Ductile Detailing of Reinforced Concrete Structure

KSHITIJA BALWAN[1], RAHUL JOSHI[2], AMIT PATIL[3]

[1]Assistant professor, Dept. of Civil Engineering, TEI, Maharashtra, India
[2]Assistant professor, Dept. of mechanical Engineering, TEI, Maharashtra, India
[3]Assistant professor, Dept. of mechanical Engineering, TEI, Maharashtra, India

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Abstract - *Structures normally experience more serve ground motion than the one envisaged in the seismic coefficient specified in the code. Since, the energy absorption capacity is available in inelastic range ductile structures are able to resist such shock without much damage. It is therefore, necessary and important that ductility must be built into the structures since brittle structures are damaged more extensively. The structure should resist minor levels of earthquake ground motion without suffering any structural damage, but may experience some non structural damage. Whereas they should resist severe earthquake having intensity equal to the strongest shaking , either experienced, or forecast at the site without collapse of structural framework, but possible with some structural as well as non structural damage. The structures are designed, considering their inelastic deferability with acceptable structural damage due excessive inelastic deformations at plastic hinges locations, taking full advantages of their ductility and over strength factors.*

Key Words: *seismic coefficient, resist minor levels framework*

1. GENERAL DETAILLING

Detailing of reinforced is a very significant aspect in the design of concrete structures. In most of cases structural distress is caused not due to incorrect analysis or incorrect design but due to improper or of reinforce inadequate layout mint while considerable attention is devoted to analysis and design of structures the same can not always said detailling specifications. And exact analysis and design of structures is of little avail, if it is not backed by sound detailing practice. In the broad sense of turn detailing includes layout of steel reinforcement, it's anchorage, slices, curtailment, and concrete cover. Detailling entails preparation of drawings for correct layout of every steel bar specified in design. It is prime responsibility of designer to ensures that the design's are translated correctly into construction through proper presentation design output in the form of detailing schedule's, which includes selection of suitable bar sizes, arranging splices, providing suitable lap lengths and allowing enough free spaces around the bars to permit the flow of beam concrete during casting.

1.1 Requirement of good Detailling:

It is essential to appreciate role reinforcement in the concrete structure in order to visualize the requirements of good detailling practice. The excessive deviation of the direction of reinforcement with that of tensile stress trajectory is likely to result in increased crack width and itroduced structural stiffness in post cracking stage. It should, however, be emphasized that the steel reinforcement can not in any case prevent cracking of concrete, the reinforcement is mainly intended to reduces, preferably to extent of the cracks being almost invisible to the naked eye. Cracking of concrete is caused not only by the tensile stresses due to improper loads , but even due to secondary effects such as creep, shrinkage bearing conditions, temperature induced stress. In the case of high compressive stress, it is desirable to confined concrete by transverse reinforcement to prevent transverse splitting.

Properly designed transverse ties ensure safety agents buckling of compressive reinforcement .Mesh reinforced on the other hand will be useful in preventing excessive surface cracks, when concrete cover is large (about 40 mm or more) and provides better protections against fire as well.

Based on above criteria, the main reinforcement of good detailing practice can be listed as follows:

1. Jonts and discontinuities should be capable of withstanding at least the same forces as the adjoining sections. This ensures that no structural distress occurs at these locations before the design loads are reached.

2. There should not be any "free" paths for propagation of cracks without being transversed by reinforcement.

3. Reinforcement should not deviate excessively from the tensile stress trajectories. This suppliments requirements mentioned in (2) above.

4. Cracking of concrete should be within the permissible limits. This is the prime requirement of good detailing practice, which can be achieved by keeping bond and anchorage requirement within safe limits. Experimental investigation provides valuable data on these aspects; the simplified expressions as well as recommendations included in various Cdes of practice are also helpful.

5. Reinforcement layout should be simple to be fabricated and placed in the forms. This may imply that accuracy can be sacrifised to some extent (of course, on the conservative side) in order to simplify the layout. It should be appreciated that detailing cannot be exact and simple at the same time except in very simple cases, such as a beam element under constant bending moment.

1.2 Detailling of earthquake Resistant Structures:

As per the IS -1893-2002 code , more than 50% areas of the India fall's under moderate and severe earthquake zones , thus signifying the importance's of earthquake detailing of R.C.C. structures.

Reliable seismic Behaviour of Concrete Structures:

For obtaining reliable seismic response behaviour the principles concerning choice of form , materials, and failure mode control requires considerations of the structural form used being appropriate for concrete,

Therefore for Concrete Structures the essential objects of failure mode control are-

1. Beams should fail before columns (unless extra column strength is provided)

2. Brittle failure modes should be suppressed.

3. An appropriate degree of ductility (toughness) should be provided.

4. Effect of reversal loading must be taking into account.

1.3 Provision of Ductility:

The concept of ductility refers to the ability of structural system to certain deformations beyond its yield point without significant loss of strength. Concrete being brittle material in capable of large deformation at the post yield stage may appear to be not an ideal material for structures in earthquake prone regions. However, Concrete Structures display adequate ductility and can sustain a no. of cycles of stress reversals, when they are designed and detailed properly. The basic principals of earthquake design practices is to ensure ductility reinforced Concrete members so that the structures can also absorb large deformation and energy transmitted by an earthquake without significant damage.

The response of single degree freedom rigid elastic and the ductile systems are indicated below

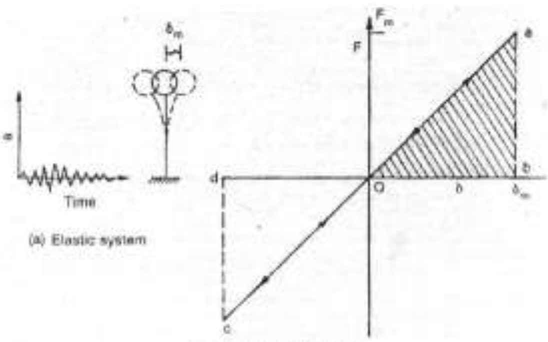

Fig. 1 Elastic System

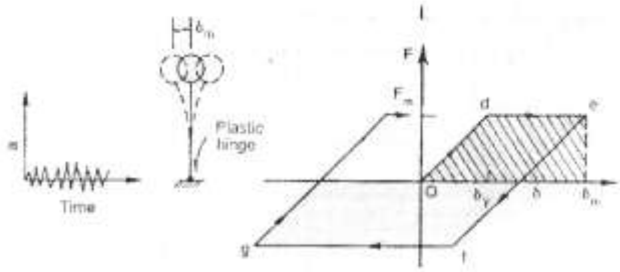

Fig. 2 - Elasto plastic system

It is observe that the system is subjected to load reversal as a result of it's response to ground motion. It is also evident that the lateral load on the structure is much smaller for ductile system than that for rised elastic system subjected to same displacement. Thus the parts of structures having adequate ductility are able to dissipate the energy. Thus the difficulty of the structures subjected to earthquake loading must be ensure and non dissipative parts of dissipative structures and their connections of the dissipative once have to be design with sufficient velocity in order to allow the cyclic yielding of the dissipative parts.

1.4 Weak Beam Strong Columns:

The multistoried building made of reinforced Concrete consists of horrizontal and vertical members, namely beams and columns. The seismic inertia forces generated at it's floor levels are tampered through various beams and columns to the ground. The correct building components need to made to ductile. The failure of 3 columns can affect the stability of the whole building, but the failure of the beam causes localized effect. Therefore, it is better to make beams to the ductile weak links than columns. This method of designed is called the strong column weak-beam method.

1.5 **Effect of Reversal Loading**

Structures subjected to ground motion (earthquakes) suffer several cycles of loading. During these cycles, the structure undergoes reversal of loading and may yield at critical sections. Thus, the critical sections should be designed not only ensure ductile behaviour, but also for

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load reversal. It is essential to provide both bottom and top reinforcement in the structural members with adequate anchorage beyond the regions of potential hinge formations. Reversal Loading causes cracking on both the faces of concrete members; repeated opening and closing of cracks may not allow the faces of cracks into exact contact, because of sign relative lateral movement and accumulation of debris in the cracks. Such extensive cracking of members causes deterioration of concrete and reduces its strength. High intensity of cyclic loading also causes deterioration of bond between steel and concrete, which should be considered in the design. Full depth flexural cracks that may develop during cyclic loading reduce the shear capacity of concrete due to reduced aggregate interlock shear. Thus, a significant components of shear force on the section must be carried by dowel action, which may induce longitudinal splitting of concrete along flexural bars. This in turn, affects the bond between steel and concrete, thereby reducing the member stiffness.

Therefore the concrete structures the essential objects of failure mode control are

1) Beams should fail before columns (unless extra column strength is provided)

2) Brittle failure modes should be suppressed

3) An appropriate degree of ductility (toughness) should be provided.

4) Effect of reversal loading must be take into account.

3. CONCLUSION

Earthquake resistant structures are designed to with stand major earthquakes likely to occur during their expected service life, such structures should be able to with stand miner earthquakes without any structural damage and major earthquakes without total collapse.

The basic principle of earthquake design practice is to ensure ductility of reinforced concrete members, so that the structure can absorb large deformations and the energy transmitted by an earthquake without significant damage. However, the structure is not usually checked for ductility during the design. On the other hand, ductility of structures is ensured by detailing the reinforcement on the basis of the recommendation of the relevant codes of practice. Design codes form a should basis for earthquake resistant structures, when properly applied. The design recommendation have been evolved consequent to several investigations reported in literature from various countries.

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BIOGRAPHIES

R.R.JOSHI
Assistant professor, Dept. of mechanical Engineering, TEI, Maharashtra, India

A.A.PATIL
Assistant professor, Dept. of mechanical Engineering, TEI, Maharashtra, India