad ...(4)$$

Passive case :

(i) Rotation about bottom

$$\Psi = [(\phi - i - \lambda)\ Z/H\ ] - \phi \quad ...(5)$$

(ii) Rotation about top

$$\Psi = [(i+\lambda)] - [(\phi - i - \lambda)Z/H] \quad ...(6)$$

The pressure distribution is obtained by differentiating equation (2) w.r.t Z i.e. by solving the following equation:

$$\frac{dP_A}{dZ} = \frac{dP_p}{dZ} = 0 \quad ...(7)$$

No separate analysis is made for translatory movement of the wall. As illustrated by Dubrova (1963), the pressure intensity at any depth Z in translatory movement may be taken as the average of pressure intensities obtained in Rotation about top and bottom cases.

The height of pressure from bottom, C_p, is

$$\frac{C_p}{H} = 1 - \frac{1}{H}\frac{\int_0^H \left(\frac{dP_A}{dZ}\right) \text{ or} \left(\frac{dP_p}{dZ}\right) Z.dZ}{P_A \text{ or } P_p} \quad ...(8)$$

CONCLUSIONS

Dubrova's concept has been utilized to develop expressions for lateral earth pressure distribution for all the three types of wall movement (i) Rotation about bottom, (ii) Translation and (iii) Rotation about top both in Active and Passive states.

REFERENCES

Dubrova, G.A. (1963), "Interaction of Soil and Structures" Rehnoy Transport, Moscow, U.S.S.R.

Saran S, and S.Prakash (1976), "Computationof Earth Pressures dependent on wall movement", J., Indian Geotechnical Society.