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Role of civil engineers in disaster mitigation

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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. Civil engineers can play a major role in disaster mitigation by creating safe structures through the integrated efforts of all those involved in the construction process.

Causes of damage

The majority of damage during natural disasters is caused due to the improper planning of cities and various infrastructure facilities, lack of site investigations, improper structural planning and design, violation of specifications, poor quality control at construction works, and lack of coordination between the various agencies involved in a project. A man-made disaster is generally caused due to terrorist activities or human carelessness and the severity depends on the security measures.

Roles and responsibilities of civil engineers

A Civil Engineer (with or without specialization) can work in different positions like

- Policy maker
- Planner
- Structural engineer
- Geotechnical engineer
- Hydrological / irrigation engineer
- Environmental engineer / Public Health / Sanitary engineer
- Surveyor
- Transportation engineer
- Marine engineer
- Construction manager
- Project manager
- Services (Plumbing, Fire-fighting, Lift, HVAC, Electrical) consultant

- Site supervisor
- Site engineer
- Builder / Contractor
- Research and development; academics
- User of constructed facilities

……. many more

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.

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, Fiber Reinforced Concrete, Self Compacting Concrete, Fiber 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.

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.

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.

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.

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.

Distraction in performing duty

Civil engineers face many distractions in performing their duties in various roles. Some of these hindrances are:

- Pressure from political or builders' lobbies
- Inadequate investigation and feasibility studies
- Delay in sanction of projects and in other administrative processes
- Pressure of time limit
- Builders not interested in quality
- Inadequate time for investigations and design
- Conflicting interests of the agencies involved
- Tendering system and specifications

- Inadequate resources and adverse working conditions

The above distractions may lead to increased hazards during a disaster. Civil engineers (in every role) should try their best to overcome the above limitations and should perform their duty with utmost care.

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.

Summary

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

The role of civil engineers, whatever post they may hold in the field, is very important in reducing the risk of damage to buildings during disasters. From the planning stage to the execution of civil engineering projects, the paramount consideration is that care should be taken by all concerned to ensure public safety in the event of a disaster.

Let's together build safe and sustainable structures for mankind.

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