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MANAGEMENT OF INVESTIGATING THE EFFECT OF BLASTING AND IMPACT LOAD IN VARIOUS STRUCTURES

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Abstract. Increasing the number of explosive threats on the structures is a warning in the direction of safety. The design of structures against the blast loads in the past has been limited to military buildings and so on. Now, with the spread of science and threats against bridges, buildings and industrial structures will require a detailed examination of the performance of these structures against the blast load. In this study, the performance of structures against explosions, the damage to the structure and the important factors in the failure of the structure were investigated and the results show that the location of the structure of the explosive factor ratio has a significant effect on stability.

Keywords: *Blast Loads, Concrete Buildings, Underground Structures, Structural Analysis.*

Introduction

Determining the effect and amount of damage caused by various phenomena on the structure is one of the most important human goals to prevent damage and in case of necessity, it should be prevented by considering appropriate solutions. One of the patterns of damage to the structure is the impact of blast loads on it.

The study of bomb blasts in general can be classified into the following fields. Parametric research, investigating the dynamic characteristics of the soil, investigating the effects of the input driver's amplitude on response, investigating the types of defensive structures, the investigation of surface explosions, the explosion inside the soil, and the explosion inside the underground table, all of the types of research in the field of explosion.

Surface structures are more vulnerable to dynamic structures compared with underground structures. So, the structures and underground corridors have a significant role in protecting the defense installations of countries. Since many strategic structures are built underground, the behavior of these structures is to be investigated in the face of such shocks.

As a result of the war, there is a heavy human and physical damage to the bombing of cities, which reduces vulnerabilities by employing non-operating defensive methods before the war. Failure to take non-operating defenses will cause heavy costs and irreparable damage, Hence, many researchers have tried to reduce the damage caused by the explosion by providing solutions for construction. In order to achieve this goal, the structures can be designed and executed according to the dynamic forces due to the explosion with the required strength and stiffness, Also, it is possible to prevent the part of the explosion energy from reaching the structure by appropriate methods and elements. The study of the effect of aerial bomb on underground structures is an applied research in the field of non-operating defense, which results from dynamic analysis has an important and effective effect in this area [1].

The importance of building corridors in ancient times to this day is such that experts have considered the construction of corridors in those civilizations as an indication of the growth of culture and the technical and economic progress of that community. The early civilizations discovered the corridors for access to minerals and natural materials such as flint and its significance for life. It was also used to transport water from the corridors. Military usage has been used in the early civilizations, in particular to raise the escape power or ways to attack the sites and forts of the enemy. Underground structures and facilities form the basis of a new urban settlement and include a large number of applications such as underground railways and intercity railways, highways, fuel storage facilities, depots, stockpiles of weapons [2].

Some installations have been built in places where there is a strong seismic event, [3] Therefore, these structures must be resistant to static and dynamic load. Experimentally, underground structures face significant risks of explosion threats [4].

The first studies on the seismic behavior of underground structures were carried out to analyze the dynamics of the ammunition depot in the 19th century. The response of the soil to seismic energy is scattered in the form of waves. These waves make a strain in dealing with the underground structures in them. These waves are four types, which cutting wave has the highest impact on the structure. These waves change the sinusoidal position along the perpendicular to the axis of distribution of the waves in the ground. To model the behavior of structures and concrete bridges, including the deck and column against the explosion load, a damaged model was applied to the materials and showed that the structural response to the explosive loads has reliable results [5-7].

Traditional methods of strengthening structures against explosions are usually carried out in state and military structures. But recently engineers have become more and more interested in the massive design of the structures against improvised explosive loads to counter anti - terrorism targets. Meanwhile, bridges are a major component of transport infrastructure because of special circumstances and damage to them has a significant impact on the economy. The strengthening of the bridge in front of the blast requires special arrangements. Therefore, it is very important to obtain bridges responses to blast loads.

The necessity of research

Over the past decades, there has been considerable emphasis on explosion and earthquake issues. The problems associated with the quake are more aging, but the majority of the data collected in this area have been over the past 50 years. The blast issues are roughly new and due to different events or intentional events, the behavior of structural members under the blast load has been the subject of many research projects in recent years. Common structures, especially those built on the ground, are not usually designed to withstand explosion forces. Since the magnitude of the design force is considerably less than the strength of the blast, the usual structures are exposed to damage caused by the blast. Considering this, researchers are increasingly looking for a solution to protect residents and construction structures. Therefore, one of the basic steps to maintain national capital and reduce risk is to study and understand the behavior of buildings under the influence of impact and explosion loads.

A review of past research

The analysis of the effect of loading the bombardment on the structure began in the 1960s. In 1959, the US Army published a publication entitled "Resistant structures against the effects of accidental explosions." The edited version of the publication, which was used in 1990, was widely used by military and non - military organizations to design structures in order to prevent the spread of explosions and protect the equipment and military personnel. Existing methods for estimating the effects of blast on construction structures are divided into different categories that are discussed below [1].

In order to determine the dynamic response of different hardening plates and to consider the effects of Mesh density sensitivity, duration of the explosion and strain rate, the hardened plates were studied under the influence of blast loads. They used the finite element method and central difference method to analyze the structures investigated [8].

In 2006, research by Pandey et al about the effect of an external explosion on a concrete crust of a structure was studied. The analysis was carried out using non - linear models to the final stages, the analysis method presented to analyze the shell structures with regard to the above models led to the production of a finite element software called DYNAIB [9].

Remennikov considered methods for estimating the effect of a bomb on the building. Simplified analytical techniques were used to determine the conservative estimates of the effects of explosion on buildings [10].

Shope studied the response of wingspan steel columns under the influence of constant axial loads and the lateral bursts of explosions. The ABAQUS Limited Components Program was used to model columns with varying weight ratios and different boundary conditions. Changes in the history of displacement and plastic hinge formation due to axial load differences were tested.[11]

Borvik et al studied the response of a steel tank as a closed structure under the influence of explosive loads. They used decreasing methods based on the Lagrange formula to reduce the number of meshes [12].

Yalciner In his research analyzed the design and analysis of structures under the influence of blast loads to understand the burst loading and the dynamic response of various structural components [13].

Explosion

The explosion is a phenomenon that has a great deal of function today and is widely used in civil projects. In addition to the benefits that this phenomenon has, it also has deficiencies and failure, which sometimes challenges its selection as an applied methodology. The shortcomings of this method can be called noise pollution and pollution in the environment surrounding the explosion. Nowadays, the explosion is known as a threat to humanity, researchers seek to achieve and develop methods to face this phenomenon. In recent years, the design of structures based on the principles of non-operating defense is such as to make the structure safer for rocket attacks, and this design has been highly regarded by engineers. Hence, the behavior of structures constructed inside the earth is under investigation.

Explosion wave

The explosion is equivalent to a very rapid release of energy in light, heat, sound and Shock wave. When an explosion occurs, energy is suddenly released in a very short time and the effect of this energy release is seen in the form of thermal radiation and propagation of waves in space. One of the important factors in the destruction of structures is the result of the blast. The waves move faster than the speed of sound, forming a wave front. When a body is equal to this wave, the pressure at its surface has increased, and at a very short moment this pressure reaches the peak of its size. This increase in the pressure caused by the explosion wave can bring loads that are much larger than the loads for which the structure was designed and cause a great structural damage [14].

Aligning with other loads entering the building, such as wind, earthquake, flood. The load caused by the explosion has the features to be seen in the design. The magnitude of the load due to the explosion wave and how the pressure on the structure is distributed depends on factors such as: geometry and shape of the structure, explosives location relative to the structure, explosive attributes (material, weight, released energy size, wave resonance rate due to collision with the earth) [15].

Types of modeling

There are various methods for determining these effects, such as physical modeling in large scale dimensions, physical modeling in small scale dimensions, and numerical modeling. Each stated method has its own advantages and disadvantages. In order to determine the effect of the explosive phenomenon, large-scale physical modeling, despite high-precision results, costs a lot and requires a proper background. Therefore, numerical modeling is one of the most common methods in determining the effect of explosive phenomenon. In numerical modeling, by examining the model and environmental conditions and loading, we can predict the results accurately, and the research costs in the modeling method will be much less than physical modeling. The experimental method is mainly related to experimental data. Most of these methods are limited by experimental limitation. The analysis methods are based on simplified models of physical phenomena.

Discussion

As mentioned, the study of the response of the structure under the explosive charge is examined by numerical and laboratory simulation. But making a real-scale laboratory model is very costly and difficult. Moreover, the assessment of important parameters and the observation of the rupture process in the near explosions is very difficult and almost impossible because of the loss of measurement equipment. Therefore, numerical simulations are a very convenient and efficient method for assessing the behavior of structures under the influence of blast loads.

Numerical simulation of surface explosion is performed on non-sticky, dry soil, which is simulated in a tunnel through a suitable method of deformation and strain on a substructure [16].

In the numerical modeling, considering the blast wave, the large strain on the soil and the change in the amplitude response range is expected that the results of the analysis are reliable and important [17].

Dynamic Rupture of the concrete using the model in the bridge analysis, is that the model can exhibit concrete under extreme dynamic loads and extreme deformations, Comparison between laboratory testing and numerical simulation has good alignment.[18]

Xu & LU studied the general behavior of concrete plates under blast loading using a numerical method and especially focusing on destruction, damage, and they proposed the experimental criteria for concrete erosion, which takes into account the three dimensional response of concrete [19].

The researchers used the dynamic analysis of the first-degree SDOF-system to determine the response of the bridges under the explosion load. In this research, pre-tied concrete was analyzed in multi-opening bridges. The geometry of the bridge, the distance of the explosion from the target to the location of the explosion has an important effect on the bridge response [20-21].

The research conducted for an effective method of analysis of the main bridge with different sizes and the location of explosives led by BAYLOT ET AL, resulted in a review and evaluation the amount and distribution of the load [22].

Conclusion

The results of the survey show that any amount of explosives is higher and the location is closer, the history of failure and pressure is greater.

In the studies, it was found that the comparison between laboratory testing and numerical simulation is in good agreement.

The concrete components are easily broken out regardless of the compressive strength of the concrete, while the reinforcement bar is not broken and can tolerate much displacement against the explosion load. The structural components must be designed to change the large plastic deformation and high deformability.

The cable system in the bridge can be designed for a varying loading route to maintain the structure under a high explosive load. Integrated performance in the pre-tied cable system, if extended across the bridge, can reduce the local damage that may occur on the bridge deck. This system also prevents the progressive destruction and expansion of degradation to adjacent openings.

The analysis of the detonation and the progressive breakdown shows a remarkable decrease in the overall loss of destruction for schemes with the improved flexural frame system than the complex system.

It can be well concluded that soil is one of the material that reduces the intensity and pressure of the blast effect on the structure, so the underground structures are more robust than those on earth.

Due to the complex environments in which the explosion phenomenon has been investigated, such as concrete and soil, and the limitation of the study, researchers have not reached the complete and comprehensive equations with high precision.

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