e-conference on Indian Seismic Codes

(January 26 - February 8, 2002)
hosted by
National Information Centre of Earthquake Engineering
Indian Institute of Technology Kanpur

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Codes and References

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Jitendra K Bothara [Monday, January 28, 2002 3:49 PM]

Dear Sir/ Madam,
Thanks Dr. Dr. S. R. Satish Kumar for raising really practicle issues.

I agree with him regarding need of an explanatory book with worked example. Realizing need of such book, a guideline was prepared by Nepal National Building Code Development Project during 1992-1994. The goal was to use Nepal Seismic and Concrete codes but as at the moment these documents were not ready so it followed IS1893 and IS456. The name of the book is: Guidelines for aseismic Design of RC bare ductile framed building" and it is divided into two parts: first part deals with basics of earthquake resistant design, steps to be followed, ductile detailing and "traps" etc and 2nd part presents a example of a real building (with giving references to different clauses of the codes). It also presents a good bibliography as well for further reading. The basic concept behind this work was if a designer, not well experienced in this sector, followed the steps as identified will end up in a earthquake resistant RC framed building. Once, we discussed about publishing of the book with a Indian prominent earthquake engineer in India but unfortunately, it could not be materialized.

Regards,
Jitendra K Bothara

R.L. Nene [Tuesday, January 29, 2002 11:19 AM]

The Indian Society of Structural Engineers has recently published a book on Design of Reinforced Concrete Structures for Earthquake Resistance. The book explains many of the queries that you are receiving. The contents of the book are as below: The purpose of this book is to make known similarities and differences between provisions in IS Codes and other codes such as ACI-318-1999, UBC-1997, Eurocode, Nepal code and New Zealand Concrete Design Code NZS-4203, to select and understand the appropriate approach for the design of normal reinforced concrete structures subjected to seismic forces and to explain the

guidelines with due weightage to the current practice of construction in India. The book discusses mainly every clause of all the three IS Codes pertaining to design of reinforced concrete structures for earthquake resistance, namely I.S.:4326-1993, I.S.:1893-1984 along with proposed revised draft code I.S.:1893-2001 and I.S.:13920-1993 with due weightage to the provisions of I.S.:456-2000 by pointing to salient features concerning the seismic design with figures, pictures, details and references along with the filtered recommendations by the Indian Society of Structural Engineers. The book has more than 300 pages and is enriched with more than 250 colored figures and photographs to make it interesting and easily understandable. It is hoped that this book will be useful from viewpoint of understanding the codal provisions for earthquake resistant structures, their importance and limitations and will render quick and lucid information on the subject.

The book has following sections. –

Section 1 : THE MOTHER EARTH AND THE EARTHQUAKES.
It deals with the basic concept of earthquakes and gives explanation about general earthquake engineering.

Section 2 : THE STRUCTURE.
It deals with the explanation on the requirements of I.S.:4326-1993 and goes beyond it, to explain the importance of architectural configurations and structural layouts.

Section 3 : PRINCIPLES FOR CONSIDERATIONS OF DESIGN EARTHQUAKE FORCES.
It deals with the explanations of the requirements of I.S.:1893-1984 and also of the draft of its proposed revision, which is under wide circulation.

Section 4 : PHILOSOPHY OF DUCTILITY.
The importance of ductility in reducing the earthquake induced design forces in structures, for economy and safety, a s well as the methods to improve the ductility of the brittle material like concrete, are explained.

Section 5 :DUCTILITY REQUIREMENTS AND DETAILING.
It deals with the explanation on the requirements of I.S.:13920-1993, and goes beyond it to explain the capacity design, design of joints, weak beam strong column concept, collapse mechanism etc. with reference to world wide scattered literature available on the subject. It explains the ductility requirements in moment resisting frames and shear walls.

Section 6 : STIFFNESS, STRENGTH AND CAPACITY DESIGN.
It explains the importance of stiffness, to resist small intensity earthquakes, and also its effect on the natural period of vibration, which is vital in determination of the response of the structure. It also brings out importance of stiffness in protecting the nonstructural and structural members against damage. Importance of strength to resist moderate earthquakes and importance of ductility and capacity design to resist severe earthquakes, are also explained. The concept of capacity design, which is vital in earthquake resistant design of structures, is explained in a simple manner.

Section 7 : LATERAL FORCE ANALYSIS OF BUILDING SYSTEMS .

It deals with the concept of distribution of lateral forces, among various members of the earthquake resistant structure.

Section 8 : THE PICTURES SPEAK.
Various photographs of actual disaster of buildings are shown and the reasons for the damage are explained for clear understanding of the subject.

Section 9 : OPEN FORUM - QUESTIONS AND ANSWERS.
The answers to various questions, frequently asked by public and technical experts on the subject, are given in this section, which are quite exhaustive and explanatory in nature.

Section 10 : ADVANCE EARTHQUAKE RESISTANT TECHNIQUES.This section deals with various latest methodologies used throughout the world, for achieving better protection against earthquake forces.

Section 11 : DESIGN EXAMPLE OF A BUILDING WITH USEFUL DATA.
Rarely any book on earthquake resistant structures, gives a practical example on the design of a common building. Here an attempt is made to design a stilt upper 10-storied residential "Earthquake Resistant Building" with unsymmetrical plan and step-by-step procedure is given, with reasons and explanations.

Section 12 : CONCLUSIONS.
Important aspects of earthquake resistant designs are summarized in this section.

APPENDIX.
Terminology used in earthquake engineering and the bibliography of the books referred to in writing this book, are stated. for further particulars, please contract ISSE Head Office. C/O S. G. Dharmadhikari, 24, Pandit Nivas, 3rd Floor, R. B. Bole Marg, Opposite D'Silva High School, Dadar - West, Mumbai - 400 028. Tel : 422 10 15, Fax : 422 40 96. E-mail: isse@vsnl.net.

R. L. NENE

Jitendra K Bothara [Tuesday, January 29, 2002 11:41 AM]

Dear friends,

Of course the Illustative Design Guidelines for Design of bare Ductile RC Framed Building is not available in the market because it could not be published. I have a copy of it and I can photocopy it and send you but it would be quite expensive. You can request National Society for Earthquake Technology-Nepal for help. They may copy it ans send you it. Their e-mail address is nset@nset.org.np.

Regards,
Jitendra K Bothara

Subhamoy Kar [Thursday, January 31, 2002 10:57 AM]

Hello...
This is in response to Dr. Gupta's E-mail…

Regarding analysis of flat slab and shear wall combination, a comprehensive treatise is given in Chapter 15 of the following book-STRUCTURAL ANALYSIS - A UNIFIED CLASSICAL & MATRIX APPROACH By A. Ghali & A.M. Neville Published by E & FN SPON, An imprint of Thomson professional, 2-6 Boundary Row, London SE1 8HN, UK.

This book has dealt with analytical modeling approach and the structural idealization of the aforesaid system. The shear wall is modeled as flexural member fixed at base and flat slab and columns are replaced by their substitute frame. Then these two structural entities are connected by rigid links (which represents the diaphragm action of the floor slab) at each floor level. The collective equivalent stiffness of all the columns and all the shear walls in the building may be calculated by standard procedure. Also, the variation of shear wall / column stiffness with height can be computed based on the actual section sizes. Once this analytical model is conceptualized, rest part of the calculation can be performed by any standard software for structural analysis (viz. STAAD III or SAP 2000). Results of analysis will yield time period of the system as well as relative sharing of lateral force by the shear wall and the substitute frame (columns). These results will be much more accurate than those obtained by empirical formulae.

Thanks and regards.
SUBHAMOY KAR

Dipak Shah [Thursday, January 31, 2002 7:42 PM]

Hello Friends,
Namskar

I have read the book "Three Dimensional Static and Dynamic Analysis of Structures by Dr. Edward L. Wilson, Professor Emeritus, University of California, Berkeley " & is extremly useful to understand fundamentals of Earthquake Analysis.

SUMMARY in prof.Emeritus words
" After being associated with the three dimensional dynamic analyis and design of a large number of structures during the past 40 years author would like to take this opportunity to offer some constructive comments on the lateral load requirements of the current code.[UBC] First: the use of the "dynamic base shear" as a significant indication of the response of a structure may be conservative. An examination of the modal base shears and overturning moments clearly indicates that base shear associated with the shorter periods produce relatively small overturning moments. Therefore, a dynamic analysis. Which will higher mode response, will always produce a larger dynamic base shear relative to the dynamic overturning moment. Since the code allows all results to be scaled by the ratio of dynamic base shear to the static design base shear, the dynamic overtuning moments can be significantly less than the results of a simple static code analyis. A scale factor based on the ration of the 'static design overturning moment" to the "dynamic overtuning moment"

would be far more logical. The static overturning moment can be calculated by using the static vertical distribution of the design base shear which is currently suggested in the code.

Second: for irregular structures, the use of the terminology "period (or mode shape) in the direction under consideration" must be discontinued. The stiffness and mass properties of the structure define the direction of all three dimentional mode shape.
The term " principal direction" should not be used it is clearly and uniquely defined.

Third: the scaling of the results of a dynamic analysis should be re-examined.
the use of site-dependent spectra is encouraged.

Finally: it is not necessary to distinguish between regular and irregular structures when a three dimensional dynamic analysis is conducted. If an accurate three dimensional computer models is created, the vertical and horizontal irregularities and known eccentricities of stiffness and mass will cause the displacement and rotational components of the mode shapes to be coupled. A three dimensional dynamic analysis, based on these coupled mode shapes, will produce a far more complex response with larger forces than the response of a regular structure. It is possible to predict the dynamic force distribution in a very irregular structure with the same degree fo a accuracy and reliability as the evalution of the force distribution in a very regular structure. Consequently, if the design of an irregular structure is based on a realistic dynamic force distribution, three is no logical reason to expect that it will be any less earthquake resistant than a regular structure which was designed using the same dynamic loading. A reason why irregular structures have a documented record of poor performance during earthquake is that their designs were often based on approximate two dimensional static analyses.

One major advantage of the modeling method presented in this chapter is that one set of dynamic design forces, including the effects of accidental torsion, is produced with one computer run. Of greater significance, however, is the resulting structural design has equal resistance to seismic motions from all possible directions."

Bye & Good Night,
Dipak Shah

R.L. Nene [Saturday, February 02, 2002 5:38 PM]

Mr. Bothra,

I strongly advise the lapping of column bars at mid height instead of a number of measures sggested. Splicing of clumns bars at the midheight is very conveniently done in quite few jobs in Mumbai. Of course, the contractor may need training. This is clearly shown in ISSE book on Design of Reinforced Concrete Structures for Earthquake Resistance. This book is available at the following address.:
Indian Society of Structural Engineers, 24, Pandit House, S. K. Bole
Road, Dadar west,
Mumbai 400 028. Tel/Fax 422 4096, tel 4365240, E-mail: isse@vsnl.net

R. L. NENE