DESIGN CONSIDERATIONS FOR EARTHQUAKE RESISTANT STRUCTURES

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ABSTRACT

Many designers rely on written reports of previous earthquakes for their knowledge of structural behaviour under seismic forces, and thus such reports should be widely distributed. Reports from recent earthquakes indicate that a very high proportion of similar failures occur repeatedly in almost every earthquake, and that these failures are usually caused by insufficient attention to basic design criteria rather than from discrepancies in the content or application of an aseismic design code. These reports show, however, that with good design and construction most building materials and most forms of construction can be made adequate to resist seismic loadings. Modern types of construction so far have had at least as good a performance as traditional filler wall types but in tall buildings special skill and experience is required to ensure full and logical compliance with current aseismic codes.

Criteria which should be considered in addition to code requirements are:-

1. Foundations: Thorough foundation surveys are a necessity, especially in loose sands, silts and clays. Possibility of floods or Tsumai *should be considered*.

2. Symmetry: To minimise torsional effects; simple foundation and floor plans are desirable and these should be symmetrical about the vertical load bearing members.

3. Building Separation: Besides from the normal sway effects hammering can also occur through rigid links connecting two buildings or from buildings tilting together because of uneven settlement.

4. Cantilevers: Cantilevers, like towers and parapets are undamped, and require high seismic design coefficients. Vertical accelerations should be considered.

5. Relative Rigidity: Accidental stiffening of isolated columns has caused many failures and should be avoided. Rigid upper storeys above relatively flexible lower storey columns should receive special attention.

6. Brittle Failure: Types of construction which have a brittle mode of failure are dangerous in earthquakes. The main frame, at least, should be able to enter the plastic range without collapse.

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7. Connections: These should be very carefully designed and constructed as they are usually the key to strength of the building.

8. Diagonal Bracing: Bracing used to provide stiffness for special requirements must be designed for the higher response of the stiffer structure.

9. Non-Structural Units: These should be designed to allow movement of the structural frame, but should not be so free as to fall from the building.

10. Workmanship and Supervision: Designers should take a keen interest in the construction of the structure as good workmanship and supervision are a necessity.

11. Factors of Safety: Roughly similar factors of safety should be achieved for all structural members, and in this respect care is necessary in working stress design.

12. Drift: Drift and inter-storey deflection should be limited to prevent secondary failures such as column buckling or excessive damage to non-structural units.

13. Code Revisions and Final Design Check: Good design implies working to current codes and imposing checking systems to correct basic errors such as those mentioned above.

14. Ductility: As it is practically impossible to ensure complete elastic action in a major earthquake, buildings should have adequate ductility and energy absorption characteristics.