Executive Summary

Background

The Indian National Academy of Engineering (INAE) and National Information Centre of Earthquake Engineering (NICEE) organized the *INAE National Seminar on Engineering Response to Hazards of Terrorism* during 25-26 September 2006 at Indian Institute of Technology Kanpur. About 70 delegates participated in the event including delegates from government agencies (like DRDO, IGCAR, NPCIL, BARC, SECL, RITES, Zonal Railway, Reserve Bank of India and Hindustan Petroleum), academic institutions (like IIT Kanpur, NIT Jalandhar, NIT Patna and CME Pune), and professional organizations (like Larsen and Toubro Limited and CES). The Seminar focused on topics like Buildings and Structures; Use of IT in Combing Terrorism; Sensors & Devices; and Special Structures & Special Situations.

Important and major systems, facilities and structures are currently being subjected to threats of terrorist attacks. Strategies and measures are required to reduce, if not to prevent, possible loss and damage due to the negative fallouts of hazards of terrorism. Four levels of security strategies are possible namely deception, intelligence, physical and operational protection, and structural hardening. *The INAE National Seminar on Engineering Response to Hazards of Terrorism* was an attempt to bring particularly the last two strategies in focus. The following is the summary of the outcome of presentations and discussions of the seminar.

Discussion

Protection of buildings and structures by structural hardening is a specialization in itself. Structures may not necessarily be designed for extreme accidental loads, but should possess reasonable strength against total damage even though they may be interrupted from operational service. In India, design of structures follows conventional design codes and procedures for blast loads that were primarily developed for the protection of military facilities for weapon-induced explosions usually external to the structures. These codes have been quite successful in ensuring safety of structures for the loading environment they were developed. But, they are not likely to provide the same margin of safety against modern day terrorist-induced explosions, which not only differ in explosive device type but also in the manner the explosions are executed.

Site planning, architectural and structural considerations and security of new buildings need to be given utmost importance. Building science professionals (architects & engineers) need to be given design guidance on blast-effects on the contents of building. Further, suitable design concepts need to be developed for the retrofit of the existing structures to minimize the effects of terrorist attacks. Significant amount of new knowledge is required with respect to definition of new design threats and corresponding design loading, performance objectives, structural analysis procedure using appropriate material behaviour, and development of design concepts and their validation for the

construction of new and existing facilities. A document on this has recently been developed by IIT Kanpur supported by the Gujarat State Disaster Management Authority, Government of Gujarat. It contains the available information on the subject of design of buildings to resist the effects of terrorist attacks, for the use of designers. The document also discusses separate mitigation measures for different terrorist hazards on existing buildings, method to assess the vulnerability of an existing facility, and measures to be undertaken to reduce the risk involved.

The 11 September 2001 terrorist incidents caused colossal destruction and significant damage to a number of buildings in the World Trade Centre (WTC) vicinity in New York City. The twin towers of the WTC suffered significant damage from the impact of the planes, though, they withstood the impact. But, the severe fires that followed the impact brought down the twin towers and a number of other buildings in the vicinity. New design provisions need to be developed which address the wide variety of possible terrorist attacks to civilian infrastructure, which must include the secondary effects of blast loads, such as, fires, smoke and progressive collapse.

Evaluation is required for the safety of existing nuclear containment structures of nuclear power plants against attacks of aircraft crash. Case studies are required on the containment structure of a nuclear power plant to demonstrate integrity and proper radiation shielding to the public. Similar exercise is required on dams, which also pose serious threat to the population of the neighborhood. Suitable safety measures need to be considered at the time of planning, designing and constructing dams. In addition, appropriate emergency response measures also are required to mitigate the consequences of successful attacks.

Security of chemical process industries now needs formal efforts to understand the damage inflicted (including casualties, economic loss, and political fallout). Each facility needs to have a security management programme, whose essential components include security risk assessment, security countermeasures and emergency response. Many of the conventional safety and security measures adopted thus far may have to be modified in light of the enhanced and complex nature of the present security threats.

Role of IT in combing terrorism is invaluable. One major aspect of the reducing disaster is systematic and safe evacuation of men and material from affected buildings. Persons inside the building can have RFID identity tags, and RFID readers spread across the length and breath of the building would be able to track each individual. Mapping the RFID tags to individual's cell number will offer a mechanism to give personalized evacuation instruction. Further, in this age of extensive use of computers, terrorists are exchanging message that are encoded using cryptographic algorithms. Cryptanalysis, the science and art of decoding encrypted messages, needs to be given more attention to improve the understanding of such messages.

Increasing terrorism and crime in public places has led to an exponential growth and proliferation of surveillance systems. Among various options available, video surveillance (VS) is a powerful tool from the points of view of the level and sophistication of the data collected. Current VS systems inevitably require a human component at the rear end. While technological advancement has dropped the costs of all other components

of a VS system, its affordability remains limited by the human component which is gradually getting more expensive. Partial automation will permit greater use of VS systems into many domains where high manpower costs presently limit their use. Physiological or behavioral characteristics of people can be automated to determine or verify identity.

Remotely operated unmanned vehicles either on ground, air or underwater are normally deployed for hazardous missions, like improvised explosive device detection, chemical contamination monitoring, mine detection and radiation hazard monitoring. A generalized interface methodology is available which allows for sensors system to be integrated seamlessly with these Remotely Operated Vehicles.

With increasing concerns about handling and use by anti-social elements, detection of chemical explosives has now become an urgent need. These compounds are handled by terrorists in simple but very carefully concealed manner to cause extensive damages. When the explosives are packaged with radioactive material, they act as dispersion device (such a device is known as a dirty bomb) and spread radioactivity to a wider area. Several methods are under development for detecting trace level of explosive vapours in ambient air, and are under different stages of development. Techniques based on spectroscopy involve fingerprinting the characteristic features of functional groups in these compounds or modification of these characteristic features on interaction of these compounds with specific reagents.

Recommendations

The National Seminar concluded with the following major recommendations for future actions in the country to improve engineering response to hazards of terrorism:

(1) General:

a. *More Brain-storming Discussion Meetings*: There is a need to have more initiatives like this 2-day national seminar, to bring together professionals discipline-wise, discuss the issues involved, and develop specific discipline wise agenda.
b. *Sensitization of General Public*: The country has a very high awareness because of losses due to terrorist hazards. This must be stepped up, and an intense sensitization program needs to be launched at the national level.
c. *Information in Public Domain*: Barring a few exceptions, most information on engineering interventions for reducing impact of terrorism should be in public domain. In the absence of this, the people with malafide intentions tend to have more expertise than persons responsible for safety. There is consensus that close-domain information leads to restriction of information to the community and not to the terrorist.
d. *Rural Focus*: While most of the development seems to be focused in the urban areas, there is a need to ensure that required attention is also paid to the safety of people and the critical and lifeline infrastructure in the rural areas.

(2) Education, Research and Training:

a. *Curriculum Changes*: Considering the wide-spread losses and ramifications of terrorist hazards to the people and built environment, the engineering and architecture curriculum should include extreme-event related knowledge and subjects. This needs to be done for the curriculum at both bachelors and masters levels; the former could include concepts, while the latter detailed engineering.

b. *Capacity Building and Training*: Comprehensive programs related to security and safety need to be launched towards capacity building of practicing professionals and training of non-technical staff in the various public and private organizations. This program should be developed based on extensive discussion with the stakeholders.

c. *Life-Cycle Cost Studies*: Studies need to be undertaken to clarify the initial cost of the structure and the losses incurred thereafter due to terrorist hazards. Such studies provide the much needed perspective on life-cycle costs (including indirect losses). Professionals need to deliver the best service by bringing into discussion the client and informing the life-cycle costs, thereby making the cost of a structure to become a social choice.

d. *Risk Assessment and Protection of Existing Facilities*: Systematic efforts are required to undertake a formal and scientific assessment of risk of major facilities in the urban and rural areas. These can be made a part of the bye-laws of the local municipal body. Critical elements of existing structures need to be identified and measures undertaken to protect them. Considering that the number of structures requiring such attention is huge, this effort needs to be undertaken in a phased manner.

e. *Fire Engineering Program*: Fire is one of the common and major consequence of many natural and unnatural (terrorism related) events. There is a need to develop a Fire Engineering Program in the country with a view to develop fire safety as a technical discipline. This will help develop an engineering approach to addressing fire safety as against the empirical approach that is being adopted currently.

f. *Computer Security*: Renewed effort is required to upgrade manuals and practices for computer security.

(3) Practice and Design Codes & Guidelines:

a. *Role of Architects*: Architects need to be sensitized on the importance of their role in town planning, site planning, and functional planning and design of structures. The Council of Architects and the Indian Institute of Architects may mobilize this effort at the national level.

b. *Update Existing Codes*: Some of the Indian Standard codes of practice for the design of buildings and structures are archaic. Pending development of codes and guidelines, engineers and architects need to become pro-active and implement the required engineering with the help of available international documents on good design practices. The revision of the Indian Standard IS: 4991 for blast resistant design of structures needs to be undertaken urgently.

c. *Implement Known Interventions*: A number of anti-terrorism low-cost measures are already available; these need to be implemented. This can lead to substantial mitigation of the effects of terrorist hazards.

d. *Develop New Codes*: New codes and guidelines need to be developed for the planning, design and construction of buildings and structures, in particular the critical and lifeline structures. Separate codes are required for design of structures to resist bomb blasts internal to the structure and external to the structure. Special attention is required to develop urban-centric blast effects on structures where reflections of the pressure waves from the neighboring structures will change the pattern of blast loading on a structure. There is a need to categorize structures depending on their importance; code provisions should fix the levels of hardening required during design.

e. *Develop Best Practice Documents*: Considering the international state-of-the-art and practice, best practice documents need to be developed for use in India on blast design, fire design, and assessment of structural safety of buildings affected by the terrorist threat.

f. *National Urban Renewal Mission*: The country has recently launched the Jawaharlal Nehru National Urban Renewal Mission to update a number of urban areas of the country. This program should include measures to mitigate the negative effects of man-made and natural hazards.

g. *Terrorism Related Manuals for Industries*: Manuals and documents need to be developed to address terrorist threat to the wide spectrum of Indian industry. Agencies like Confederation of Indian Industries (CII) need to take the lead in this direction.

(4) Research on Protective Technologies:

Two types of challenges exist today in the design of structures – *natural* and *man-made* hazards. Many anti-terrorist strategies and engineering technologies are already available; these need to be internalized by the professional practice.

a. *New Technologies*: More technologies need to be developed for extreme events. National funding agencies, like Department of Science and Technology (Government of India), need to consider giving special priority to the matter by assigning ear-marked funding and constituting special Technical Committees to develop, implement and monitor research programmes in the areas of protective technologies for *natural* and *man-made* hazards.

b. *Hazard Detection Equipment*: Coherent pro-active R&D initiatives are required to evolve technologies that will lead to development of devices and equipment for identification of nuclear, chemical, biological and radiological hazards.

c. *Communication Technologies*: A major R&D effort is required to identify suitable and appropriate communication technologies that are suitable for use in situations arising out of extreme events.