



Talk on “Developing a Feel for Structural Behaviour and Structural Design from a Consulting Engineer’s Perspective (Back to Basic Using Hand Computation to Check Computer Results)”

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This talk was organized by IEM Civil & Structural Engineering Technical Division on 23 July 2011. It was attracted the attendance of 129 participants. In the talk, the speaker, Ir. M.C. Hee covered the following 3 major topics:

1. How to develop a feel for structural behaviour and to use simple hand computation to check computer results.
2. Unified approach for the analysis/design of member sections utilizing a unifying parameter called combined reinforcing index q that applies to reinforced, partially prestressed and fully prestressed sections in a transparent way (comparison between BS8110/EC2).
3. Why sometimes we get it wrong – lessons learned.

Ir. M.C. Hee commenced the talk by revisiting the basic fundamentals of structural designs of bending moments, shear forces, equilibrium equations and basic structural deformations. These individual basic fundamentals were explained in detail and in relation to the Principle of Virtual Displacement (PVD). PVD comprises four components i.e. axial, bending, shear and torsional deformations. Two typical examples of propped cantilever at mid-span deflection and end rotation were demonstrated with the use of Graphical Integration Diagram, to compute deflection and rotation.

The concepts of Moment Distribution Fundamental, stiffness of joints and structures subjected to lateral loads and braced/ unbraced conditions were also deliberated. The use of manual check methods such as a 2-cycle moment distribution together with the sketch of the deflection profile to check against the computer results for a typical continuous beam analysis was shown using Midas software.

The second part of the talk covered the application of unified approach for the analysis/design of reinforced, partially prestressed and fully prestressed member sections. The three types of beam failures, namely balanced failure (tension bar yields at the same time as concrete crushes), ductile failure (tension rebar yields before concrete crushes) and compression failure (concrete crushes before tension rebar yields) were explained using member cross-section and stress/ strain diagrams. Beams should be designed to be under-reinforced that is ductile failure shall occur in structures.

Equations and diagrams showing the combined reinforcing index q and the limiting q values for beam ductility design and the comparison between BS8110 and EC2 were highlighted by the speaker.

The final part of the talk was based on lessons to be learned from past mistakes or failures. Typical examples of why sometimes we get it wrong are as follows:-

1. Engineers tend to model a sub-frame as a continuous beam and the member negative moment at the top of the member because the stiffness of the column was overlooked. As such it is good practice to place 25% to 50% span steel at the top of the beam to overcome the cracking problem in beams (% of steel depends on the stiffness of beam to column ratio).
2. The mistake by assuming all the columns in the whole building as braced and forgetting that the column size reduces as we progress up the building, as such the upper storey columns could be unbraced.
3. Neglect to include the cantilever member rotational deflection for the design. The member could be in tension or compression due to vertical load or uplift.
4. Insufficient links in exterior columns and the result of buckling length of the exterior beam becomes too long.
5. Failure to check for secondary deflection for slender walls since the walls were designed for axial load only.
6. Lack of support for diagonal compression in secondary beams and the need for introduction of links for secondary beams indirect support.

Lastly, the speaker informed that more details and work examples of this talk would be covered in the coming IEM Civil and Structural Engineering courses and eventually these materials would be published in a book (under preparation) by the Speaker.

The talk ended with a note of gratitude from the Civil & Structural Engineering Technical Division to Ir. M.C. Hee. This was followed by a round of applause by the participants.

