Zeitschrift: IABSE congress report = Rapport du congrès AIPC = IVBH Kongressbericht

Band: 14 (1992)

Artikel: Structural contribution to natural disaster reduction

Autor: Sinha, D.K.

DOI: https://doi.org/10.5169/seals-13787

Structural Contribution to Natural Disaster Reduction

Contribution du génie civil à la réduction des catastrophes naturelles

Bauliche Vorkehrungen gegen Naturkatastrophen

D. K. SINHA
Prof. of Applied Math.
Univ. of Calcutta
Calcutta, India

SUMMARY
The central message of the International Decade of Natural Disaster Reduction (IDNDR) is that in any endeavour pertaining to IDNDR, 'pre' elements should have a precedence over 'post' counterparts. This shift in paradigm has obviously implications for developmental activities pertaining to IDNDR. Prevention, Preparedness, Response, Recovery and Rehabilitation form the bulwark of IDNDR, and any developmental effort must necessarily reflect these essential components; also any structural activity that impinges on enterprises peculiar to the profession. Risks and vulnerabilities for every structural enterprise need to be identified and considered in the context of tenets of IDNDR. Accordingly, risk asessment on the basis of prior knowledge of mapping of disaster prone areas becomes a must for any constructional activity.

RÉSUMÉ
Le message essentiel de la "Décade internationale pour la réduction des catastrophes naturelles" (IDNDR) est qu'il faut donner la priorité aux mesures de protection avant toute catastrophe potentielle plutôt qu' à des aides postérieures. Ce changement de prioritiés a naturellement des conséquences pour les activités dans le programme IDNDR; ces dernières peuvent être caractérisées par les cinq termes: prévention, préparation, réaction, rétablissement et reconstruction. Toutes les actions entreprises dans le cadre IDNDR, y compris celles en relation avec le génie civil, doivent nécessairement refléter ces éléments. Les dangers et les faiblesses doivent être évalués selon les principles IDNDR. Quelque exemples illustrent les caractéristiques de quelques constructions vis-à-vis d'effets de certaines catastrophes.

ZUSAMMENFASSUNG
Zentrales Anliegen der Internationalen Dekade zur Verringerung von Naturgefahren (IDNDR) ist in allen Bereichen der Vorrang von Vorsorgemassnahmen gegenüber der Hilfe nach Eintritt der Katatrophe. Der Paradigmenwechsel wurde in die fünf Schlagworte Verhütung, Bereitschaft, Reaktion, Erholung und Wiederherstellung gefasst. Diese Komponenten erscheinen notwendigerweise in allen Entwicklungsanstrengungen und zugehörigen Bauaktivitäten: Risiken und Verwundbarkeit aller Bauprojekte müssen identifiziert und an den IDNDR-Prinzipien gemessen werden. Generelle Ausführungen zu diesen Prinzipien werden anhand der Eigenschaften einiger Bauwerke gegenüber ausgewählten Katastropheneinwirkungen erläutert.

1. INTRODUCTION

It would sound like a travesty of history and truth, as well if there is an assertion that there has not been hitherto any endeavour to contain, to prempt and to grapple with natural disasters. Noah's heroic effort for mitigating a natural disaster is a classic example of its kind. The contemporary surge of interest and activity on natural disasters can largely be attributed to developments in Science & Technology (S & T) and the use of the same in such contexts. IDNDR not only conjures up what have gone by but also opens up what need to be generated in the arena of S & T. All facets of Science, Engineering and Technology need to be looked at afresh and Structural Engineering (SE), in particular, can hardly escape from such exercises. This paper is essentialy an attempt to harp on IDNDR so that SE can acquire new dimensions. Hence considerations of perspectives of IDNDR are to be necessarily resorted to, vide, Sinha [1, 2, 3, 4, 5, 6, 7] and this is precisely what follows this introduction. Having sought these, it is found worthwhile to identity and also to seek overall features pertaining to SE. Some specific natural disasters are then touched upon briefly so as to facilitate further discussions on building codes, building practices etc. Finally some remarks are set forth so that imperatives of IDNDR are met not just as rituals but as far reaching activities with inputs from traditionally deemed extra-engineering sectors on a continuing basis.

2. IDNDR : A CRITIQUE

The UN resolution on IDNDR, effectively put into operation nearly two years ago, proves, doubtless, the genesis of the concept of IDNDR; the concept has since then evolved on account of versions in a variety of national contexts and of commentaries, as well. Such exercises keep on adding lustre and rich complexions to the concept per se. Indeed, perspectives of IDNDR continue to be built around three major subconcepts : (a) the generation of knowledge about natural disasters (b) the dissemination of the knowledge (c) the application of knowledge. Apparently, this sequence may run counter to a ritualistic way of setting forth the goals of IDNDR but the essence of the concept as a whole is hardly diluted. Speaking in relatively mundane terms, to improve the capacity to mitigate the impact of natural disasters, to draw upon the extent knowledge, to disseminate information across potential users to foster scientific and technological research so as to build up predictive capability, to prepare, to educate and to make the country aware about natural disasters continue to be overriding tenets of IDNDR. The accent of IDNDR is more on 'pre'part rather than 'post' counterpart which, in a way, has continued somewhat unabated in an uncritical manner. IDNDR is a pointer to take up cudgels so as to grapple with natural disasters as an ongoing endeavour, reckoning scenarios and milieu. The comprehensive character of UN resolution on IDNDR hardly leaves anything for thoughts and activities on natural disasters to any adhocism and laissezfaire effort; on the contrary, any component of it whatever be the phase pre/post/during - disaster, can hardly develop if it is delinked from the overall conceptual construct of IDNDR. As a corollary, it follows that any functionary working in this field has to be imbued with the central message of IDNDR so that one may distill the essence of it in the field of SE.

3. IDENTIFICATION OF RELEVANT FACETS

Of all aspects of activities in the wake of IDNDR, natural disaster preparedness and mitigation continue to play dominant roles while recovery and redevelopment take place after the occurrence of such phenomena. It has almost become banal to say that building practices need to be stressed as effective approaches for minimizing the effects of natural disasters. A natural disaster has little or no impact when a structure is rationally designed, appropriately constructed and adequately maintained so as to withstand the onslaught of disasters. This brings in its trail a variety of issues and problems for the simple reason that the first part of it namely the design is, by all counts, in such contexts, complicated problem. From the standpoint of structural mechanics one may pose the questions: what forces will the structure be subjected to ? How do they interact ? How do construction materials respond to the forces of onslaught ? IDNDR calls upon every engineer and more so, a structural engineer to answer such questions.

Let us delve a bit into this. First let us talk about building practices. There is hardly any dearth of practices on this score. By and large, these are empirical in nature and over the years, prior to the beginning of IDNDR engineers have generally drawn upon these rules so as to make buildings perform well during natural disasters. On the other hand, new building practices throughout the world galore, one must cull those elements that are highly innovative; even if these are fraught with new limitations, they offer opportunities to think about and to do something later on. Construction techniques have improved considerably over the decades. It is often held that cement mortar rather than lime mortar, using reinforcing steel on attaching diaphrams to the walls may be used so that vulnerability of masonary buildings in the wake of natural disasters can be greatly lessened; in fact, in the case of earthquakes, the damage can be minimized. Likewise, if the roof is attached to the walls and walls to the foundation of a wooden framehouse. destruction because of severe winds, cyclones etc. may not be that enormous. Closely on the heels of safe construction are techniques and criteria that otherwise go by the labels 'building codes and regulations'.

4. SOME SPECIFICS

It would be helpful if we begin with an example. India like many others is a country that has to concentrate attention to construction of houses, shelters etc. which need to withstand somehow the ravages of cyclone, because of farily large areas prone to cyclones and floods. Housing is also found in jeopardy because of landslides in hilly regions; the same is true of areas prone to seismic tendencies. Hence, from a wider standpoint housing and vulnerability are inextricably bound up. Badly sited houses for example buildings on flood plains, badly constructed houses, bad roof constructions etc. give rise to vulnerability in various forms. Indeed this is what led O'Keefe [8] to set forth the precise definition of natural disasters as interfaces between a natural disaster and a vulnerable condition such as those mentioned just now. Davis [9] 's seminal work brings to the fore not only the issues but also strategies for survival, safety measures for building practices etc. One must readily mention recomendations of Cyclone Review Committee chaired by late Prof. A. K. Saha [10] this report has a definite relevance to other countries as well, even though intended for the Indian setting.

In regard to floods, a near annual affair in our setting, 'flood proofing' has a bearing on SE practices. Here the need is to design or even to reconstruct buildings so as to reduce the potential flood damage; one of the activities is to raise buildings on silts or bunds or to construct water tight walls and gates properly. Flood plain management is a crucial procedure in developing countries like Bangladesh; in fact, indigeneous ways of such a management requires a novel and fresh approach to building and construction practices.

Such problems warrant from a wider point of view namely wind disaster mitigation vis-a-vis building structures. The continuing concern here is about damage caused by winds associated with natural disasters; indeed, as is well known, wind storms occur with wind speeds in excess of design speeds which therefore bring about damage. It may just be mentioned that the Institute for Disaster Research, Texas Technological University, USA has done an excellent job on documentation of damage in a large number of wind storm incidences, according to which one can categorize diverse nature of buildings. There is a host of problems indentified from the standpoint of building structures but these are left out here in the hope that they are covered elsewhere as key facets.

A few remarks about effects of earthquakes on structures. There is a tendency in such situations to look for an optimality of loss vis-a-vis costs incurred. But this can in no way be the rationale for prioritizing the task of formulating and enforcing building codes. Any kind of decision on optimality regarding earthquake risks must go in for predictions (probabilistic) of what are customarily called 'ground motions' and certainly their adverse effects on structures, people, property etc. Hence, having undertaken indepth research on better assesment of probabilistic parameters of earthquake magnitudes, location of potential sources and times of occurence, one should look for zoning and micro zoning. These bring up a host of problems, the most important of which is whether one can allow constructions in vulnerable areas. What is often overlooked is that design coefficients of different types of structures should not be proportional from zone to zone and also that these coefficients depend on how sensitive a structure is to ground motion-duration which increases with focal distances. Structural responses, structural capacity etc. are topics that need totally new consideration during IDNDR. Obviously, as mentioned above there is a tremendous scope for mathematical modelling on this score besides the task of quantifying risks and associated sensitivity studies.

BUILDING CODES & PRACTICES

It is well known that the basic parameters to codify wind effects are wind speed, terrain exposure, building geometry, building permeability etc. These lead to model building codes which, it is presumed, will be dealt with in depth in the other plenary lecture. But it would not be inappropriate to refer to standard codes in different national setting, for example the Indian Standard (IS) code. It has several plus points particularly on mapping giving zones of different wind processes varying with height; ofcourse from a certain height above the ground level. It is not clear whether such codes put any stipulation on the design of low rise buildings vis-a-vis velocity and time of winds. There is thus a large area for research particularly the study of variation of wind height and other characteristics of cyclonic winds so essential for codal specifications. It is often recomended that cyclone-resistant houses with

precast reinforced concrete skeleton with roof and infilled walls made for housing in cyclone prone areas. As desired in the goals of IDNDR, we ought to implement compatible recommendations, particularly on codes and design vis-a-vis damage analysis, of Indo-US workshop [11] on the theme.

The contemporary experience on building and construction practices shows that remarkable and vast changes have come up in this direction. Some of them are being grafted on elsewhere without reckoning deeper implications. What is often glossed over is the validation of new methods both from observational and laboratory points of view. The tendency seems to be for new buildings and far from rehabilitating existing unsafe buildings which recent R & D efforts may bear out. We have to turn necessarily once again to the tenets of IDNDR which should compel us to undertake what is often called problem - focussed applied research, vide Housner [12]; the safety analysis of existing concrete dams against earthquakes or construction of new ones is an example in point. No single country, it looks, can afford to contain seismically vulnerable styles of ground on its own, primarily because of lack of adequate instrumentation and hence lack of recording an information, too. It is being increasingly felt that each country in the context of IDNDR, ought to take up, notwithstanding disaster preparendess, pilot projects on (a) reducing the vulnerability of residential housing (b) developing repair procedures and (c) consistent building regulation standards and practices.

CONCLUDING REMARKS

The reconnaissance report on the last Armenian earthquake has brought to the fore, besides harrowing tales of horror and sorrow, serious lacunae on construction codes and standards in Armenian Soviet Socialist Republic. Research and data acquisition (and surely prediction) continue to mitigate natural disasters only to the extent that they are integral parts of a mitigation process which should include (a) the design and the construction of disaster resistent structures and other facilities (b) the strengthening or dismantling vulnerable existing structures and (c) land management that eliminates or modifies the construction of structures on hazardous sites. As already remarked, a lot of scientific and technological activity should become necessary for every attempt to mitigate natural disasters. Tinkering or refurbishing the interior many times in any building has to be abjured.

A structural engineer has to keep in view the totality of sequence of measures on disaster mitigation. This may be structured in the way the tenets of IDNDR are set forth. First, one has to have a building inventory which alone can provide the essential database for the building loss estimate, whatever be the site; second, estimates about damage and loss; third, adoption and adaptation of building codes and measures; fourth, design and development of building practices including constructional practices. An important ancillary, if not a back up activity, is expansion of educational efforts directed towards all segments of building community. What is often lost sight of is that natural disaster mitigation process must be applied to relevant life lines that are usually categorized as (a) water and sewer facilities (b) transportation facilities (c) communication facilities (d) electric power facilities and (e) gas and liquid fuel lines.

Model scenarios on natural disasters, as advocated in the UN report of the Adhoc Expert Committee on IDNDR, have relevance hereto. This is all the more necessary for a local engineer who has to understand broader community processes set in train by natural disasters. The Counter Disaster College of Australia [13] has dwelt on models of disasters for such categories of functionaries. Such exercises on modelling and simulation shed insights into occurrence of events which are yet to be; of course model studies perse, at a deeper level, for example, on stochastic models, on wind climate, of wind speed and of wind structure are afoot. The measure of uncertainty is a vexed issue; one has often to turn to reliability theory for assessing properly uncertainties. Risk assessment has a definite theoretical content in the context of natural disasters.

In sum, one can perhaps say that IDNDR calls upon us to examine threadbare the understanding of the relation between natural disasters and housing without losing the total framework. The Disaster Management Centre at Oxford has done some exemplary work on small dwelling, safer settlements and low income dwellings which can scarcely dispense with few cross cutting issues such as risk assessment, emergency planning, risk mitigation, training and education. All these speak obviously of an integrated approach. Frontier ideas, thoughts and as a spin off, appropriate technology in this context have become essential. But that NGO's, governments, academia and funding agencies need to share roles and responsibilities can hardly be contested now; insurance that has taken so far a backseat in many developing countries has to come up now. So is the case with private sector which can hardly ill afford to shirk its responsibility now and more so, when there is a renewal of thinking on economic overtures in developing countries like ours. In brief, a structural engineer has to combine in one self the traits of a management scientist so that physical & financial management aspects are adroitly handled.

As all such programmes and activities are basically concerned with human elements, human touch can hardly be overlooked. Social and cultural milieu, values and ethics can in no way be lost sight of. Community based mitigation [14] has to holdsway, reckoning S & T. A total view is therefore a must and an integrated approach becomes inevitably a part of daily usage. A structural engineer imbued with such values and qualities may aspire to be a disaster activist without shedding professional roles and responsibilities that have become all the more onerous and contingent on the building community because of IDNDR. One can then hope for a structural S & T to keep pace with evolution of concepts and ideas on IDNDR, tempered with professionalism, compassion and dedication.

REFERENCES

1. SINHA, D.K. : Coping with Natural Disasters : An integrated approach, General Presidential Address, 78th Indian Science Congress, 1991.

2. SINHA, D.K. (ED.) : Natural Disaster Reduction for Nineties : Perspectives, Aspects & Strategies, International Journal Services, Calcutta (In press).

3. SINHA, D.K. (ED.) : Readings on Natural Disaster Reduction, (1990), Monograph, Centre for Atmospheric Sciences, University of Calcutta.

4. SINHA, D.K. : IDNDR : a critique on Information Management, CSI - 90, Silver Jubilee Convention (1990), pp. 47-49.

5. SINHA, D.K. : Some remarks on Management of Natural Disasters pertaining to Coastal Areas in Coastal Zone Management of West Bengal (1991), Sea Explorers' Institute, Calcutta.

6. SINHA, D.K. : Key note Address, Seminar on 'Natural Disasters' Scenario of West Bengal , Indian Science Congress Association, 1991, Calcutta.

7. SINHA, D.K. : Natural Disaster Management : a critique of Trends & Perspectives, Theme lecture, All India meeting of S & T Councils and Departments, (1991), Goa, India.

8. O'KEEFE PHILLIP : Taking the naturalness out of natural disasters, Nature, Vol. 260 (15 April), 1976, pp. 566.

9. DAVIS, I : Shelter After Disaster, Oxford Polytechnic Press (1978), Oxford

10. SAHA, A.K. : Cyclone Review Committee (1986), Vol. III, Dept. of Science & Technology, Govt. of India, New Delhi.

11. INDO-US WORKSHOP : Wind Disaster Mitigation (1985), Deptt. of Science & Technology, Govt. of India and National Science Foundation USA.

12. HOUSENER, G.W. : An International Decade of Natural Disaster Reduction : 1990 - 2000, Natural Hazards (1990) Vol. 2 No. 1 pp. 45-76.

13. ACKEHURST, ETAL : The Local Government Engineer in Disaster Recovery, Australian Counter Disaster College, 1989.

14. MASKREY, ANDREW : Disaster Migitation - A community based approach, Oxfam (1989). Oxford

Leere Seite
Blank page
Page vide