Rescue and Emergency Management Plan :

Collapsed Building, Man-Made Disaster : MEERUT CITY

1. Introduction

Building collapses are a major cause of mortality and morbidity around the world. In the last decade, a number of buildings have collapsed causing a significant number of deaths and illness. With the rise of multistory buildings, collapse of multistory buildings is certainly a great havoc to the residents.

Reasons of Single story or multistory buildings Collapse:

1. Earthquake .
2. Gas explosion – Storage or Piped Gasline.
3. Unregulated Digging of basement in the adjoining Plots.
4. Structural Failure. Violation of Nation Building Code.
5. During construction due to poor material use, heavy rains, Failure of supports.
6. Loose soil filling in the base or sudden sinking of land at the base.
7. Missile/projectile attack, terrorism/war.
8. Fire, electric Shock, Other reasons.

This man-made disaster caused a massive loss of human and material, economic, and environmental loss.

Local volunteers with the help of the trained forces were deployed to rescue the victims, whether dead or alive. Unsafe human act took this greatest toll, but the same mankind came forward to save hundreds of lives from the terrible event.

Immediate Steps to be taken :

When such incident occurs, immediately Fire Department, Police department & Local Administration is informed. They further call various related departments –

1. Development Authority with trained Engineers, Heavy earth moving equipments, RCC Cutters, Heavy Drill Machines, Generators, lights, check Layout/Map approved/not, following NBC.
2. Municipal Corporation : (incase collapse is in city) Multistory building are abundant in the city areas only. Heavy Earth moving equipments, Generators, lights, electricians, trained engineers/workforce, RCC cutters, Drill etc.
3. Fire Department : Disaster trained manpower, fire tenders for extinguishing fire, leakage of gas, thermal imagers, Drill machines, ropes, Generators etc.
4. Medical health department with ambulances, Doctors, paramedical staff for providing immediate frst aid to the rescued persons & shifting them to hospitals & mortuary as required. Medical collage should be informed.
5. National Disaster Relief Force (NDRF), if nearby for expert rescue team and equipments. They have sniffer dogs who can locate dead/alive persons, latest thermal imaging sensors, drill machines, RCC cutters, Generators, lights, ropes for rescue of persons from the collapsed structure.
6. Army- Disaster relief unit- Specially trained for the purpose along with resources- heavy machinery, equipments etc.
7. Private heavy industries, road/building/mining contractors who have earth moving equipments, expert engineers, labours for rescue.
8. Civil Defence, Local volunteer organization, NGO's for relief work.
9. Police Force: Cordon off the disaster area so that the rescue team can work properly without interference.
10. Media management. Management of kith & kins.
11. Nearest Engineering Collage can help in disasters.

Building Collapse Rescue: Operational Considerations

Although there has been recent development of new equipment that has made a significant improvement in how building collapse rescue operations are resolved, the strategy and tactics of the collapse rescue operational plan As sustained heavy damage during many bombing raids, and scores of people were trapped in collapsed buildings, a five step plan was developed by government's Civil Defense Department, fire service and military to organize the confusion at a collapse operation.

This five-step plan is essentially the same plan that is taught today in many courses, although the first two components have been combined, resulting in a four-step sequence.

COLLAPSE RESCUE OPERATIONAL PLAN

Survey/assessment and surface search → Void search → Selected debris removal → Human Bodies Removal → General debris removal

By following the above plan and breaking the incident down into four main stages, the collapse rescue operation can progress from one step to another in a systematic manner.

The extrication of occupants trapped in the rear of these partially collapsed row dwellings would pose a significant operational challenge to any fire department. A four-phase collapse rescue operational plan, effective use of outside resources, proper shoring techniques, and specialized rescue tools and training are required to resolve collapse incidents safely.

1. SURVEY/ASSESSMENT & SURFACE SEARCH

The most important step in this operational plan is the initial size-up performed in the survey/assessment phase. Actions taken early on usually set the tone for the entire operation. A complete safety assessment of the entire area should be undertaken by the first-arriving unit(s). This survey should include a six-sided approach to the total area involved (front, rear, sides, top, and bottom of the collapsed structure) and should specifically include a survey for victims, status of utilities, visible fire, extent of collapse and obvious dangers. The remaining building should be surveyed to see how it can be shored and stabilized. At this time, the remaining upper sections of the building should be checked for hanging structural hazards. A size-up and check of the basement for structural conditions and stability should also occur during this stage. Potential for secondary collapse should now be carefully evaluated.

At this point, information regarding the building's use, the number of occupants, and the number of victims trapped and their probable location should be ascertained. Concurrently, as the safety assessment priorities listed above are being evaluated, the incident command system should automatically be activated.

Similar to a hazardous materials incident, the area should be broken down into three distinct zones: the "hot" zone (the collapsed building itself along with adjoining exposures and any secondary collapse potential sections), the "warm" zone (where specialized equipment is staged and a cutting station is set up for shoring operations), and a "cold" zone (where the command post and a staging area for remaining personnel and apparatus are set up).

It is imperative that all utility services are shut down as soon as possible to minimize the dangers to buried victims and also to firefighters operating at the collapse site. Utility companies should also be notified to respond via the radio dispatcher automatically for consultation and assistance, even if a specific utility service is not involved at this point.

Standard operating procedure for the first-due engine company is to obtain a hydrant position and immediately stretch a hoseline. The second-, third- and fourth-due engine companies should obtain a hydrant position and, as conditions dictate, will stretch additional hoselines.

As in other special operations, it is extremely important to have an outside resource list in place for specialized equipment and personnel that are not available from within the fire department. Strong consideration to utilize part (or all) of the assets on the list should begin early in the operation (during the survey/assessment phase). The following speciality areas should be included on the list: structural engineers, architects, practical shoring engineers, utility company contacts (for emergency operations and also for readily available heavy construction equipment), demolition contractors (with an itemized list of heavy equipment available), search dogs, sources for immediate delivery of lumber for shoring, technical advisors (for example, personnel from the Nationall Emergency Management Agency's Urban Search And Rescue Task Forces), and other municipal departments (such as the highway department for heavy equipment).

This is the stage of the operation where needs are projected for the entire duration. Due to the extended "reflex time" required to get certain resources on the site, it is standard practice to request the response of certain outside resources immediately upon assessment, even though these resources will not be used until the third or fourth stages of the operational plan.

As the survey/assessment phase switches into the "action" phases, the search and removal of victims on the surface (and also those victims who can be easily extricated from minor debris entanglement near the surface) of the collapse site is now accomplished. According to statistics, half of the people rescued from collapsed buildings are found during this stage.

2. VOID SEARCH

After the first stage is completed, all voids (spaces and crevices throughout the rubble) should be identified and searched. About 25% of victims are found during this phase. There are four major types of collapse patterns.

- **Pancake collapse void.** Floors fall as a unit and fall in a stacking effect on top of each other. Victims are usually found between floors or in voids created by furniture or machinery.
- **V-shaped collapse void.** The floor breaks near the center and falls to the floor below while still attached to the exterior walls, forming a "V."
- **Supported lean-to collapse void.** The floor fails at one end and stays anchored at the other end.
- **Unsupported lean-to collapse void.** Sometimes called lean-to cantilever collapse void, this is similar to a supported lean-to collapse, with the following important exception: the failed end hangs with no solid support, creating the most unstable and dangerous type of collapse. The potential for secondary collapse is significant; the unsupported floor area must carefully be secured and stabilized.

At this point, a determination should be made as to whether the operation will proceed as a rescue operation or a body recovery. If it is determined to be a rescue, then the time factor becomes critical, and rescuers could expect to be exposed to a certain amount of calculated risk. If it is a body recovery, time is no longer a controlling factor, and risk to firefighters is not acceptable. "Rescue vs. recovery" is one of the most critical decisions the incident commander has to make.

The type of building construction involved will have a significant impact on this decision due to the fact that the type of building materials involved will dictate the types of tools required, and the specific tactics for the extrication of victims. Most importantly, it will dictate the time required to complete the task.

Although monitoring for secondary collapse must occur throughout all four stages of the operational plan, it is mandatory that it occurs during the void search phase. This is accomplished by assigning at least one member to closely monitor the area(s) involved. This position is usually augmented by another member who will use a builder's transit to detect any movement in the portion of the building (or exposures) still standing. Any visual changes are then immediately communicated to the incident commander, and the operational plan is adjusted accordingly.

Locating Buried Victims

One of the most challenging aspects of collapse operations is locating buried victims. This is critical because efforts spent in shoring and breaching operations in the wrong area will waste valuable time and resources and unnecessarily fatigue the rescuers. Four main methods are employed.

Physical search is the most dangerous for rescuers, because it involves deploying personnel over and around a collapse and actually committing rescuers into unstable void spaces to physically search for victims. One method employed by firefighters conducting physical searches in void spaces is termed "Round-the-Clock." After complete silence is obtained (all radios turned off, etc.), members try to establish contact with any victims and determine a "fix" as to their location. Once a "fix" has been made, an additional "fix" is attempted from another angle to minimize error. Once communication has been established with a victim, one member is assigned to maintain this vital link. Specialized rescue equipment, such as this portable hydraulic generator with a rotary hammer drill.

Electronic search is usually employed in the form of acoustical listening devices. These instruments are designed to pick up the slightest sound(s) of a buried victim. One style of this piece of equipment has two leads which can be stretched in different directions and, along with a metering device, can pinpoint the location of a

victim buried under the rubble of a collapsed building. This is a slower type of search, but it is not nearly as risky to rescuers.

Canine search involves dogs and their handlers specifically trained in building collapse operations. Canine search teams should be available from the outside resource list. This type of search covers the largest area in the quickest amount of time.

Fiber-optic search is the most sophisticated and the most accurate type of search method. It is used in conjunction with concrete or masonry drills that bore narrow inspection holes. The flexible scope of the camera is then inserted into the holes, and a television-like picture is then transmitted back to the operator. This verification leaves no guesswork as far as the location of the victim and the degree of entrapment.

Thermal image camera system & carbon dioxide analyzer:

It is standard practice to blend all of the four search capabilities into one logical plan. The area in question should be sectored, and general features of the structure should be sketched to use as a reference. Buried victim location should be confirmed by two separate search methods whenever possible.

A systematic search of all collapse voids should occur. Obviously, natural voids (voids already created by the collapse) should be searched prior to trenching and tunneling. Natural voids will be the fastest and easiest to explore, and most surviving victims will be found there. During the void search phase (after natural voids have been identified and searched), trenching and tunneling may be required to reach buried victims. In this operation, void spaces are created by rescuers. This operation is extremely dangerous because of the potential for rescuers to cause a secondary collapse. **A hydraulic-powered chain saw with a diamond-tipped cutting chain, allows rescuers to penetrate concrete effectively during collapse rescue operations.** Once the location of buried victims is confirmed, a transition is made from search to rescue operations. Most collapse rescue operations benefit from a "two-sided" approach. This two-sided approach was successfully used at a recent building collapse operation. One approach was from the top down and one was from the Exposure D (or Exposure 4) side. This resulted in firefighters being extricated through the top and the side; both approaches taken by rescuers led to the same voids involved. If the attempt in the first area takes longer than expected (or no longer becomes viable due to unforeseen obstacles encountered), the second access route is already identified, and work in that area is already underway, saving valuable time.

There is also a process known as 'slabbing', where heavy slabs of concrete are removed in order to free survivors. Concrete saws, jackhammers, chainsaws, bolt cutters, cranes and bulldozers are all part of the tool kit; chains, cables, anchors and rope-hauling systems are used to remove large pieces of masonry. Other equipment may include flat bags that are inserted under heavy objects and inflated with an air pump, and “shoring” equipment, which ensures passageways are stable and safe.
As survivors are removed, their medical condition is determined; patients are prioritized according to triage - based on the severity of their condition

Shoring Operations
While some shoring activity will most likely have occurred as the search is being conducted, shoring operations will increase in complexity as breaching and tunneling is done to reach the victims and extricate them. Collapse rescue shoring is defined as the temporary support of only that part of a damaged or partly collapsed structure that is required for conducting operations at reduced risk.
Weights of common building materials have a definite impact on the type of shoring system constructed. The difference between wood debris (35 pounds per cubic foot) and steel debris (almost 500 pounds per cubic foot) is substantial, and shoring systems have to be constructed in order to support the total load encountered. A quick rule of thumb used to calculate the weight of concrete or masonry rubble is 10 pounds per square foot (per inch of thickness).
Four major types of shoring materials or systems are utilized by the fire service: wood, mechanical, pneumatic and hydraulic. Similar to the six-sided approach to the entire building that is taken in the survey/assessment phase, each individual void space where extrication operations take place must be evaluated from the same

perspective (top, bottom, front, rear, and both sides). Areas that are of questionable stability must be shored and stabilized.

3. SELECTED DEBRIS REMOVAL

Work in this stage includes the removal of debris according to a pre-determined plan based upon how the floor has fallen, where the victims may have been at the time of collapse, the type of collapse, etc. Many times, this debris removal requires the use of rigging expertise in conjunction with heavy construction equipment such as a backhoe or hydraulic crane.

4. GENERAL DEBRIS REMOVAL

This final phase occurs after all other methods have been employed, persons are still missing and/or their location is still unknown. This task must be accomplished in a systematic, rapid manner. All debris is removed (usually by heavy construction equipment) and taken to a secure area near the collapse site where it is carefully sorted through for bodies or body parts.

5. Referral System of the Patients

Victims rescued from the disaster were primarily treated just outside of the collapsed building. There were two health camps engaged in providing 24-hour first aid treatment. Minor cut injuries were managed locally and released after initial treatment given at the center. Each of the health camps was equipped with first aid medicines and instruments. Doctors were responsible for immediately diagnosing the severity of the condition of the injured and referred to the appropriate health care facilities. However, some patients were directly transferred to referral centers without treatment from the health camps because of the degree of severity

Damage prediction of houses
(complete collapse, half collapse, no damage)
Determination of peoples trapped alive
in collapsed buildings
Prediction on human suffering
(death, heavy injury, slight injury, without injury)
damages of houses are classified following three categories; ‘Complete collapse’, ‘Half collapse’ and ‘No damage’.

Probabilities Trapped in collapse house

	No Damage	Half collapse	Complete Collapse
Trapped Ratio in collapse house	10%	17%	35%
Ratio of escape for oneself	90%	83%	65%

Challenges during Emergency Management

As a country, very limited resources to manage a large scale emergency situation. A number of challenges were faced during the rescue operation. Crowd management was crucial; there were thousands of people who came to see what was going on; many of them were relatives of the victims and they were waiting with apprehension to see if their relatives were alive and needed to be rescued or not. Moreover, another mass of people came to help the rescuers and rescued persons by providing food, medicine, and other necessities. Armed forces, Civil Aviation, Rapid Action Battalion, and Police played a tremendous role in managing the crowd. However, there was always a risk of mishap or an accident at any time. The majority of the public did not have any idea or training on how to rescue people from inside the building.

A volunteer said, “It was dark all around and I have seen many people crawling around in the light of their mobile phones. There was lot of dust from the collapsing debris, worsening smell of dead bodies were all around, inside the trap was hot because of full summer season and deficit of air ventilation.”

Rescue operations had proven to be thoroughly difficult. The pillars and ceilings had collapsed at so many angles and in such precarious ways that any wrong move could cause a fresh tragedy. The army had brought in huge cranes to pull the concrete blocks apart. But these could not be used earlier for the fear of further collapse.

There were also limitations for not having necessary equipment to rescue people in such an emergency. Moreover, there was a lack of highly skilled rescuers to manage the critical time; those who are engaged in the rescue period were not properly trained on how to handle such conditions. However, members of the Armed Forces, Border Guard Bangladesh, and Fire Service and locals were carrying out the rescue operations; they pored over huge piles of rubble and twisted metal in the search for survivors at the building.

Engagement of Media

Media played a crucial role after the disaster. National TV channels including and private TV channels, government radio station and FM stations started broadcasting live news from the start of the tragic event. Private TV channels scrolled the breaking news and special news was telecasted at regular intervals. A number of TV channels live telecasted from the spot the whole day. Media helped a lot to inform the relatives of those who worked in that building and many of the relatives started to come from villages just after getting information.

Due to the continuous news updates, many people started to come to the place to help and join the rescue process. Like this, many people also provided support and aid by knowing the facts through live telecasts and radio news updates. Moreover, the printed media detailed the entire situation including regular updates on how many people were rescued, how many were still missing, and how many of them had already died. People also read that news from newspapers and came to help the injured people. A few printed newspapers started a fund for the victims and many people donated money to the newspapers' bank account.

Operational Guidelines

A building collapse rescue operation is one of the most demanding incidents a fire department can encounter. Following are some general guidelines for operations at collapse sites:

- It is safer to reach entrapped victims from above, although consideration may be given to enter a collapsed area from below (for example: where a roof or floor may have fallen, a basement sidewalk entrance door may allow access to a cellar from which the rescuer can enter the building from the outside, then ascend the interior stairs to the specific collapse area).
- Breaching and shoring (similar to tunneling and trenching) may be required to reach some victims.
- The cutting of holes in floors and using a "shaft approach" is much safer than the breaching of walls.
- Do not attempt to return structural components to their original configuration. Stabilize and shore the structure according to the way you find it.
- Wood (timber) shores should be kept as short as possible.
- Air shore, hydraulic or mechanical systems can be used in conjunction with or in place of wood (timber) shores.
- Once shoring is in place, it should never be removed.
- A safety officer should be designated and assigned for the entire duration of the operation. He should have the authority to stop the operation any time he deems necessary.
- Consideration should be given to gain access to the basement of a collapsed structure by breaching the party wall of an adjoining building in the same row.
- Limit the number of firefighters working in the danger zone to the bare minimum required.
- Utilize a search rope in tunneling/trenching operations. If a secondary collapse occurs, the rope identifies the path to the trapped rescue personnel.
- Meter readings for oxygen and combustible gas must be taken during tunneling and void space operations. Confined space operational procedures must be adhered to as required.
- Consideration should be given to utilize supplied air breathing systems (air source, air extension hose, and face masks) in a tunnel or void space where there is a danger of smoke, oxygen depletion, or exhaust fumes (and SCBA duration will be too limited or SCBA will be too bulky in narrow opening of void space).
- A personnel accountability system should be utilized for firefighters operating in the "hot zone."
- Hoseline(s) should be stretched into or in the vicinity of each major void space operation, even if fire is not evident upon entry into the void space. Conditions can rapidly change. Fire could be burning undetected underneath the area where you are working, and this precaution will save valuable time if the conditions change.
- Every collapse incident should be reviewed/analyzed in a post-collapse critique.