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EDGE RESTRAINTES ON THE POST- YIELD BEHAVIOR OF
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Abstract

In this research, a complete load-deflection behavior of isotropically reinforced concrete square slabs supported on three variously restrained edges with the fourth edge free and subjected to uniformly distributed load is presented. The proposed theoretical model takes into account the elastic deformations of the slab, the in-plan shear forces as well as the membrane forces that are usually induced in the slab as yield proceeds.

Firstly, the slabs are categorized into six cases depending on the geometrical configurations of the slab boundary restraints. All these slab cases are represented by one generalized slab from which any particular slab case can directly be deduced. Thereafter the simple yield line theory (which ignores the effect of membrane action) has been used to determine the yield line pattern and the primary collapse load of this generalized slab.

In the second part of the research, and based on the assumption that the yield line pattern as predicted by the simple yield line theory remains unchanged with further slab deflections, theoretical analysis is carried out to include the effect of membrane action and in-plane shear forces. The analysis at this stage of research assumes that the slab behaves in a rigid-perfectly plastic manner and therefore the elastic deformations of the slab are not included. Based on these assumptions, the load-deflection behavior of all the six slab cases is expressed in one single general equation as a function of the slab material properties and the configuration of the slab boundary restraints.

In the third part of the research, a simple elastic-plastic model is proposed to include the elastic deformations of the slab at early stages of loading. The proposed model can be considered as a modification of the already derived rigid-plastic solution to obtain the complete load-deflection behavior of the studied slabs.

For any specified partially restrained R.C square slab of the six cases, the load-deflection behavior of the slab has been found to be largely affected by many parameters including the steel ratio ρ , yield strength of steel f_y , concrete compressive strength f'_c , slab thickness h and most importantly the supporting condition of the slab edges. Similarly to the behavior of completely restrained slabs, the results show that partially restrained slabs can also sustain loads higher than those predicted by Johansen's simple yield line theory (though with a lesser margin) and the enhancement in load is greatest for slabs having lower values of h , ρ , f_y but higher f'_c .

The benefit of including the effect of membrane action in the analysis of R.C slabs is demonstrated. A particular example of a $6^m \times 6^m$ R.C square slab with one free edge having $\rho = 0.3\%$, $f_y = 400\text{MPa}$, $f'_c = 25\text{MPa}$, $h = 140^{\text{mm}}$ is considered which shows a significant increase in the actual uniform live load carrying capacity by 3.2 times that estimated by the simple yield line theory provided the slab has at least one or more edges fixed against rotation and horizontal translation.

Key words: membrane action. Yield line theory