CHAPTER II

LITERATURE REVIEW

2.1. Blast Phenomena

Bare, solid explosives must detonate to produce any explosive effect other than a fire. The term detonation refers to a very rapid and stable chemical reaction which proceeds through the explosive material at a speed, called the detonation velocity, which is supersonic in the unreacted explosive. Detonation velocities range from 22,000 to 28,000 feet per second for most high explosives. The detonation wave rapidly converts the solid or liquid explosive into a very hot, dense, high-pressure gas, and the volume of this gas which had been the explosive material is then the source of strong blast waves in air. Pressures immediately behind the detonation front range from 2,700,000 to 4,900,000 psi. Only about one-third of the total chemical energy available in highest explosives is released in the detonation process. The remaining two-thirds are released more slowly in explosions in air as the detonation products mix with air and burn. This after burning process has only a slight effect on blast wave properties because it is so much slower than detonation (UFC 3-340-02, 2008).

2.2. Blast Effect

An explosion is an extremely rapid release of energy in the form of light, heat, sound, and a shock wave. A shock wave consists of highly compressed air traveling radially outward from the source at supersonic velocities. As the shock wave expands, pressures decrease rapidly (with the cube of the distance) and, when it meets a surface that is in line-of-sight of the explosion, it is reflected and amplified by a factor of up to thirteen. Pressures also decay rapidly over time (i.e., exponentially) and have a very brief span of existence, measured typically in thousandths of a second, or milliseconds (FEMA 428, 2003).

Diffraction effects, caused by corners of a building, may act to confine the air-blast, prolonging its duration. Late in the explosive event, the shock wave becomes negative, creating suction. Behind the shock wave, where a vacuum has been created, air rushes in, creating a powerful wind or drag pressure on all surfaces of the building. This wind picks up and carries flying debris in the vicinity of the detonation. In an external explosion, a portion of the energy is also imparted to the ground, creating a crater and generating a ground shock wave analogous to a high-intensity, short-duration earthquake (FEMA 428, 2003).

2.3. Building Damage

The extent and severity of damage and injuries in an explosive event cannot be predicted with perfect certainty. Past events show that the unique specifics of the failure sequence for a building significantly affect the level of damage. Despite these uncertainties, it is possible to give some general indications of the overall level of damage and injuries to be expected in an explosive event, based on the size of the explosion, distance from the event, and assumptions about the construction of the building.

The air-blast shock wave is the primary damage mechanism in an explosion. The pressures it exerts on building surfaces may be several orders of magnitude greater than the loads for which the building is designed. The shock wave also acts in directions that the building may not have been designed for, such as upward on the floor system. In terms of sequence of response, the air-blast first impinges on the weakest point in the vicinity of the device closest to the explosion, typically the exterior envelope of the building. The explosion pushes on the exterior walls at the lower stories and may cause wall failure and window breakage. As the shock wave continues to expand, it enters the structure, pushing both upward and downward on the floors (see Figure 2-1), (FEMA 428, 2003).

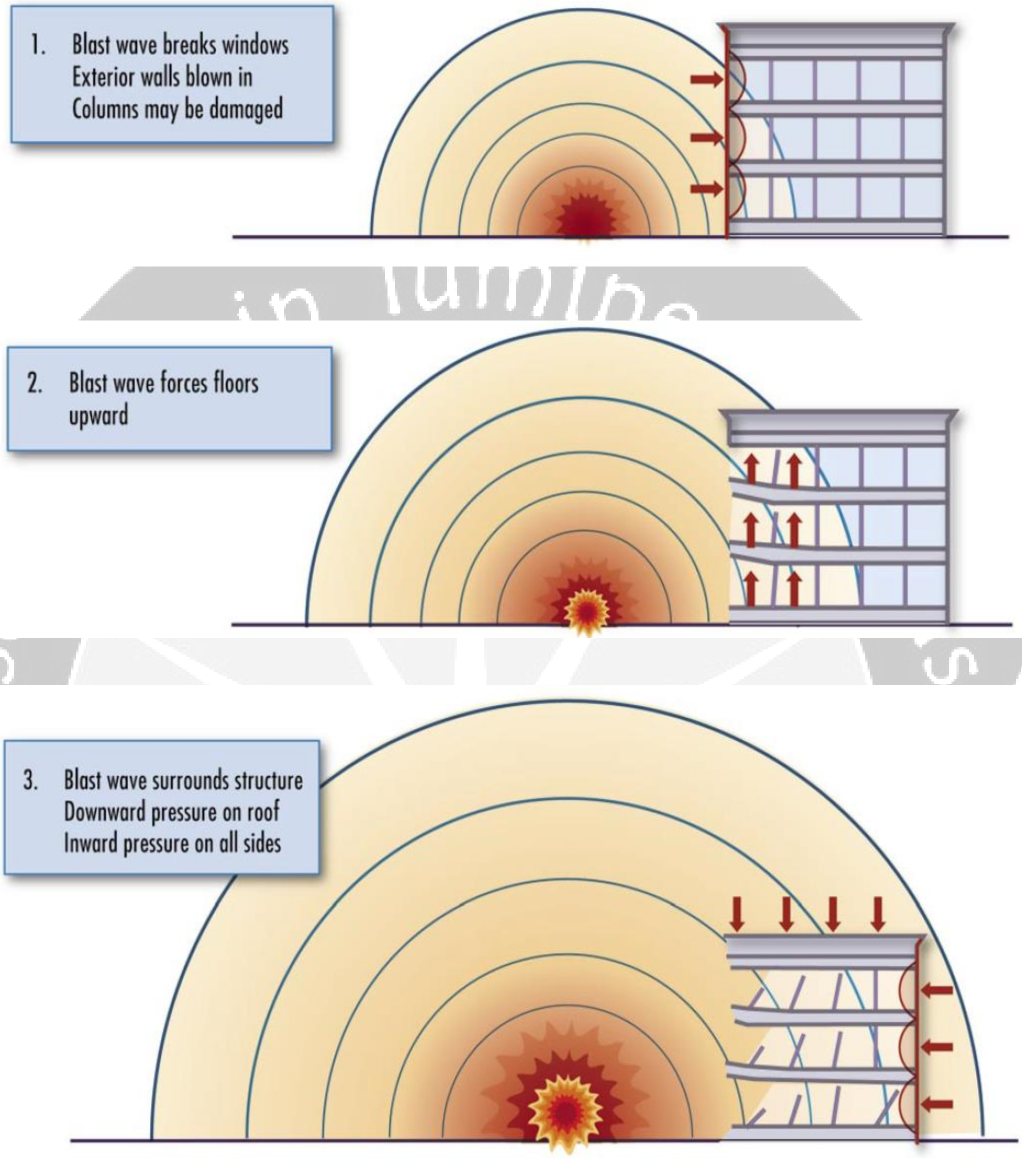

Figure 2-1 Blast pressure effects on a structure (FEMA 428, 2003)