# Letters to the editor

## Slab deflection control to IS: 456-1978

This refers to the paper by Ghanekar, Mittal and Kumar in your issue of June 1984[1].

For the rational design of reinforced concrete members, IS: 456-1978 has identified various limit states, amongst which the limit state of serviceability deserves special attention because of the need to limit the deflection at service loads[2]. The process of actual deflection computations as per IS:456-1978 is quite cumbersome and iterative in nature which, at times, becomes time-consuming. In the absence of actual deflection computations, the code specifies certain $L/d$ values for achieving control of deflection for beams and one-way and two-way slabs. These $L/d$ values lead to considerably higher thicknesses of slab which become uneconomical.

Ghanekar, Mittal and Sudhir Kumar have attempted in their paper to fill the void by giving the slab thicknesses for design purposes[1]. It appears that in arriving at these thicknesses, the guiding criterion had been the $L/d$ ratios prescribed by the code. Actual deflection calculations do not appear to have been carried out. Consequently, the values of slab depth given in the paper do not appear to satisfy deflection requirements.

In order to have the realistic slab depth values satisfying the deflection requirements of the code, a detailed study of the behaviour of the reinforced concrete slabs is carried out by the undersigned by computing actual short-term and long-term deflections in the two-way slabs according to the procedure prescribed by the IS:456-1978. The following parametric variation is considered in this study:

(*i*) weight of floor finishes is taken as 1.0kN/m² in addition to the self-weight of slabs
(*ii*) live load values considered are 2.0, 3.0, 5.0, 7.0 and 9.0kN/m² respectively
(*iii*) aspect ratio is varied from 1.0 to 2.0
(*iv*) short span is taken as varying from 2.0m to 10.0m
(*v*) slabs do not have any compression reinforcement
(*vi*) effective cover is taken as 20mm
(*vii*) concrete grade is M15 and steel grade is Fe415.

In the deflection computations, long-term deflection due to creep $a_{c(perm)}$ is obtained as

$$a_{c(perm)} = a_{i,c(perm)} - a_{i(perm)} \quad \ldots (1)$$

where, $a_{i,c(perm)}$ is the initial plus creep deflection due to the permanent loads and it is obtained by using the expression for maximum elastic deflection for a slab with given boundary conditions and taking the modified modulus of elasticity as per the following expression,

$$\text{Modified modulus of elasticity, } E_{cm} = \frac{E_c}{1+\theta} \quad \ldots (2)$$

$$\text{Modified modulus ratio, } m_u = \frac{200000(1+\theta)}{E_c} \quad \ldots (3)$$

Consequently, effective moment of inertia has also been based upon the modified modulus ratio $m_u$ defined in equation (3).

In the expression (1), $a_{i(perm)}$ i.e. the short term deflection due to permanent loads, has been computed by using $E_c$ amd $m$.

*Tables* 1 and 2 provide the comparative study of the recommendations of the paper and the slab thickness obtained by actual deflection calculations. *Table* 1 gives the values for the aspect ratio 1.0 and live load of 2.0 kN/m² and *Table* 2 gives the values for the aspect ratio of 1.5 and live load of 5.0kN/m². Three short span values viz. 2.5m, 4.0m and 5.0m have been considered for all the three boundary conditions, as defined below:

(*i*) interior panels, i.e. all edges continuous

(*ii*) one short edge continuous, 3 edges simply supported

(*iii*) simply supported on all edges.

The above comparison indicates that the $L/d$ values recommended by the code of satisfying deflection requirements are too conservative and lead to uneconomical design of slabs. The writers have verified it for the live load as high as 9.0kN/m². Therefore, the $L/d$ values prescribed in the code need modifications in the light of this study. For details, reference may be made to the detailed report of this study[3].

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### References

1. GHANEKAR, V. K., MITTAL, M. K. and KUMAR SUDHIR, Slab deflection control to IS:456-1978. *The Indian Concrete Journal*, July 1984, Vol. 58, pp. 183-188.

2. _____ *Indian Standard Code of Practice for Plain and Reinforced Concrete (Third Revision)*, IS:456-1978. Indian Standards Institution, New Delhi.

3. AGARWAL, SUSHIL K. and GUPTA, VINAY K. *Deflection Control measures for slabs as per IS:456-1978.* Report of the Structural Engineering Section, Civil Engineering Department, University of Roorkee. July 1984.

## Authors' reply

The authors thank the discussers for their interesting comments on their paper. For checking the limit state of deflection, IS: 456-1978 prescribes two alternative approaches, viz., the computation of actual deflection and the limitation on the span to effective depth ratios. As mentioned by the discussers, the procedure for computing actual deflections is quite cumbersome and time-consuming. In general, therefore, designers seldom carry out actual deflection computations. As an alternative to computing the actual deflections, Clause 22.2.1 of the Code stipulates that vertical deflection limits for slabs are generally deemed to be satisfied provided that the span to effective depth ($L/d$) ratios specified therein are not exceeded.

Thus, limiting the $L/d$ ratios to the values prescribed in Clause 22.2.1 is a valid check on deflection. These $L/d$ ratios are generally used by designers to arrive at the effective slab depth as this is a very convenient mode of deflection control. It is certainly not mandatory on the part of the designer to carry out an actual deflection computation in addition to a check on the $L/d$ ratio. Indeed, it would not be necessary to do so, considering that the $L/d$ ratio procedure is permitted in the code in the first place as a simplified check on deflection to avoid the cumbersome calculations of actual deflection, specially for standard routine designs such as those of slabs in buildings. In view of this, the discussers, when stating that in arriving at the slab thicknesses, the guiding criterion had been the $L/d$ ratios prescribed by code and that in the absence of actual deflection calculations the values of slab depth given in the paper do not satisfy deflection requirements, appear to have overlooked what