CHAPTER 3: ANALYSIS

3.1 3D ANALYSIS (OPTIONAL)

The analysis technique should be capable of performing 3D analysis of a whole building:

- Internal frames - Portal columns, rafters, knee and apex braces
- End frames – Columns, rafters, mullion columns, door framing
- Purlins and girts
- Cross bracing including compression struts
- Roof and wall panels (diaphragm action) converted to equivalent cross bracing in addition to true cross bracing
- Other major structural elements, when applicable – roof beams, mezzanine floors beams, columns and joists, etc.

3.2 ANALYSIS WITH TENSION ONLY MEMBERS

This functionality is required when flexible elements such as rods or strap braces are used in cross bracing and when roof and wall cladding is designed as a stressed skin diaphragm.

Tension only members, in particular cross bracing equivalents of a stressed skin diaphragm, may be designed as plastic fuse elements with limited maximum tension force. Analysis should perform redistribution of axial forces, shear forces and bending moments in cases where tension forces exceed the maximum tension capacity of plastic fuse elements. Alternatively, plastic fuse elements are not considered in the analysis whenever tension forces exceed the maximum tension capacity of plastic fuse elements.

3.3 PLASTIC ANALYSIS

Plastic analysis can be used with plastic hinges formed at different locations such as column bases and connections.

Plastic analysis can only be used only if research shows sufficient ductility and rotational capacity at locations of potential plastic hinges. In particular, plastic hinges at column bases may be formed due to various reasons:

- Limited capacity of footings
- Limited bolt slip capacity
- Limited base steel connections capacity

3.4 COLUMN BASE FIXITY

Fixed rotational supports at column bases should not be used except where it can be demonstrated that full fixity can be achieved such as in a case of cast in place columns. Partial rotational stiffness (spring supports) should be used instead with corresponding parameters based on research data.

3.5 TYPE OF ANALYSIS

First order analysis is considered sufficient for almost all buildings within the scope of this Design Guide. Second order analysis is recommended for unusually slender structures with significant P-delta effect resulting in more than 10% difference in bending moments as compared to first order analysis. The engineer should use good engineering practice to determine if a second order analysis is required, taking into account the member configurations and restraint conditions.

Notes:

1. Secondary framing elements may not be necessary to consider in 3D analysis –bridging, window framing, local framing for roof ventilation units and similar, fly bracing.
2. Some structural elements such as bridging and fly braces may be pre-engineered and should be considered in the design of other elements. However it is not necessary to consider them in analysis.
3. Pre-tensioned elements, in particular cross bracing, should not be used within the scope of this Design Guide.

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