Unreinforced Curved Stone Masonry Retaining Walls for Garhwal-Chamoli Region*

by

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Author's Reply

Author's are thankful to Dr. G.S. Dhillon, Director, Irrigation and Power Institute, Amritsar, for rising interesting and important criticism about the use of Classical Rankine theory for the Designing of stone masonry curved retaining walls for hilly areas of Garhwal. Curved stone masonry retaining walls are typical earth-retaining structures which are supported in such a manner that they become inseparable part of the backfill and can not fail by simple rotation. The findings of Ohde, Krynine and others as referred to by the discusser were for single negative batter retaining walls giving about 25 per cent additional active earth pressure after Coulomb and point of action upto 0.6H after yielding and slipping of the wall and are not applicable in this case as the wall is curved and is made up of two negative batters one upto level 2-2 and another above that level as shown in Figure 7.*a* of the Paper.

Even if curved wall is assumed as having single negative batter along the virtual wall line joining heel and inner top point of the wall, the maximum active earth pressure after Coulomb theory works out to be 30 tonnes/m along the critical slip plane making an angle of 50° from the horizontal and acts at a height of 2.4 metre from the base (Figure 1*a*). When worked out for two negative batters the maximum active earth pressure rises after Coulomb to 33 tonnes/m and point of action at 2.7M above the base (Figure 1*b*). The portion on the wall above level 2-2 is subjected to negligible earth pressure as its inner slope nearly coincides with the angle of repose (50°) of the soil mass of the slope and if taken as surcharge the effective height of the wall above the base reduces to 5.4 metre. The corresponding total active earth pressure due to surcharge load and backfill soil as per clause 1.442 of Civil Engineering Code of Practice No. 2, earth retaing structure, published by Structural Engineers, London-1951, works out to be about 18 tonnes/m and point of action at 2.15 metre above the base (Figure 3).

Passive earth pressure by Coulomb theory based on plane failure surface for angle of friction greater than 10° (more than one-third angle of internal friction of the particles of soil mass) leads to excessively high values. In the present case angle of wall friction is about 20° and will lead to unrealistic values of passive earth pressure (Figure 2). Using Rankine's Classical theory, therefore, the corresponding active earth pressure and point of action for curved retaining wall work out to be 39.43 tonnes/m and 3.47 m above the base repectively which were higher and have been considered safer from the design point of view of the above wall. The

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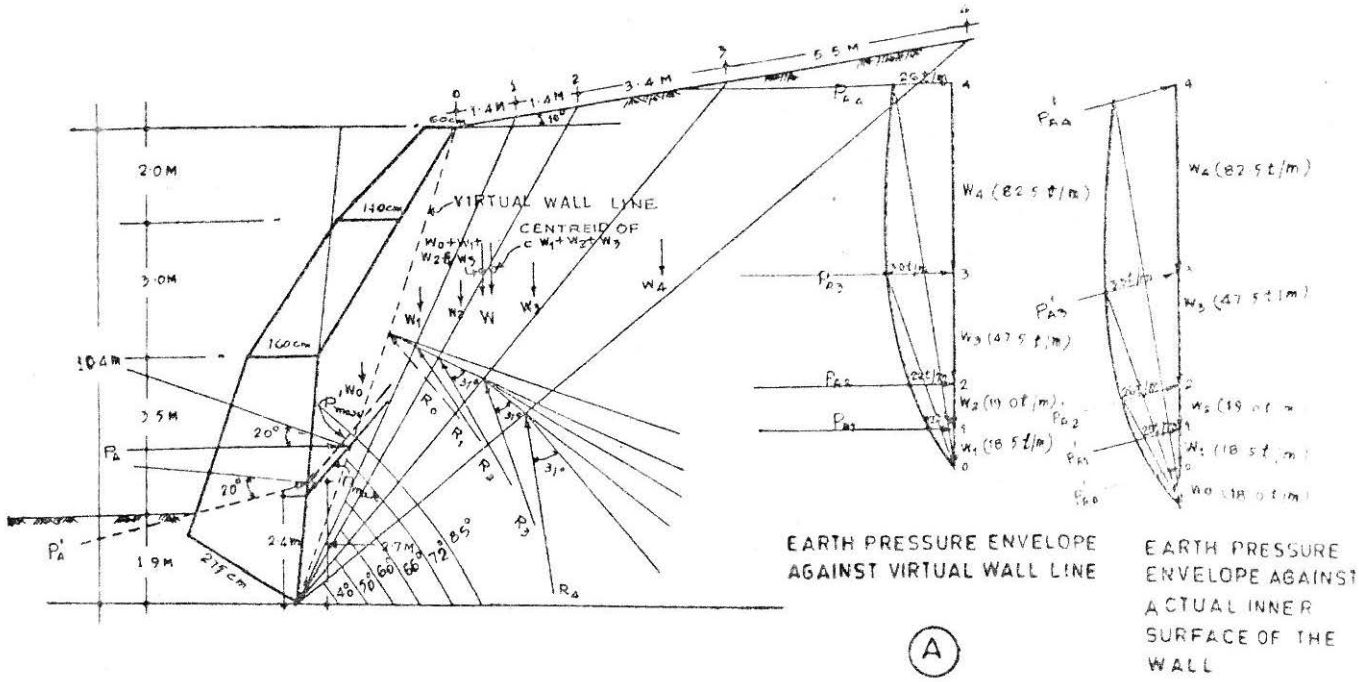

FIG. NO. 1

FIGURE 1 Active Earth pressure and point of action after Coulomb theory

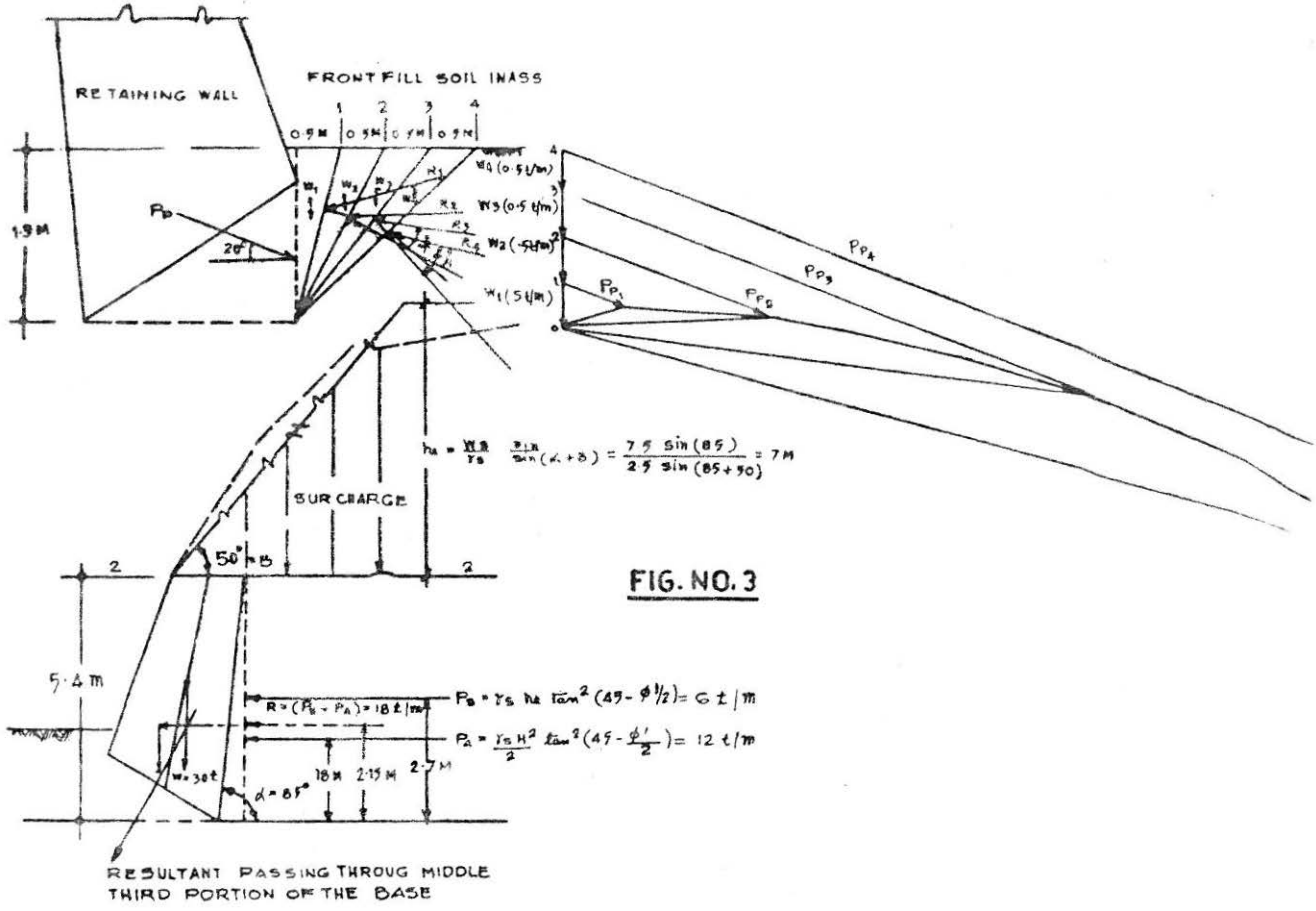

FIG. NO. 3

FIGURE 2 Passive Earth pressure Envelope with no minimum value

FIGURE 3 Estimation of Active Earth Pressure with wall and soil mass above level 2-2 acting as surcharge

corresponding passive earth pressure works out of be 13.33 tonnes/m and acts at 1/3rd height from the base of fundation.

Further, the slopes are made of loosely packed rocks in soil mass and validity of the estimation of earth pressure from any well known earth pressure theories would be controversial in the strict sense of the term. There may be additional earth pressure due to land slips in adjacent areas, tectonic disturbances, earth tremors, rock falls, and ponding of water etc. It is difficult to account for these factors in the analysis and therefore evaluation on the basis of Rankines theory which is on conservative side, was considered more practical. The curved masonry wall was constructed at Gaurikund (U.P.) in 1978 and till date it has not shown any distress.