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DISCUSSION ON PAPER 9083 STRUCTURAL ENGINEERING GROUP

Elastic solutions for axisymetrically loaded circular raft with free or clamped edges founded on Winkler springs or a half-space

J. A. Hemsley

Mr G. E. Bratchell, *NCL Stewart Scott Ltd*

The Paper analyses, *inter alia*, the bending moments in a raft under uniform loading, and with free edges. The following comments apply to that case, and to any composite cases which use the results of that case.

43. It is vital to distinguish between a bending moment in a structural element which transfers a load to supports, and that of a bending moment in an element which is being subject to enforced curvature as between an applied load and its corresponding reaction—for example, a slab on the ground.

44. In the former, steel reinforcement in the concrete is essential to prevent collapse. In the latter, this is often not the case. In cases where the load is uniform and the raft is relatively flexible, as is usual with large diameter storage tanks, it simply acts as a membrane following the dishing of the ground, which may be part elastic and part consolidation settlement.

45. It is therefore essential to appreciate that uniformly loaded large diameter relatively flexible slabs must be investigated primarily as an enforced strain case and not designed on a bending moment basis derived from the anticipated curvatures. When settlement occurs, such slabs suffer enforced curvature, and no practical increase in thickness or amount of reinforcement will significantly reduce it. The correct procedure is to establish the strains which occur in the concrete so as to evaluate the stresses.

46. If no steel is provided, and if the curvature stress exceeds the concrete tensile stress, then the concrete slab will crack into discrete pieces, and the purpose of adding reinforcement will simply be to ensure an integral slab. Any reinforcement provided will hardly affect the curvature and it will be stressed by the appropriate strain. Paradoxically, as reinforcement quantity is increased, so will a greater corresponding concrete compressive stress be induced at a given curvature. It should be noted that a thin slab is desirable in order to reduce the enforced stresses. It should also be noted that if the curvature exceeds a certain amount, then a reinforced concrete slab may not be a viable solution.

47. It is accepted that bending moments due to shell loads and edge restraint are real and do need appropriate reinforcement.

Dr Hemsley

The flexural analysis described in the Paper is meant to encompass circular rafts of any relative stiffness. If the raft is thin or of large diameter, its relative stiffness will usually be very low, as will be the computed raft bending moments under distri-

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buted loading. The action of concentrated loading will be only to impose localized perturbations on the general displacement pattern. This behaviour is well known, and is illustrated in the Paper.

49. Where such a raft is uniformly loaded, for example, its vertical displacement profile will be virtually identical to that for the limiting case of vertical pressure applied directly to the ground. This is partly why solutions for displacement are included in the analysis. When required, they enable the ground curvature to be estimated, from which the flexural strains in a thin raft can be calculated. These strains, when combined with those induced by shrinkage, temperature gradients and the like, then provide the basis on which to specify the necessary steel reinforcement.