

Post-mortem of a disaster

ARCHITECT DR. NIZAMUDDIN AHMED

OVER the past few years, there have been several instances of building collapse, as in structural failure, some with devastating and telling tolls so much so as to awaken concerned professionals to search for answers as to who, why and how 'Where' was as obvious as the heaped debris, burial mounds may be more appropriate an expression, and 'when' was a simpler question.

In the infamous Spectra Sweater Factory building cave-in in April 2005, sixty-four people were killed, more than seventy injured. Within a year on 25 February 2006 a five-story building in Dhaka's Tejgaon industrial area collapsed during unauthorized renovations of the building housing Phoenix Garments killing 22 and injuring 50.

On both occasions the city's emergency and rescue resources, meagre as they are, were exposed as severely under prepared, materially and technically, for such disasters, imminent they are in view of our total disregard for compliance with building codes.

The incongruity is that the incidents, not to be confused with accidents, could have been avoided. Both were, as are most others, the result of simple greed and a strange hunger to flout rules, an ailment that affects people seeped in political or governing power. The absolute failure of the actors concerned cannot be overemphasised.

The very unfortunate and uncalled for occurrences have highlighted the need for 'forensic engineering', that is, the investigation of materials, products, structures or components that fail or do not operate or function as intended, causing injury and fatality.

Any building collapse, accidental or due to sabotage, unintended or intentional, demand inquiry to search for answers to

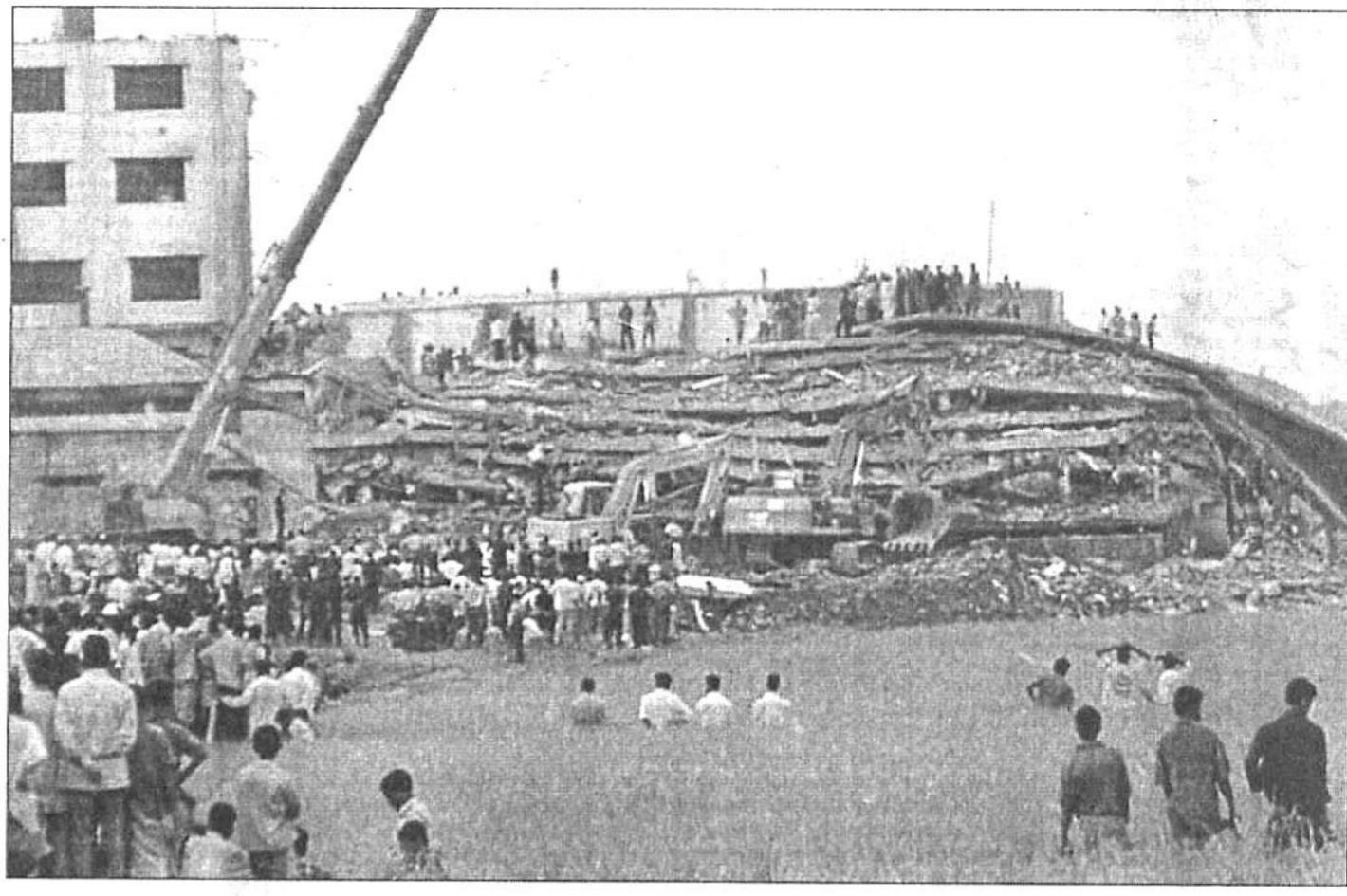
what led to the horrific calamity and for means of preventing a replication.

Soon after the Savar tragedy, Institution of Engineers Bangladesh (IEB) formed an Investigation Committee to probe the catastrophic failure and to determine the lessons learnt with Dr. Engr. A.M.M. Saifullah, incumbent Vice Chancellor, BUET, as its Convener. This week we present the first half of the IEB report.

Considering the grievous consequences of building subsidence, there is the growing want for Emergency Medical Technician (EMT) and Emergency Medical Service (EMS), a point illustrated in the first part of Clark Staten's paper this week on rescue technology.

We dedicate the current issue to the expectant mother who defied her husband's plea to stay home that fateful night. She argued that she had to work the nightshift at Spectra because the management had promised to pay her monthly dues, if she did so. She and her baby are no more.

The author is Professor, Dept of Architecture, BUET and Consultant to the Editor on Urban Issues



Savar Spectra sweater factory failure

Institute of Engineers Bangladesh (IEB) Investigation Report: Part I

ONE 9-storied sweater factory building owned by Spectra Sweaters Ltd., located at Palashbari Village under Savar Thana of Gazipur District collapsed in the early hours (1.15 am) on April 12, 2005 killing more than 60 and injuring more than 100 workers. The incident was deeply shocked by the incident. The Honourable President and Prime Minister of the Government of the Peoples' Republic of Bangladesh visited the site a short time after the incident. The site was also visited by political leaders, members of IEB, RAJUK, BGMEA, BUET, BACE and other concerned organizations a short time after the incident and several days later. Separate investigation committees were formed by different organizations to find out the causes and frame comprehensive recommendations to prevent this type of failure in future.

This report has been prepared on behalf of IEB by a Committee constituted by it but does not necessarily reflect the opinion of the IEB.

Description of the incident

On the eastern side of the Kaliakoir-Nabinagar Highway is the 5-storied Shahriar Garments Factory building, which is unaffected. The collapsed 9-storied building is located east of the Shahriar Garments Factory and adjacent to a ditch further towards the east. Both the factories belong to the same owner. The collapse took place in a sudden failure without any warning.

Soon after the collapse the Fire Brigade, Engineers Corps of Bangladesh Army, and other different agencies started the rescue operation, which continued for 8 days (up to the 19 April 2005) till all the debris over the fallen building was cleared; all the trapped victims were rescued, and the dead bodies were recovered.

The IEB Investigation Committee

Soon after the incident, Institution of Engineers Bangladesh formed an Investigation Committee to investigate into the causes of this catastrophic failure. The Committee consisted of the following members:

Dr. Engr. A.M.M. Saifullah Convener
Eng. M. A. Sobhan, P.Eng. Member
Eng. Md. Mahmud Hussain Member
Eng. Md. Abdur Rouf Member
Eng. Md. Ahsanul Huq Member
Eng. A.H.M. Shahiduzzaman Member
Later the Committee co-opted the following members into the Committee:
Eng. Mir Zahir Hossain Member
Eng. S.I.M. Yasin Member
Dr. Engr. A.B.M. Saiful Anan Member Secretary

As per the terms of reference of IEB, the Committee is to 'find the causes that triggered the failure process and resulted in complete collapse of the structure'. The committee further extended its scope to make recommendations so that such situation can be prevented in future.

Methodology used for the investigation

The investigation has been conducted based on information received through the owner, news media, available photographs, field visits, and critical observations made during the rescue operation and after removal of debris of the collapsed building from the site. The following steps were taken to find out the cause(s) of the disastrous collapse of the building:

Step-1 A layout plan and design prepared by the Engineer employed

by the Owner was obtained. Sep-2 In absence of the As-built drawings, the building's layout plan was reconstructed from the visible column locations after the site was cleared.

Step-3 A pre-design soil boring report (of March 1999) used by the designer was collected from the owner. Subsequently a report on the post-failure field investigations including SPT bore log prepared on behalf of BGMEA was collected and super-imposed over the pre-design bore log.

Step-4 The test results of some materials of the collapsed building (tests performed at BUET Laboratory) were obtained for analyses.

Step-5 An account of additional installations in the building and loading conditions prevailing at the time of collapse was reconstructed by interviewing some workers who were on duty at the time of the incident.

Step-6 A description of the piling work and sinking operation of the two tube wells adjacent to the pile foundations was obtained through interviewing the piling and tube well sub-contractors for use in the review and analysis.

Step-7 A three-dimensional finite element model of the structure was developed to simulate different probable failure modes and verify those with the post-failure revelations, based on the re-constructed layout plan, post-failure survey information and design sheets provided by the design engineer.

Step-8 The design of the respective foundations was checked to assess their design adequacy. To this end, the capacity of the pile groups was calculated based on the both pre-failure and post-failure soil exploration reports.

Step-9 After completion of the normal clearance of the debris, foundation of the northeast end corner column and the pile cap was exposed by additional removal of debris and excavation. The conditions thus revealed gave evidence as to how collapse of the building was initiated.

Observation bases formulated during the investigation

The following observation bases were formulated through field investigations, measurements, review of design reports and press reports regarding the nature of failure and the immediate factors that caused it:

(i) The building collapsed due to bursting of the boiler.

(ii) The building was constructed on the soft soil and in the ditch/khal and the cast-in-situ bored pile foundation has failed.

(iii) The quality of concrete and other construction materials, and workmanship was poor.

(iv) The building was designed for 4-storyed but the construction was done for 9-storyed, and thus the building was overloaded.

(v) The structure was constructed without any proper and sound design.

(vi) The construction wasn't supervised properly.

(vii) The contractor didn't follow the design drawings.

(viii) The design was faulty.

It's natural that immediately after such a catastrophic collapse such guesses would appear before the nation. The Committee however looked into each of these possibilities and by eliminating improbable ones tried to arrive at the root causes of this disastrous failure.

IEB Investigation committee findings

Boiler blow out: The issue had been investigated and was discarded because the boiler was found in an unburnt condition after the incident.

Failure of foundation: As stated earlier, it was observed after clearing the debris that none of the pile caps including that of the north east corner column showed any sign of undesirable settlement or failure. Therefore, the assumption that the failure resulted from weak soil condition and foundation failure is discarded.

Overloading of the building: According to media reports, the

ground floor slab had gone down by about 11 feet from the surrounding surface and there was little settlement of rest of the floors or footings.

building might have been overloaded on two counts, either the construction was made for higher stories than the structure was designed for and/or, the service load far exceeded the design loading. Design reports received from the designer shows that the structure was designed as an eight-storyed building but a portion of the building was constructed as nine stories. Loading in excess of the design load is likely but the extent of overloading could not be confirmed.

Large variation in quality of concrete: There has been considerable variation in concrete strength as found from test results (tests done by BUET testing laboratories) using random samples from columns and slabs. This reveals systematic and proper quality control operations were not performed in constructing this building. Also the onsite investigations suggests that the quality of construction materials used in this project didn't satisfy the specification requirement. It was observed that the brick chips were used as coarse aggregate whereas the designer specified stone chips for it. However, it should be noted that strength of samples taken belonged to the collapsed structure; therefore, some deterioration in strength could be noted with the design.

Non-availability of appraised design and As-built records: No approved architectural or structural drawings could be found for the building. There has been some confusion as to whether the collapsed factory building and the surrounding area are under the jurisdiction of the Savar Cantonment Board or RAJUK. The factory owner in an interview mentioned that he contacted the Cantonment Board for permission to construct an eight storeyed building but some officers of the Board suggested him that the Board would not approve such high rise building at the moment and that he should apply for a four storied building. It was suggested that if the design had been made for an 8-storyed building and he constructed only four stories at that time, he might later apply for higher stories.

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