Introduction

Elastic stress solutions can be used to estimate earth pressures induced on walls by surcharge loads. Applying these solutions in practice has not been a straightforward matter for several reasons: (1) The elastic stress equations are complex, and performing calculations and checking results can be time-consuming; (2) Because the stresses on non-yielding walls are twice the free-field stresses, and equations for both have been published, it is sometimes unclear whether published equations represent free-field stresses or stresses on non-yielding walls, and (3) Because some published elastic stress equations have contained typographical errors, it has been difficult in some cases to verify the equations. The purpose of this report, and the accompanying Excel workbook, is to make the use of these elastic stress solutions easier and more reliable.

Elastic Stress Solutions

Solutions included in this report. Equations for horizontal stresses induced by vertical surface loads have been developed for point loads, for line loads oriented parallel to the wall, for strip loads parallel to the wall, and for line loads perpendicular to the wall. These conditions and solutions are shown in Figures 1 and 2.

All of the equations in Figures 1 and 2 give horizontal stresses on non-yielding walls, which are equal to twice the free-field horizontal stresses. Stresses on yielding walls (retaining walls) can be estimated as 1.5 times the free-field stresses, or 75% of the values given by the equations in Figures 1 and 2.

Young's Modulus and Poisson's Ratio. Horizontal stresses due to vertical loads in elastic media are independent of the value of Young's modulus (provided it is constant), but they do depend on the value of Poisson's ratio. The higher the value of Poisson's ratio, the higher the horizontal stress, all other things being equal. Because the value of Poisson's ratio is difficult to estimate, the equations shown in Figures 1 and 2 have been developed for Poisson's ratio = 0.5, the maximum value. The horizontal stresses computed using these equations are therefore conservatively high.

Superposition. Stresses due to multiple loads can be computed using these solutions by considering each load separately, and adding the effects. For example, the stresses due to a wheeled vehicle can be computed by calculating separately the increment of stress due to each wheel, and adding these increments to compute the stress due to the whole vehicle.

St. Venant's Principle. This principle states that, in order to compute the stresses due to a distributed surface load, some approximations can be made in the way the load is distributed on the surface. For example, a wheel load can be approximated as a point load, ignoring the fact that the wheel load is actually distributed over an area rather than being concentrated at a single point.