Quiz on the evaluation of vertical stress in footing problems

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The problem

When carrying out finite element analysis of footing problems it is observed that the vertical stress at integration points at the bottom of the footing is often lower than the applied vertical pressure. In addition, the vertical stress profile should have a peak value at the edge of the footing as shown below:



The initial model

The initial mesh chosen for this problem is shown below

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Mesh 1

The soil is assumed to be elastic, drained and weigthless (ie no in-situ stresses). The properties are

| Soil | E=5000KPa, | v=0.2 |
|----------|------------|--------|
| Concrete | E=2E7KPa, | v=0.15 |

To find the vertical stress, we select the integration point in the soil element immediately below the footing as shown.



The resulting pressure profile for mesh 1 above is shown below



Causes of problem

After a discussion on the possible causes of this in-accurate profile, it was concluded that this is due to a numerical approximation. This problem is common in all finite element codes.

Solution

A new mesh which resolves this problem is shown below (notice the fine elements near the footing corner)





The resulting pressure profile is shoon below



The vertical stress is closer to the applies pressure of 100 KPa and has the correct profile with a peak at the edge of the footing.