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DEMOLITION OF BUILDINGS BY IMPLOSION

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ABSTRACT

The life cycle of concrete structures is usually 40 to 90 years. During this life, structures often meet with some situations like disasters, changing functions, city reconstruction, or higher residence demand due to population, all these lead to demolition or reconstruction of existing structures. In developed countries demolition is very essential for development of new structures for various residential and industrial purposes. Any kind of demolition work needs labor forces for executing the work. Today various kinds of demolition methods are available, but the method of implementation for demolition work varies with the site condition, safety and cost. The demolition method also varies with the time available for demolition and need of site clearance for the new structure. Before execution of demolition work, the careful study of site condition, the type of structure, structural member, demolition range, rural or urban area and frequency. The application of method for demolition depends upon actual site condition and available space.The demolition technology that is practiced to demolish the concrete structures in a controlled way especially in Indian conditions. The important methods practiced in this field are mentioned. Demolition is the deliberate destruction of structures and materials by means of explosives, mechanical devices, fire, chemical agent.

***Keywords:* Implosion , Detonation, Dynamite , RDX**

I. INTRODUCTION

Every structure is designed for a life period. After that service life period its existence become very dangerous to its occupants and surrounding buildings. The building act usually contains provisions to control demolition works for the protection of public safety and to ensure adjoining premises and the site are made good on completion of the demolition. When demolition of a building takes place, the owner must inform the council and permission for the same shall be obtained. Greenhouses, conservatories, prefabricated garages and sheds do not require permission to be demolished. Permission for demolition is not required if building to be demolished has a volume of less than 1750 cubic feet (49.56 cubic meters) [4]. Demolition of any structure is a ground to earth technique which means destroying down or falling down of a building with the help of equipments, machineries, explosives or with manual techniques without affecting the surrounding. When explosives are used for this then the demolition process are called as an implosion.

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II GENERAL STEPS IN DEMOLITION

1.Pre-Planning of Demolition Activity

Pre-Planning of the Demolition activity starts with Surveying of the site. Study of different parameters of the structure and its surroundings with structural point of view is carried out in surveying. Two types of surveying are mainly conducted. They are Building Surveying and structural surveying which includes the (a) Record Drawings and (b) structural details of the building to be demolished.

2. Stability Report: According to Building (Administration) Regulation, the Demolition Plan must accompanied by

a) Stability Report

(i) A report on the stability of the building to be demolished during all stages of the process.

(ii) In the case when powered mechanical plants or equipment are used, a report on the stability with supporting calculations to demonstrate the use of the plants and equipment will not render inadequate the margin of safety of, or cause damage to any building, structure, street, land and services

(ii) In the case when powered mechanical plants or equipment are used, structural calculations for all temporary supports and bracings should be done.

(iv) A report on the stability of neighbouring buildings and adjoining properties.

(v) In the case when temporary or permanent supports are required to neighbouring buildings, adjoining properties and party walls, structural calculations for these temporary and permanent supports.

(vi) A report with calculations demonstrating that the demolition work will not render inadequate the margin of safety, or cause damage to any building, structure, street, land and services.

3. Safety Measures

(a) Training and Communication: Demolition workers, including plant or equipment operators, shall go through proper job safety training and be aware of the potential hazards by attending training sessions as well as on-the-job training.

(b) Equipment Maintenance: All equipment shall be examined before use. They shall be properly tested, stored and maintained. The equipment shall be inspected daily and results of the inspection shall be recorded. A detailed safety instruction shall be provided to cater for specific situations of the project, if necessary.

(c)Electrical Safety: A properly connected power source from a local electric utility supplier or a mobile electricity generator shall be utilized in demolition sites. The safety requirements given in the Factories and Industrial Undertakings (Electricity) Regulations shall be adhered to.

(d) Fire: All flammable goods shall be removed from site unless they are necessary for the works involved. Any remaining flammable goods shall be stored in proper storage facilities. All furniture, timber, doors, etc. shall be removed before any welding work is performed. Fire fighting appliances shall be provided and maintained in working conditions. The Construction Site (Safety) Regulations require the contractor to maintain in good condition and free from defects all fire fighting appliances provided in such construction site.

(e)Occupational Health: The health of workers on site shall be properly protected in accordance with the relevant subsidiary regulations of the Factories and Industrial Undertakings Ordinance and the Occupational Safety and Health Ordinance with particular attention to areas such as:Exposure to Dust, Chemical Exposure, Heat Stress and Ventilation, Noise Exposure, Medical and First Aid Facilities, Sanitation and Occupational Diseases.

(f) Emergency Exit Requirements in Demolition Sites: Emergency exits shall be provided during building demolition. In case of any emergency evacuations, the emergency exit will serve as a lifeline for transportation of injured workers. A minimum of one exit route shall be maintained and designated as the emergency exit at all times during the demolition.

Adequate lighting and fire extinguishing equipment shall be provided. Emergency exit shall be properly protected, free of obstruction, and properly marked with exit signs or other indications to clearly show the route. All workers shall be informed about the exit route.

(g) Vibration: Demolition work will cause vibration to neighboring buildings or structures to various extents, depending on the method of demolition. The most serious vibration is caused by implosion. The effect of vibration caused by implosion is categorized as follows:-

1. Permanent ground distortion produced by blast-induced gas pressures;

2. Vibratory settlement of foundation materials; with supporting calculations. The Stability Report shall include the following parts

3. Projectile impact (blast fly rock)

4. Vibratory cracking from ground vibration or air blast.

(h) Environmental Precautions

(a) Air Pollution: Concrete breaking, handling of debris and hauling process are main sources of dust from building demolition. Dust mitigation measures complying with the Air Pollution Control (Construction Dust). Regulations shall be adopted to minimize dust emissions. Burning of waste shall not be allowed. Diesel fumes generated by mechanical plant or equipment shall be subject to the control of the Air Pollution Control (Smoke) Regulations.

(b) Noise: Noise pollution arising from the demolition works including, but not limited to, the use of specified powered mechanical equipment (SPME), powered mechanical equipment (PME), such as pneumatic breakers, excavators and generators, etc., scaffolding, erection of temporary works, loading and transportation of debris, etc. affects the workers, and the sensitive receivers in the vicinity of the demolition site. Silent type PME shall be used to reduce noise impact as much as practicable. Demolition activity shall not be performed within the restricted hours as

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established by Environmental Protection Division (EPD). Currently under the Noise Control Ordinance, noise from the use of SPME and PME within restricted hours is governed by a Construction Noise Permit (CNP) system.

(c) Water: The discharge of wastewater from demolition sites requires a valid discharge license from the EPD and the application of such a license shall be made under the Water Pollution Control Ordinance (WPCO). Effluent shall be treated to the standards as stipulated in the license before discharge.

(d) Hazardous Materials: If removal of asbestos containing material is needed, an Asbestos Investigation Report (AIR) shall be submitted to EPD. An Asbestos Abatement Plan (AAP) shall be submitted at least 28 days before the asbestos abatement work commences. The asbestos abatement works shall be carried out in accordance with the Air Pollution

Control Ordinance (APCO) and the Factories and Industrial Undertakings (Asbestos) Regulations before demolition. Other materials such as LPG cylinders in domestic flats, toxic and corrosive chemicals for industrial undertakings, and any other hazardous materials have to be identified and properly handled and removed prior to the commencement of the demolition of the building. The management of waste must fully comply with the Waste Disposal Ordinance. Additionally, management of waste which is classifiable as a chemical waste must also comply with the Waste Disposal.

II DEMOLITION USING IMPLOSION

Implosion is the term that was coined in the late 1950s to describe the process of using the minimum amount of explosives with minimal structural preparation expense to get a structure to collapse in a controlled fashion. The term is technically incorrect, since implosion implies a collapse from external pressure. A true implosion usually involves a difference between internal (lower) and external (higher) pressure, or inward and outward forces, that are so large that the structure collapses inward into itself. Building implosion techniques do not rely on the difference between internal and external pressure to collapse a structure. Instead, the technique weakens or removes critical supports so that the building can no longer withstand the force of gravity and falls under its own weight. Implosion method is adopted for high raised buildings in urban areas, where the other demolition methods are not acceptable.

In order to demolish a building safely, blasters must map out each element of the implosion ahead of time. The first step is to examine architectural blueprints of the building, if they can be located, to determine how the building is put together. Next, the blasting crew visits the building noting down notes about the support structure on each floor. Once they have gathered all the raw data they need, the blasters figure out a plan of attack. Drawing from past experiences with similar buildings, they decide what explosives to use, where to position them in the building and how to time their detonations. In some cases, the blasters may develop 3-D computer models of the structure so they can test out their plan ahead of time in a virtual world. Implosion is considered when the building to be demolished is surrounded by structures that must be preserved. Demolishing the building in such a way that it collapses straight down into its own footprint (the total area at the base of the building).

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Blasters will explode the major support columns on the lower floors first and then a few upper stories. For example, In a 20-story building, the blasters might blow the columns on the first and second floor, as well as the 12th and 15th floors [2]. In most cases blowing the support structures on the lower floors is sufficient for collapsing the building, but loading columns on upper floors helps break the building material into smaller pieces as it falls. This makes for a perfect demolition and easier cleanup following the blast.

Explosives Used For Implosion: Once the blasters have figured out how to set up an implosion, it's time to prepare the building and selection of the explosives used for the demolition. The most common explosives used in demolition are dynamites (straight, ammonia and gelatin), water gels, emulsions, PETN (penta-erythritol tetra-nitrate) and RDX (Cyclotrimethylene-trinitramine).

(a) Dynamite: Dynamite is a combination of nitroglycerin with inert filler, making the end product stable for handling which was invented by Alfred Nobel in 1866. Dynamite is just absorbent stuffing soaked in a highly combustible chemical or mixture of chemicals. When the chemical is ignited, it burns quickly, producing a large volume of hot gas in a short amount of time. This gas expands rapidly, applying immense outward pressure (up to 600 tons per square inch) on whatever is around it. Blasters cram this explosive material into narrow bore holes drilled in the concrete columns. When the explosives are ignited, the sudden outward pressure sends a powerful shock wave busting through the column at supersonic speed, shattering the concrete into tiny chunks. For concrete columns, blasters use traditional dynamite. This has the advantages of being good to excellent for water resistance as well as being predictable and reliable. Dynamite comes in a wide range of small and medium-diameter cartridges of different lengths. A most common seen dynamite available in the market is shown in Figure 3.1.

Fig.3.1 Dynamite

(b) Cyclotrimethylenetrinitramine (RDX): RDX-based explosive compounds expand at a very high rate of speed, up to 27,000 feet per second (8,230 meters per second). Available in powder form as shown in Figure 3.2. It is a high-velocity explosive. Instead of disintegrating the entire column, the concentrated, high-velocity pressure slices right through the steel, splitting it in half. Additionally, blasters may ignite dynamite on one side of the column to push it over in a particular direction. Demolishing steel columns is a bit more difficult, as the dense material is much

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stronger. To bring down the buildings with a steel support structure, blasters typically use this specialized explosive material

Fig.3.2 RDX

(c). Water Gel and Emulsions: This consists of water-containing chemical mixtures that are either water gels or emulsions. Water gels contain oxidizing salts and fuels that are dissolved in water. Emulsions are fine droplets of oxidizing salts and water surrounded by a fuel mixture of wax and oil. These explosives are even more stable. These products are available in several forms and sizes. The standard size used to demolish concrete and brick structures is 31mm diameter by 200mm long cartridge configuration or in bulks [3]. A. Quantity Of Explosives Blasters determine how much explosive material to use based largely on their own experience and the information provided by the architects and engineers who originally built the building. But most of the time, they won't depend on this data alone. To make sure they don't overload or under-load the support structure, the blasters perform a test blast on a few of the columns, which they wrap in a shield for safety. The blasters try out varying degrees of explosive material, and based on the effectiveness of each explosion, they determine the minimum explosive charge needed to demolish the columns. The cross-sectional dimensions of the column, its concrete compressive strength, its condition, and details of its reinforcement are all variables which affect the column charge quantity and type of explosive required. By using only the necessary amount of explosive material, the blasters minimize flying debris, reducing the likelihood of damaging nearby structures. B. Placement of Explosives Almost all the explosives used in implosions are placed in or on columns and load bearing walls.

Columns at the lowest floor levels are the most important as that is where the stored potential energy in the structure is most effectively released. Usually, explosives will be placed on the lowest floor level and then are spaced out in blast floors along the height of the building, closer together at lower floors and more spread out at upper floors. The type of explosives placed on steel columns is very different than the ones used on reinforced concrete columns. Steel is very ductile and tough. Further, when the steel sections (flanges and webs) are thin, making internal confinement of explosives impossible, as compared to concrete columns, it can have explosives loaded into drilled holes. For

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steel columns shaped charges are used. Commercial shaped charges are typically Chevron shaped copper clad linear elements filled with RDX explosive. For reinforced concrete columns, holes are first drilled in the column, the cartridge explosive is placed in the hole and stemming (typically tubular bags of sand or high density foam) are placed in the balance of the hole to confine the charge. When the explosive detonates, the concrete in the column is fragmented, leaving the reinforcing bars bent, but intact. When tightly pitched spirals or stirrups are encountered, they must often be exposed and cut first, depending on structural analysis allowances, site conditions and possible live loading. If they are uncut, unfractured concrete might remain and the column may retain some of its load carrying capacity. Hence, tight spirals and other robust reinforcing in concrete columns help resist progressive collapse. This is one of the reasons that reinforced concrete structures designed toresist intense earthquakes have some innate resistance to explosives, because their columns contain tight spirals.

To further reduce flying debris, each column may be wrapped with chain-link fencing and geotextile fabric. The fence keeps the large chunks of concrete from flying out, and the fabric catches most of the smaller bits. Blasters also wrap fabric around the outside of each floor that is rigged with explosives. This acts as an extra net to contain any exploding concrete that tears through the material around each individual column. Structures surrounding the building may also be covered to protect them from flying debris and the pressure of the explosions. The loading of the column and wrapping with a proper cover is shown in figure 3.3

D. Electrical Detonator: To ignite both RDX and dynamite, you must apply a severe shock. In building demolition, blasters accomplish this with a blasting cap, a small amount of explosive material (primer charge) connected to some sort of fuse. The traditional fuse is a long cord with explosive material inside. When we ignite one end of the cord, the explosive material inside it burns at a steady pace, and the flame travels down the cord to the detonator on the other end. When it reaches this point, it sets off the primary charge. Now-a-days blasters use an electrical detonator instead of a traditional fuse. An electrical detonator fuse (lead line) is just a long length of electrical wire. At the detonator end, the wire is surrounded by a layer of explosive material. This detonator is attached directly to the primer charge affixed to the main explosives. When current is passed through the wire (by hooking it up to a battery), electrical resistance causes the wire to heat up. This heat ignites the flammable substance on the detonator end, which in turn sets off the primer charge, which triggers the main explosives.

I. SEQUENCE OF DETONATIONS

The concept of implosion is to create an almost fluid motion in the collapse of the building. This methodology reduces the ground impact and resultant vibration. Carefully designed building implosions create ground vibrations less than 25 mm/s peak particle velocity [1]. Columns at the bottom of the building are detonated first to make maximum amount of potential energy available immediately to get the progressive collapse. Columns at other floors are detonated anywhere from a few milliseconds to several seconds later to help fragment the building debris or control its fall direction and velocity.

Timing of detonations between columns is part art, part science and all experience. There is chance of building to get pancake if the detonations are too close together and portions of the building may expand outward in random directions.

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Too far apart and the fluid motion is disrupted. More explosives would be needed to overcome the inertia of the building between each spill. More importantly, an interruption of the fluid motion can cause elements to disengage, causing complete loss of control over the trajectory of the structure. When a column is detonated, the structure above begins to accelerate towards the ground at less than 10 m/ s2 freefall [1]. The actual acceleration is less than the acceleration of gravity because still standing portions of the structure act to arrest its fall, resisting moment or consuming kinetic energy as elements are crushed. The forward momentum can be slowed or stopped by because of naturally occurring alternate load paths in the structure. During a building implosion, the detonations are timed so that just before the alternate load path is created, the adjacent column line is detonated to allow continuity of the progressive failure. Therefore, assuming freefall, if there was a one second delay between adjacent column lines, the column line just detonated would have dropped almost 5.2 m [1] thereby impacting the ground before the next column line is detonated. This eventuality is to be avoided as a premature ground impact by a portion of the structure may redirect the still standing portions into unexpected directions.

Fig.3.3.Columns fully loaded with explosives and hooked up to blasting caps and fuses.

IV. CONCLUSION

Demolition method applied in a structure depends upon various factors such as site condition, type of structures, age of building, height of building and economy and most important its location with presence of its surrounding with its structural stability. Controlled demolition of building is necessary to ensure safety of both the workers and the surroundings so as to cause least amount of injuries and accidents. Building implosion is the strategic placing of explosive materials and timing of its detonation so that a structure collapses on itself in a matter of seconds, minimizing the physical damage to its immediate surroundings. Despite its terminology, building implosion also includes the controlled demolition of other structures, such as bridges, smokestacks, towers, and tunnels. The Advantages of implosion technology method over conventional methods are: It is less expensive; it is a quickest method, Suitable for multi- storeyed structures / high piers, distressed piers etc. The disadvantages of this method over conventional methods are: Large pieces of debris might project towards spectators away, A small carelessness will lead to huge damage, Need of Experienced hands. The advantages of this method make this method more acceptable over the other demolition methods.

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