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Thy Study of the Loads and Extracting the Methods Used in the Design of High Rise Building

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ABSTRACT---

The countries of the world are witnessing these days a great architectural renaissance, where the planning, design and implementation of high-rise buildings are done. Estimating the impact loads of winds, earthquakes and others in these facilities requires accurate assumptions, special analyzes and advanced designs with the use of techniques for modern construction materials.

All this is accompanied by advanced executive programs in terms of implementation methods and construction equipment; with the aim of providing safety, speeding up implementation, reducing costs, and providing the highest level of quality, durability and sustainability.

An accurate understanding of the foundations adopted in determining the type of loads affecting high structures, as well as advanced construction methods, helps determine the effective impact of forces, torques, and others.

Thus, design theories can be developed or developed and the necessary maintenance methods for such facilities can be proposed to ensure their safety and prolong their life.

The technical development in the equipment used in construction enables the preparation of advanced and distinguished executive programs that give high efficiency in quality and speed in implementation and reduce costs.

This project will give a scientific background on determining the impact of loads affecting tall buildings and design considerations for the approved finishes and construction aspects, while addressing the advanced methods of implementation

Index Terms— high rise building, structure, analysis

Literature Review

Many forms of tall buildings have been studied, and they include all the loads that affect them, such as vertical loads, wind loads, earthquakes, and other loads that these buildings may be exposed to, in which all the precautions and requirements necessary for the construction of tall buildings are studied so that they resist the forces of gravity in addition to vertical weights (Gravity loads) so that cracks and collapses do not occur in buildings during the occurrence of earthquakes or high winds, which can cause the collapse of specific elements that do not have resistance and the complete collapse of buildings.

Therefore, a careful study of the wind speed, the degree of earthquakes, and the extent of their impact is required to be determined and converted into design effects in order to calculate their dynamic pressure through the modern specifications followed.

One of the most important methods used in this field is the modular construction method, which is widely used in Europe for multi-story residential buildings, which demonstrates how the basic cellular approach in modular construction can be applied to a wide range of building forms and heights. The study also shows how the structural work of modular systems affects the concept of architectural design for tall buildings.

This study is based on the stability of the buildings through the distribution of loads on all elements of the facilities by creating a system that takes into account most of the changes that occur to it from any external force (winds, earthquakes, etc.).

The bell type is used in places with a small scale of vibration, the silent bell in the medium, and the glass clock in the large one. One of the practical applications of connected dampers is the use of the bell type in the Kajima building, as it is not the relative movement in the transverse direction that is processed in this building, but also the Torsional Motion between the two buildings has been taken into account. In this way shear forces were reduced 20-40% in Building A and 30-10% in Building B.

Another example of these dormant: it was applied in the Lala-port ski dome of the type of glass hour. The building was divided into four sectors, each sector having its own natural frequency different from the others when taken alone. In this building shear forces are reduced to within 40%.

The tremendous development in the requirements of human societies and the increase in their needs for various modern services and the accompanying progress in many areas of life, which contributed mainly and greatly to the assembly of work and housing sites in the form of high facilities that accommodate many users, as these facilities were distinguished by their towering height and high level in providing the required services. It has become a haven to achieve many of the daily requirements of man, as it has become distinguished and proud of major capitals in the countries of the world, but in many cases it has become major landmarks for most commercial, residential and service centers.

The skills and genius of architects and structural engineers have emerged in presenting the distinctive shapes and appearances of such human marvels in the construction industry. Undoubtedly, all of this worked to stimulate the required engineering and technical capabilities in providing what such facilities need in terms of technologies for materials, and advanced equipment at a high and distinguished level in the type of services that provide people in our time with the highest standards of comfort and safety.

The development in the various fields of knowledge and the concerted efforts made thinking strongly about establishing high-rise facilities that are distinct in their forms and types.

In the year 1885 AD, the first skyscraper consisting of ten floors of insurance was built in Chicago, and an American architect designed the Insurance House building, which is considered the first skyscraper in the world, and its construction began in 1885, but it was demolished in 1931, and the first structural steel building known since that time (the Chicago structure) was implemented. After that, Wainwright was built in St. Louis in 1891 AD from steel frames. At the end of the nineteenth century, tall facilities began to spread in the United States, Britain and Australia.

At the beginning of the twentieth century, the spread of high steel structures for environmental aesthetic reasons and fear of fires stopped in some European countries such as Belgium and Italy, where the Born Torne building was built in Antwerp in 1931 AD with 26 floors, then the Torre Bikni building in southern Italy in 1940 AD with 31 floors.

Competitions also began in building tall facilities between New York City and Chicago, where the highest skyscraper in the world was built for forty years in the year 1931 in New York City, known as the Empire State Building (form 8.2), with a height of 381 meters, 102 floors, and 449 meters at the peak.

The first World Trade Tower was established in the year 1972 AD, and it was a skyscraper in the world for two years, with a height of 457 meters and 110 floors, and a peak height of 526.3 meters. Figure (9.2) shows the building that was blown up in the events of September 2001 AD. Then, the Sears Tower was established in Chicago in the year 1974 AD, with a height of 442 meters, 108 floors, and a peak of 527 meters. Figure (2.10) Finally, the tallest tower in the world was constructed in the United Arab Emirates (Dubai) in 2004 AD, with a height of 850 meters and 163 floors.

Since the year 1930 AD, skyscrapers have spread in various cities of the world. In Latin America, the cities of Sawia, Lou, Caracas, Mexico, and in Asia (Tokyo, Shanghai, Hong Kong, Singapore, Malaysia), the construction system has also evolved from the steel structural to the tubular system that was led by Eng. The past rang and continued for fifty years after.

The concept of the skyscraper was the result of the creativity of the industrial age, thanks to the provision of energy and the supply of raw materials used in the construction industry; because the quantities of steel, concrete and glass that the skyscraper needs are very large and they represent the largest amount of the needs for that.

The tall skyscrapers are characterized by their weight, and this means that they need stable and strong foundations, not as is the case with low-rise buildings. Also, most of the materials for construction are transported to high altitudes and are therefore very expensive. In addition to this, the skyscraper needs energy to supply the floors with drinking water and other necessary materials, and to operate special pumps to complete the transportation.

The skyscraper is usually designed by adopting mechanical ventilation and elevators instead of stairs, and natural lighting that cannot be used in rooms far from windows and those spaces represented in stairwells, bathrooms and elevators.

Types of loads affecting tall buildings

Loads are the group of forces that affect the structure, and the structure is designed to bear them.

When calculating the maximum load values, different groups of loads that the element or structure can be subjected to must be chosen at the same time, and which have the greatest impact over other different groups.

The values of the rates of increase or effects of loading differ according to the type of loads affecting the structure and its various elements, as well as the loading directions.

Therefore, when calculating the values of the loads affecting a specific element, the value of each load must be set separately according to its type.

The following are the different types of loads that affect the structural elements of a building.

Direct loads:

They are the loads that the structure is usually subjected to, and they include

Dead Gravity loads.

Extra loads.

Dynamic loads.

Wind loads.

Earth quick loads.

Sudden loads.

The main factors in the structural design: -

Economic cost

Safety for all elements of origin.

Limits of the building's serviceability in terms of avoiding excessive deflection and cracks that annoy users.

Aesthetic aspects of the origin.

Permanent loads (dead loads):-

They are the weights of the constituent materials of the members of the origin, which are permanent in effect and fixed in location, as a result of the earth's attraction to it, and are calculated from the product of multiplying the member's volume with the specific weight of the member's material.

Where the specific weight is as follows:

For steel = 77 kN/m^3.

For concrete, the area R.C = 22-25 kN/m^3.

Cement brick buildings Brick work = 7-5kN/m^3.

Wood Timber = 5-9kN/〖m〗^3.

Additional (moving) loads:

These are the loads whose location, quality and value can be changed during their impact on the structure, and they include:

Static weights of furniture, appliances, and machinery.

The weights of the people using the facility, provided that the dynamic factor resulting from movement and weights is taken into account.

Weights that the structure may be subjected to during the implementation stages, such as the formwork, winches, and equipment used in construction.

These loads are estimated according to the nature of use of the structure, and are usually in accordance with its specific design specifications.

Use of origin value Aries

Residential 1.5kN/m^2

Offices 2.5-5kN/m^2

Classrooms 3kN/m^2

Theaters with fixed chairs 4kN/m^2

General stores 2.4kN/m^2

Light workshops 5kN/m^2

Dynamic loads:

They are dynamically impacted moving loads that vibrate, fluctuate and reflect in the effective stresses, and it is calculated as a percentage of the moving loads causing it.

Wind Loads [3,8,9]:

It is the force of the wind in a direction perpendicular to the roofs and walls of buildings and installations, and it is positive if it is pressing on the structure and negative if it is dragging, and it depends on the wind speed and its directions in the construction area.

Seismic loads [1,4]:

The impact of these loads varies according to the area in which the building is located and according to the geographical distribution. There are so-called seismic maps that identify and classify the globe according to seismic activity based on geological studies, and these maps give information about the seismic zone number).

Indirect loads:

They are the loads that the structure may be subjected to suddenly, and they are as follows:

Heat loads:

Facilities are generally exposed to formations as a result of changes in the temperatures they are exposed to between night and day, and between season and season of the year, which makes them subject to additional loads, and the resulting loads increase with the increase in the amount of change.

Contraction and expansion loads:

It results from climatic changes or the lack of treatment of construction materials in the absence of experimental data, and the effect of shrinkage is taken into account equivalent to the effect of stress or in dry desert areas, and where appropriate treatment is not available for the surrounding conditions, the amount of strain increases.

Creep load:

Creep is a strain of additional formations as a result of the impact of loads over time under the influence of all or some operating loads. Which increases gradually with time and inelastic formations are added to the instantaneous elastic formation resulting from the direct loading of operating loads?

Factors affecting creep

Creep increases with increasing loading stresses.

Creep decreases as the concrete ages when loaded.

Creep increases with the increase in the percentage of cement in the concrete.

The creep increases with the increase in the ratio of the amount of mixing water to the cement.

Creep increases with decreasing element thickness.

The most important loads that affect tall buildings:

Wind loads:

(kN / m ^ 3) The wind pressure or pressure is measured in units of force distributed over the area exposed to the wind, and the effect of the wind on the origin is calculated from the relationship

$q=\square(1/2)\ \rho v^2$

Whereas:

q = dynamic pressure in Pascal

P = specific density of air

V = wind speed, which can be set as the maximum value depending on the origin.

And since q is a dynamic pressure, it can be converted to use it as a static pressure, according to the design equations.

$P=C^1\ C^1...q$

Where: P = static pressure

Factors.. $C^1\ C^1$ = coefficients determined by some design specifications, and the values of these coefficients depend on various environmental and operational factors such as the implementation area, the location of the structure in relation to the region, the duration of its exposure to winds, the condition surrounding the structure, and the dimensions of the structure, especially the vertical.

The wind loads must be taken into account when designing the various steel structures, in addition to the high structures in general, and are sometimes neglected in the low structures with a large mass in which the vertical effect is greater than the effect of the wind.

A proposal to develop the Libyan specifications for calculating seismic loads:

Structural systems are exposed to several types of design loads, including seismic loads. Seismic loads are considered important design loads in Libya, which neglect and lack of consideration may lead to damage to the structural structure of the engineering system, and may lead to its collapse.

When conducting the structural analysis process and calculating the loads involved in the design process, you find that there are many international specifications that may be appropriate and usable in Libya, despite their relatedness to the geographical and geological location and local conditions, but these specifications become unusable in calculating wind loads, heat and earthquakes, for which the geographical location and local conditions are of great importance.

In this chapter, a developed local model for calculating the occasional seismic loads on buildings in Libya will be presented. Probability theory was used in the development of this model, as well as the idea of the response spectrum, which depends on the rate of suppression and the periodic time of the structural system. This chapter also includes a comparison between the developed model and the proposed Libyan specifications used in calculating seismic loads.

Proposed model for calculating total earthquakes in Libya:

Introduction:-

This model was developed at Qar Yunis University (1) in the Faculty of Engineering, in which a thorough study was carried out to calculate the loads resulting from seismic tremors on buildings in Libya, due to the importance of these loads when designing buildings and the seriousness of neglecting their value, especially in areas with high seismic risk in Libya, or when designing important buildings such as hospitals, atomic reactors, etc.

This model relies on the classification of seismic zones, which were divided according to the most recent methods used in the division, such as the statistical method used in the study of earthquake risk, which divided Libya into five seismic zones with varying values of seismic hazard.

This chapter has been divided into two parts, the first part deals with the Garyounis model and includes calculating the shear forces resulting from seismic loads and clarifying the rates of the Garyounis model and its method of use.

The design of any building on the following structural elements:

The structural structure as an integrated unit, including the bases and foundations.

Structural members such as ceilings, walls, etc.

Cladding, windows, etc.

Wind load calculations depend on several factors, the most important of which is the maximum wind speed in the region, the location of the structure in relation to the region, the duration of its exposure to winds, and the condition surrounding the structure, in which the wind speed is transformed into dynamic loads, and then these dynamic loads are converted into static loads.

And when calculating wind loads for private buildings and facilities, such as:

Buildings and installations of unusual shapes, buildings and installations to be built in unusual areas such as roofs and mountain peaks, buildings and installations subject to unusual vibration or under the influence of wind, such as suspended ceilings.

As well as the dynamic method in structural analysis to determine the effect of wind on strength, internal determination and change in shape.

In all cases, the wind resistance of these buildings must not be less than that resulting from the use of the design wind loads stipulated in the design specifications for the region.

Conclusion

Through our study of the systems in the aforementioned tall buildings, we find that the important thing that the engineers focused on is the amount of stability of the buildings, through the distribution of loads on all the elements of the structure by creating a system that contains most of the changes that occur to it from any external forces (winds and earthquakes......) The figure shows the increase in the height of buildings resulting from the development of building systems.

Recently, we notice the spread of many tall buildings in Libya. These buildings need great care and attention in terms of design and implementation, which does not come easily and requires studies... Perhaps one of the most important concerns is considering the effective loads, which are mostly environmental, as they differ from one region to another, and the tall buildings that are being implemented in our country at the present time. Because tall buildings are not subject to the same design and studies of low buildings in terms of loads, implementation methods, and construction methods.

The subject of the study concludes with the following:

1- The design of tall buildings is significantly different from low and medium buildings.

2- The impact of lateral loads from winds and earthquakes that cause vibrations to the point of destruction.

3- One of the most important dangers resulting from vibrations is the occurrence of what is known as resonance, which is the loss of control over buildings.

4- Vibrations cannot be prevented or (quelled) completely, but their impact can be reduced in an appropriate manner. These methods of control and control are real and applied to several buildings globally and have proven to be very successful.

5- The methods of control and control require a high cost that may increase the cost of the buildings many times, but we need this control and control according to the importance of the building from the personal circle and others.

6- There are no specifications for winds and earthquakes in Libya, but there are scattered individual judgments that need someone to adopt and develop them.

The occurrence of vibrations in tall buildings due to external forces resulting from winds and earthquakes or internal forces caused by the movement of machinery inside the building may require a high level of damping. This may reach thousands of tons at a cost that is not commensurate with the cost of building the building.

7- These loads may cause large dynamic displacements, resulting in cracks in the finishing and some structural elements, and may cause resonance, which is considered one of the most harmful and uncontrollable vibrations.

The phenomenon of resonance occurs when the frequency of the stimulus is equal to the natural frequency of the origin, as it loses control over the origin, which leads to a complete collapse despite the quality of design and implementation.

Therefore, when designing, the natural frequency must be made much higher than all possible influencing frequencies.

8- When conducting the structural analysis in tall buildings, the additional stresses resulting from vibrations as a whole must be taken into account, as well as the resonance phenomenon.

9- Controlling vibrations in tall buildings needs theory and experimental practical research with the use of computers in measurement and analysis, and then practical application on real buildings and verification of results over time periods of up to tens of years.

10- It is not easy to implement control and vibration control programs in buildings; this is because the wind speed is not fixed and changes in direction, which makes the control programs costly. However, there are buildings of a special nature that need the use of such programs, such as the buildings of the civil offices and the buildings of military commands.

11- Some instantaneous control systems, such as adjusting the variable hardness, which are the best ways to control and control vibration in buildings, but they are very expensive and may be difficult to install in existing buildings.

Recommendation:

1- Conducting a similar study of the effect of internal vibrations caused by machines.

2- Conducting practical experiments on types of dampers and verifying their efficiency.

3- Applying the aforementioned proposals to buildings in Libya.

4- Issuing specifications for wind loads and earthquakes in Libya.

5- Determining the types of loads that must be taken into account in the design of high facilities in accordance with the local reality.

6- Presenting the construction methods and systems used in such facilities and extracting the best.

7- Determining the important operational considerations that must be taken in the construction of tall facilities.

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