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ROLE OF CIVIL ENGINEERS PRE, DURING AND POST DISASTERS

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ABSTRACT

Disasters are adverse or unfortunate events or great and sudden misfortunes which have a profound effect on society and the nation. They may occur due to natural causes such as earthquakes, tsunamis, floods or cyclones or due to man-made causes such as blasts, missile attacks or fire. Generally, during a large-scale disaster, civil engineering structures like buildings, bridges, dams, roads, water supply projects, coastal structures, infrastructure facilities etc are severely affected, causing immense inconvenience to people and disrupting routine life. Prevention of natural disasters is not possible but reduction in the undesirable effects of disasters can be the only way to cope with them. Natural disasters identify the mistakes made in the process of development of civil engineering structures in that particular locality, and teach important lessons for the future. If the learning from such undesirable events is utilized, hazardous effects can be reduced in the coming years.

Key words: Disaster, Disaster Management, Civil Engineers, Technological Developments.

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1. INTRODUCTION

The natural environmental changes such as global warming, heat island phenomena in mega cities, the decrease of the forest, desertification and erosion of rivers, are resulting in extremely heavy rains and snows, huge typhoons and hurricanes, abnormally high temperature, and high tidal waves. In addition to the change of natural environment, our social environment is also changing and it is becoming fragile against natural disasters. Those are highly congested urban areas, depopulation of rural areas, human habitation on disaster-prone lands, lack of cooperation and communication among recent urban societies, and insufficient infrastructures for disaster mitigation. The characteristics of the natural disasters are changing due to the changes of the natural and social environment [1]

India is a disaster prone country. With her topography and the recent changes in the climate, 50 million Indians on an average are affected by a disaster every year besides loses in property in millions [2]. Annual droughts, flash floods, avalanches, landslides make 25 of the 35 states and Union territories, disaster prone [3]. According to a recent Ministry of Home Affairs publication, we lose about 2% of our GDP on an average to disasters [4]. India has been traditionally vulnerable to natural disaster on account of its unique geo-climate conditions. Floods, droughts, cyclones, earthquakes, and landslides have been recurrent phenomena. The loss in terms of private, community and public assets has been astronomical. At the global level, there has been considerable concern over natural disaster. Even as substantial scientific and material progress is made, the loss of life and property due to disaster has not decreased. In fact human toll and economic losses have mounted [5].

The majority of damage in the event of a disaster is due to improper city planning, failure of structural design, poor infrastructural facilities, ignorance of building norms, low quality substitutes of building materials and lack of site investigations [6]. A structural engineer, a geotechnical engineer, a marine engineer, a surveyor, a city planner, a construction manager, all different types of civil engineers, have an active role to play in disaster management and mitigation [2].

2. DISASTERS

A sudden, calamitous event that seriously disrupts the functioning of a community or society and causes human, material, and economic or environmental losses that exceed the community's or society's ability to cope using its own resources [7].

2.1. Classification

Researchers have been studying disasters for more than a century, and for more than forty years disaster research. The studies reflect a common opinion when they argue that all disasters can be seen as being human-made, their reasoning being that human actions before the strike of the hazard can prevent it developing into a disaster [8].

All disasters are hence the result of human failure to introduce appropriate disaster management measures. Hazards are routinely divided into natural or human-made, although complex disasters, where there is no single root cause, are more common in developing countries. A specific disaster may spawn a secondary disaster that increases the impact. A classic example is an earthquake that causes a tsunami, resulting in coastal flooding [8].

A natural hazard is a natural process or phenomenon that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage [5].

Various phenomena like earthquakes, landslides, volcanic eruptions, floods, hurricanes, tornadoes, blizzards, tsunamis, and cyclones are all natural hazards that kill thousands of people and destroy billions of dollars of habitat and property each year. However, the rapid growth of the world's population and its increased concentration often in hazardous environments has escalated both the frequency and severity of disasters. With the tropical climate and unstable land forms, coupled with deforestation, unplanned growth proliferation, non-engineered constructions which make the disaster-prone areas more vulnerable, tardy communication, and poor or no budgetary allocation for disaster prevention, developing countries suffer more or less chronically from natural disasters. Asia tops the list of casualties caused by natural hazards [8].

Airplane crashes and terrorist attacks are examples of man-made disasters: they cause pollution, kill people, and damage property. This example is the September 11 attacks in 2001 at the World Trade Centre in New York [9].

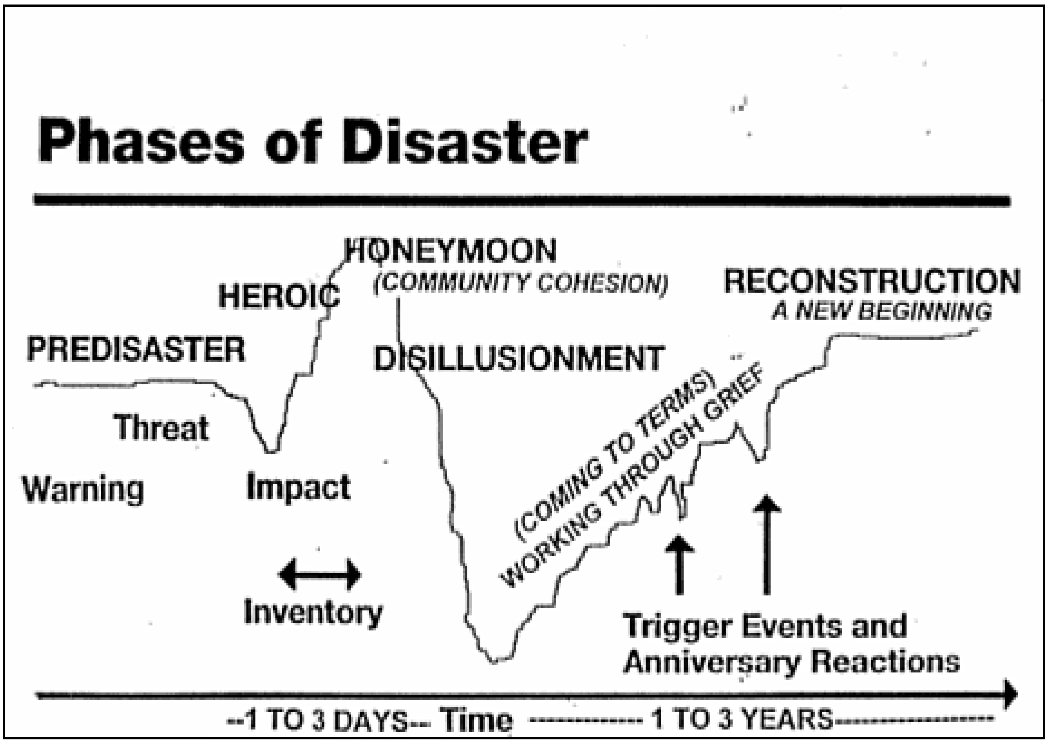


Figure 1 Phases of Disaster [10]

2.2. Disaster Management

Disaster management (or emergency management) is the creation of plans through which communities reduce vulnerability to hazards and cope with disasters. Disaster management does not avert or eliminate the threats; instead it focuses on creating plans to decrease the impact of disasters [8].

Figure 2 Logo of the National Disaster Management Authority, India [11]

Failure to create a plan could lead to damage to assets, human mortality, and lost revenue. Currently in the United States 60% businesses do not have emergency management plans. Events covered by disaster management include acts of terrorism, industrial sabotage, fire, natural disasters (such as earthquakes, hurricanes, etc.), public disorder, industrial accidents, and communication failures [8].

3. ROLE OF CIVIL ENGINEERS

3.1. Diversity of Roles

Policy makers and planners should prepare the development plan of an area considering the vulnerability of the area to various hazards. Specifications and guidelines for construction activities should be carefully laid down particularly for vulnerable areas. Before sanctioning any project, all the details need to be scrutinized by the authorities. A third party check or peer review should be insisted upon at the design and supervision stages. Local authorities must check for compliance of the project with all the requirements or specifications before granting Building Use (BU) permission [6].

Structural engineers should be involved from the planning stage of the structures and should follow all specifications laid down by the Code of Practices. The structural engineer needs to use the latest methods of analysis and provide well-detailed structural drawings including ductile detailing. Advanced methods like Performance Based Design (PBD) must be followed for high-rise and irregular buildings rather than following simple code-based approaches. Advanced materials like High Performance Concrete, Fibre Reinforced Concrete, Self Compacting Concrete, Fibre Reinforced Polymers etc. should be used whenever required in the construction of new buildings and in the retrofitting of existing structures. Soft storeys, floating columns and other structural irregularities need to be avoided [6].

A geotechnical engineer should provide a detailed investigation of the subsoil, which would be particularly useful for earthquake-resistant design. The site-specific ground response and the liquefaction potential must be assessed before the planning and execution of a project. An irrigation engineer can provide hydrological data for structures like bridges and dams that have to be constructed on rivers. A hydraulic engineer can suggest flood control measures including early warning systems [6].

The construction manager can schedule the activities on site so that there will be enough time, material and manpower to execute the job. He must also ensure quality control of each activity. The project manager can liaise between all the agencies involved in the execution of the construction project and should monitor the progress of the project. Site supervisors or site engineers execute various construction activities. It is their responsibility to use appropriate material and appropriate construction technologies, and get the work done as per the detailed drawings and specifications. In particular, earthquake resistant construction practices need to be followed. If any problem occurs on site, it should be solved in consultation with the structural engineer. The materials used in construction like concrete and reinforcement (ductile steel) must be tested for quality. It is necessary to maintain documentary evidence (in the form of drawings, reports, photographs etc.) of all construction activities that are undertaken [6].

After the construction work is completed, it becomes the responsibility of the users of the buildings to ensure proper maintenance. If any addition or alteration in the structure or building use is required, a structural engineer should be consulted. Civil engineers also play an important role in post-disaster conditions – in rescue operations, damage assessment and the retrofitting of structures [6].

Civil engineers need to keep themselves updated about the latest research and developments in construction technology, advances in construction materials and analysis or design procedures. A convenient way of achieving this goal is by attending seminars, workshops, training programmes and conferences. Civil engineers should also take support from other branches of engineering for the better planning, execution and functioning of their building and infrastructure projects [6].

3.2. Technological Developments In Disaster Management

Technological innovations are vital for effective disaster management, the DST; Govt. of India is taking several measures to upgrade technological inputs. The important developments include:

3.2.1. India Disaster Resource Network

This is a web enabled centralized data base which will ensure quick access to resources to minimize response time tune in emergencies. This database will be available at National, State and district level simultaneously. Police network is another important communication network to be used for disaster management. In emergency, mobile satellite based units which can be transported to disaster sited are being procured.

3.2.2. Development of Gis Based National Data Base for Disaster Management

The GIS is an effective tool for emergency responders to access information in terms of crucial parameters for the disaster affected areas. This includes location of public facilities, communication links, transport network etc. The GIS data is already available with government agencies, it is currently being upgraded. Comprehensive data district wise, multi layered maps based on this data are being generated.

3.2.3. Installation of Early Warning and Hazard Detection Equipment

Early warning system has already been installed for cyclones and floods in the country by IMD and CWC. There is a well established organizational set up for detecting, tackling and forecasting cyclones. There are six cyclone warning centres at Kolkata, Bhubaneswar, Vishakhapatnam, Chennai, Mumbai and Ahmadabad. Cyclone tracking is done with the help of INSAT satellite. Cyclone detection radars are located at ten centres in different coastal areas. CWC does flood forecasting. There are nearly 700 stations from where hydrological and hydro meteorological data are collected. Now, govt. has also succeeded in acquiring and installing the Tsunami warning and detection system in the aftermath of Tsunami disaster of 2004 [12].

3.3. Role of Civil Engineering Students

Students of civil engineering need to give due importance and attention to each and every subject that forms a part of their under-graduate and post-graduate studies. The course structure and syllabus is designed to impart the necessary theoretical background of all aspects of civil engineering. However, practical training is a very important aspect of the curriculum and students should take it seriously. More site visits and interaction with professionals will enable a better concept of the construction process and will familiarize students with the latest practices. Seminars and project work in advanced and interdisciplinary areas will broaden the students' knowledge about the civil engineering field. The involvement of students in on-site training strengthens their understanding of various construction activities. Students should learn about various types of disasters and about the behaviour of various structures during earthquakes, tsunamis and cyclones. Students should also be aware about the blast-resistant features of structures. A strong theoretical background and a significant amount of practical exposure will help young engineering graduates to prevent and control the adverse effects of unforeseen disasters before they occur, and to mitigate their effects afterwards [4].

4. OVERCOMING HAZARDS DUE TO MAJOR DISASTERS

Table 1 Type of Disasters, Their Major Causes and Technologies Developed Around The World to Overcome Damage Due to Them.

Sr. No.	Type of Disaster	Causes	Technologies Adopted
1	Earthquake	Fault movement Volcanism induced seismicity	Use of energy dissipating devices Braced structure frames Moment resisting frames Base isolation
2	Flood	Monsoons Highly silted river systems Steep and highly erodible mountains	Water tight building construction Building elevation Dry flood proofing Wet flood proofing Use of floodwalls

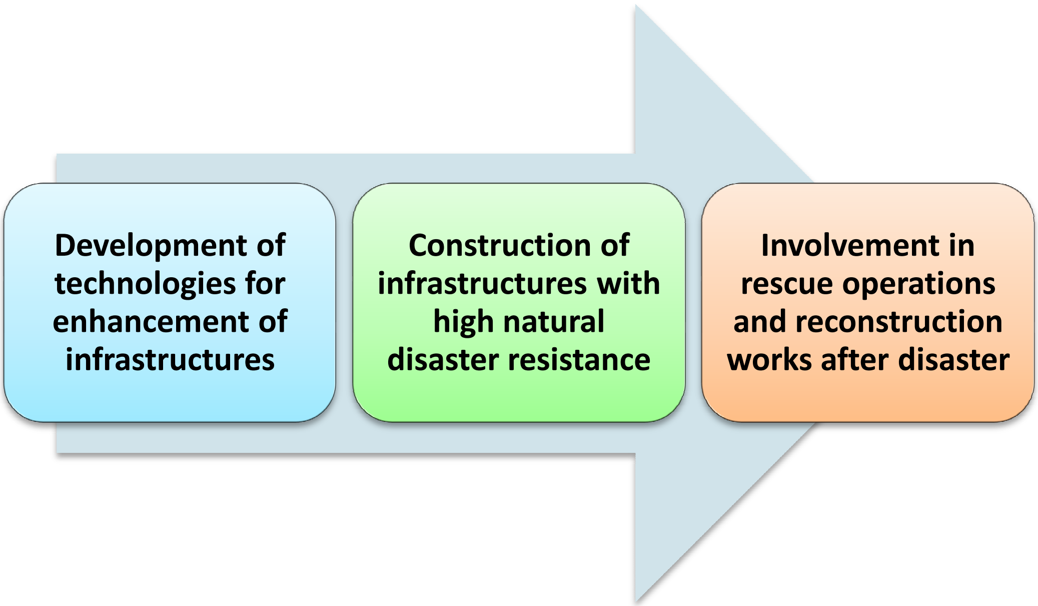
3	Landslide	Accompanying other natural hazards such as earthquakes, floods, hurricanes, and volcanic eruptions. Blasting, vibrations from machinery or traffic, construction imposing new load on the slope and altering the shape of the slope.	Soil reinforcement using geo-synthetic materials Construction channel systems Retention systems Deflection walls
4	Tornado	Water vapour condenses to form clouds and rain, warming the surrounding air.	Use of hurricane straps to strengthen connections Special attention paid to load pathsand connectors Impact resistant doors and windows Braced roof trusses and gables.

5. RESULTS AND DISCUSSION

It was studied how civil engineering and disaster management are in fact very dependent topics. Structurally sound structures play a crucial role in the safety of the people during a disaster. Currently adapted techniques and new developments in technology further assist civil engineers to play their role in disaster management. Thus, a civil engineer has contributed efficiently in disaster management by developing and expanding the knowledge and techniques in the following three technologies:

- High performance structures
- Improvement of soft soil
- Warning and rescue systems

Professional discipline, sensitivity to the needs of society, an interdisciplinary approach, and integration of focused efforts towards the development of built environment, building and infrastructure projects will lead to a safer society in future [4].



6. CONCLUSION

The contribution of engineering has been important in the setting of engineering codes and standards, and in the development of engineering resources, tools, and methodologies for use in mitigating the impacts of natural and technological hazards on the built environment. However, engineered-hazard mitigation options alone do not guarantee protection from natural and other hazards. Therefore, a holistic multi-hazard perspective that integrates social, economic, and environmental issues to hazard reduction is preferred. The engineering professionals, who contribute to hazard reduction, will be increasingly required to work across disciplines, and with many actors and stakeholders.

Engineering has contributed to our overall understanding of natural hazards and their impacts and the vulnerability of the built environment to these hazards. Improved understanding of natural hazards results in better forecasting of natural hazards, and more effective disaster prevention and mitigation practices and preparedness planning. One such example is HAZUS-MH, which not only provides estimates of potential damage and economic losses from natural disasters, but also provides useful data for emergency preparedness and response planning [13].

Engineering will continue to contribute to hazard reduction as cities become ever more complex and interdependent, and as new threats emerge (e.g., impacts of climate change, water scarcity, terrorism). Engineers will be required to apply new knowledge and skills to develop innovative and effective ways to prevent, prepare for, and respond to future disasters.

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