STRUCTURAL COLLAPSE GENERAL HAZARDS

INTRODUCTION

Structural collapse operations cover a wide range of incident scenarios. These incidents can be as relatively minor as a deck or porch collapse resulting in easily accessible victims, or as heavily taxing as a multistory concrete building collapse that entombs hundreds of victims. Regardless of the collapse scenario encountered, first responders must be familiar with a variety of safety hazards and associated issues. Effective rescue operations at a structural collapse will only be possible if rescuers are fully aware of the hazards involved and the methods necessary to mitigate those hazards.

In order for rescuers to perform at an optimum level of safety, they must be familiar with:

- Categories of hazards; building construction types and characteristics
- Types of collapse voids and likely areas of survivability
- Safety equipment
- Safety procedures
- Safety considerations

Understanding and properly applying these factors is essential if rescuers are to perform rescue operations safely in a structural collapse.

Structural instability

The aftermath of a building collapse will cause a variety of structural instability hazards for rescuers. These may include weakened walls, floors, columns, or beams that are incapable of supporting the remains of the structure. Secondary collapse of structural elements will be a major concern to rescuers working in areas supported by these weakened building parts.

Freestanding walls and damaged or loose chimneys can easily fall because of a lack of support, wind load, or earthquake aftershocks. In earthquake-prone areas, collapses resulting from quakes will be highly vulnerable to further collapse because of aftershocks.

Normal settlement and shifting debris, vibrations, and aftershocks can cause secondary collapse and previously accessible voids to become inaccessible, or eliminate the void spaces altogether. Secondary collapse may cause currently undamaged attached or exposed structures in close proximity to fail.

Very often, structural stability is difficult to evaluate and requires the services of a structural engineer. Responders are encouraged to contact structural engineers in their response areas to determine their availability if needed.

Overhead Hazards

Rescuers performing operations at a collapse site must evaluate the scene for overhead hazards that have the potential to fall and strike rescuers. Overhead hazards may include loose debris and building components suspended overhead, sections of concrete hanging from attached reinforcing bars, or dislodged bricks precariously perched on a broken wall assembly. Unsecured building contents such as file cabinets, bathtubs, refrigerators, and other furnishings can also create overhead hazards should they fall out of the structure.

Damaged electrical wires hanging low or heavily tensioned and ready to fail may pose an electrocution danger, choking, and entanglement hazard.

Scaffolding and stacked building supplies, such as piles of drywall perched on an upper floor of a building under construction, are overhead hazards common to construction site collapses. Rescuers must take the necessary time to evaluate their surroundings and to identify these potential hazards before committing resources to a dangerous area.

Rescue operations that are being performed also can create overhead hazards from crews working above each other and the sudden failure of rigging chains or slings that are damaged or overloaded during a crane lifting operation. This may cause massive building components to be dropped on rescuers working in close proximity to where the lift is being performed. It is for this reason that all rescuers must be informed when heavy equipment will be used for performing rescue operations. All rescuers also must clear the area when a load is being lifted overhead.

Surface Hazards

The environment within which rescuers must operate at a building collapse will be fall of sharp debris that can cause injury. This debris will differ depending on the building's construction and contents. Generally, rescuers will be faced with broken glass, nails, wood splinters, jagged metal, and rough masonry. Difficult footing will be common due to spilled fluids and pools of water and sewage. Ground fissures, depressions and uneven or unsecured walking surfaces around the collapse site will add to difficult footing which can potentially result in injuries to responding personnel.

Water and other liquids on the ground will obscure the view of the walking surface and reduce friction, potential electrocution if contacting an energized power source and drowning if the water is deep enough to cover the rescuer's face. Liquids will also cause hypothermia problems for rescuers and victims, add additional weight to structural elements and debris and softens the ground supporting structural elements and debris.

Rescuers must be aware of the potential for downed or exposed live electrical wires. All wires and conduits must be considered live until confirmed otherwise.

Heavy equipment vibrations can cause debris to shift and secondary collapse. Engine noise can drown out communication and other sounds which could warn rescuers of changing conditions, operators with an obstructed view while backing or turning could run into damaged structures and over rescuers, and a secondary collapse can be caused by lifting, pulling or removing structural components with powerful heavy equipment unable to feel the structure shifting.

Additional potential surface hazards include open manholes resulting from flooding, or ground-level openings created by the force of the collapse. Fallen trees and utility poles blocking roadways may cause access problems for responding apparatus and personnel.

Below-Grade Hazards

These hazards will occur in areas such as basements, underground parking garages, or low lying void spaces. The potential exists in these areas for the accumulation of atmospheric hazards due to ruptured natural gas lines or spilled chemicals. Contaminated atmospheres can be flammable, toxic, or oxygen deficient. Flooding from broken water or sewer lines also may cause difficulties for rescuers by obscuring the view of the walking surface and reducing friction, electrocution if contacting an energized power source, drowning if the water is deep enough to cover the rescuer's face and contamination from raw sewage and other chemicals mixing with liquids.

Utility Hazards

The most common utility types include natural gas, propane, electrical, stewn, water, and sewage. When these utilities are disrupted because of a collapse, they will cause serious safety hazards for rescuers. These will include electrocution and fire hazards from broken electrical wiring, and explosion hazards from broken natural gas and/or heating fuel lines. Disrupted steam lines can cause burns to rescuers exposed to them. Sewage from broken sewer lines can release toxic gases such as hydrogen sulfide or methane, and can expose rescuers to bacteria.

Hazardous Materials

The California Health and Safety Code defines hazardous materials as "any material that because of its quantity, concentration, or physical or chemical characteristics, poses a significant present or potential hazard to human health or safety, or to the environment if released." Common examples are flammables such as gasoline, corrosives such as hydrochloric acid and toxics such as pesticides.

The type of building affected and its normal contents will help to identify potential hazardous materials that may be released during a collapse. Rescuers must be cognizant of this potential at residential dwellings as well commercial establishments.

Residential hazardous materials can be found in kitchens, laundry rooms, garages, and sheds and may include ammonia, bleach, oven and drain cleaners, spot removers, gasoline, paint thinners, pool chemicals, pesticides, herbicides, and other garden supply chemicals.

Commercial establishments that are common to most cities and towns and their associated hazardous materials include:

- Supermarkets, hardware and sporting good stores: paint and paint thinners, caustic paint removers and oven cleaners, pesticides, herbicides, and aerosol cans, liquid and powder chlorine, muriatic acid flammable gases, gunpowder and ammunition.
- Schools: gases, flammable liquids, cleaning supplies, poisons, and biological hazards in chemistry and biology classrooms.
- Hospitals and laboratories: flammable and toxic gases, flammable liquids, poisons, cryogenic liquids, radioactive, and biological hazards.

Other Hazards

Rescuers may face additional incident hazards that do not fall into any previously listed categories. Some of these hazards are related to the cause of the collapse, and others are actually created by rescuer actions. Fire, smoke, or explosions force responders to wear a higher level of personal protective gear than normal collapse operations. The collapse may have resulted from the fire or explosions, or the fire and smoke may be the result of the collapse. Secondary explosions may be caused by a secondary explosive device intended to harm the rescuers.

It is important for rescue workers to realize that a collapsed structure will be much more susceptible to fire after the collapse and much harder to extinguish. This is due to the disruption of any built-in suppression systems, disrupted utilities, and the larger surface-to-mass ratio of the splintered flammable building materials and deep difficult to access debris piles.

Vibrations from various sources are a safety concern to rescuers, because these can cause a secondary collapse of unstable building parts. Vibration sources can include:

- Rail traffic, such as trains and subways
- Vehicular traffic on nearby roadways
- Air traffic or helicopters over the collapse site Heavy construction equipment
- Responding fire and rescue apparatus

Particulate matter such as smoke, concrete dust and asbestos must be recognized and appropriate personal protective equipment (PPE) must be worn to prevent this material from entering a rescuer's respiratory system. Exposure to particulate matter can cause immediate and long-term problems if not appropriately mitigated.

Rescuers will be faced with several hazards created by their own actions such as operating internal combustion engines and power tools within confined areas and contaminating the atmosphere. Rescuers may have difficulty operating heavy tools in small and cramped spaces in awkward positions causing potential muscle strain.

Loud noises will be created by rescuers using power tools inside confmed areas and while operating around heavy construction machinery. This can cause damage to rescuer hearing, ineffective communications, and the inability to hear structural element movement and a victim's calls for help.

Uncoordinated rescue operations and unorganized rescue teams can add weight and cause unnecessary movement above other rescuers.