

DISCUSSIONS

Static and seismic passive earth pressure coefficients on rigid retaining structures: Discussion¹

Jyant Kumar

The author needs to be commended for his computational efforts in determining the passive earth pressure coefficients for both the static case as well as in the presence of pseudo-static earthquake forces. The upper bound theorem of limit analysis with the use of a kinematically admissible translational failure mechanism was formed as the basis for solving the problem. In this discussion, the passive earth pressure coefficients given by the author have been compared with those obtained on the basis of the limit equilibrium technique by employing the composite logarithmic spiral failure surface both for the static (Kumar and Subba Rao 1997) and the pseudo-static cases (Kumar 2001). The comparison of all of the results is given in Tables D1 and D2. The two approaches compare well with each other. The passive earth pressure coefficients generated on the basis of the upper bound limit analysis in most of the cases are found to be either almost the same or only marginally greater (for larger values of δ) than those computed with the limit equilibrium approach. However, compared to the limit equilibrium technique, the limit analysis has an obvious advantage

in that it can take into account the kinematics of the problem. The upper bound theorem of limit analysis is based on the associated flow rule condition. However, it was recently demonstrated by Drescher and Detournay (1993) that for a statically determinate translational collapse mechanism, the upper bound theorem of limit analysis can also be extended to determine the solutions of stability problems even for material following the non-associated flow rule. In his paper the author has given an expression, as originally formulated by Drescher and Detournay (1993), for obtaining equivalent c^* and ϕ^* values in place of c and ϕ values (where c is the cohesion and ϕ is the angle of internal friction) for non-associated flow rule material depending on the given value of the dilatancy angle, ψ . It should be noted that this expression is applicable only for soil mass with coaxial flow rule, i.e., material having the same directions of principle stresses and plastic strain rates. However, for noncoaxial flow rule material, which is often the case, the passive earth pressure coefficients even in the case of non-associated flow rule material will remain unchanged irrespective of the value of ψ .

Table D1. A comparison of static passive earth pressure coefficients for $\beta/\phi = \lambda/\phi = 0$. δ ; angle of wall friction.

ϕ	Static passive earth pressure coefficient, K_{py}							
	$\delta = 0$		$\delta = \phi/3$		$\delta = 2\phi/3$		$\delta = \phi$	
	Kumar and Subba Rao (1997)	Soubra (2000)	Kumar and Subba Rao (1997)	Soubra (2000)	Kumar and Subba Rao (1997)	Soubra (2000)	Kumar and Subba Rao (1997)	Soubra (2000)
10	1.42	1.42	1.51	1.51	1.59	1.60	1.66	1.67
15	1.70	1.70	1.89	1.89	2.06	2.08	2.22	2.25
20	2.04	2.04	2.38	2.39	2.73	2.77	3.07	3.12
25	2.46	2.46	3.06	3.08	3.72	3.79	4.42	4.51
30	3.00	3.00	4.02	4.05	5.26	5.40	6.68	6.86
35	3.69	3.69	5.42	5.48	7.78	8.06	10.76	11.13
40	4.60	4.60	7.58	7.70	12.24	12.83	18.86	19.62
45	5.83	5.83	11.10	11.36	20.88	22.22	36.95	38.61

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J. Kumar. Civil Engineering Department, Indian Institute of Science, Bangalore-560012, India (e-mail: jkumar@civil.iisc.ernet.in).

¹Paper by A.H. Soubra. 2000. Canadian Geotechnical Journal, **37**: 463–478.

Table D2. A comparison of seismic passive earth pressure coefficients for $\beta/\phi = \lambda/\phi = 0$.

ϕ	Horizontal seismic coefficient, K_h	Seismic passive earth pressure coefficient, K_{py}							
		$\delta = 0$		$\delta = \phi/3$		$\delta = 2\phi/3$		$\delta = \phi$	
		Kumar (2001)	Soubra (2000)	Kumar (2001)	Soubra (2000)	Kumar (2001)	Soubra (2000)	Kumar (2001)	Soubra (2000)
30°	0.00	3.00	3.00	4.02	4.05	5.26	5.40	6.68	6.86
	0.05	2.92	2.91	3.89	3.91	5.08	5.20	6.44	6.61
	0.10	2.82	2.82	3.75	3.77	4.89	5.00	6.19	6.35
	0.15	2.72	2.73	3.61	3.62	4.69	4.79	5.93	6.07
	0.20	2.62	2.63	3.46	3.47	4.48	4.57	5.66	5.79
	0.25	2.51	2.53	3.30	3.31	4.27	4.34	5.37	5.49
	0.30	2.39	2.42	3.13	3.13	4.03	4.10	5.07	5.17
45°	0.00	5.83	5.83	11.10	11.35	20.88	22.22	36.95	38.61
	0.05	5.78	5.71	10.83	11.07	20.35	21.65	36.01	37.61
	0.10	5.63	5.58	10.56	10.78	19.82	21.06	35.05	36.60
	0.15	5.49	5.46	10.28	10.49	19.27	20.47	34.08	35.56
	0.20	5.34	5.33	10.00	10.19	18.72	19.86	33.08	34.51
	0.25	5.20	5.20	9.71	9.88	18.15	19.24	32.06	33.43
	0.30	5.05	5.07	9.41	9.57	17.57	18.61	31.02	32.33

References

- Drescher, A., and Detournay, E. 1993. Limit load in translational failure mechanisms for associated and non-associated materials. *Geotechnique*, **43**: 443–456.
- Kumar, J., and Subba Rao, K.S. 1997. Passive pressure coefficients, critical failure surface and its kinematic admissibility. *Geotechnique*, **47**: 185–192.
- Kumar, J. 2001. Seismic passive earth pressure coefficients for sands. *Canadian Geotechnical Journal*, **38**: 876–881.