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Wind Design Loads on High-Rise Reinforced Concrete Buildings in Maysan Province Southern Iraq

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ABSTRACT: In recent years Maysan province subjected to high speed winds and cause damaged to many structures especially cladding and components of the structures, thus the study of wind effects on buildings and especially high-rise building is necessary. In this study the ASCE7-05 quasi-static analytical procedure is used to determine the design wind loads on high-rise reinforced concrete buildings with height to width ratio less than four (rigid buildings) in Maysan province in which all factors are presented to correspond the Maysan province topography and environment conditions. The basic wind speed for design purposes is specified according to Iraqi standards IQ 301. The combinations of wind loads with other loads on high-rise concrete buildings are presented based on ASCE7-05 provisions. A flow chart of design procedure is presented and then programmed into Excel sheets for practical uses. A design tables are developed that cover most possible dimensions and elevations of building in Maysan province nowadays and in near future, These design tables consider a useful tool for researchers, designers, engineers and local authorities that have attention in the field of construction, development and risk analysis in Maysan province. The tables provide design values for the following quantities: pressure distribution along building elevation, Maximum horizontal force, Maximum base moment, Maximum building upward force, and Maximum building torsion force. Interpolation is allowed for values not listed in tables.

KEYWORDS: Maysan province, wind loads, high-rise buildings, concrete buildings, design for winds.

I. INTRODUCTION

The lateral loadings due to wind and earthquakes are the major factor that causes the design of high-rise buildings to differ from those of low-rise buildings. In general for buildings of up to 10-stories and of typical properties, the design is rarely affected by wind loads. Above this height (approximately 30 m) with increasing in structural members and the possible re-arrangement of the structure to account for wind loading, lead to incur a cost premium that increase progressively with height, [1,2].

In Maysan province, all multi-story buildings relatively low to medium heights. This low construction is for economical reasons, mainly due to weak soil (3-10 ton/m2) in Maysan province which make any increasing in height will lead to uneconomical construction, i.e., expensive foundations. Also low construction is because of available and cheap lands parcels which encourage increasing length and width (top-plan) of buildings and reducing the height to satisfy the required service area of building.

Based on roughly survey, the highest buildings in Maysan province consist 12 stories. Thus it can be said that all multi-story buildings in south of Iraq nowadays not exceed 40 m in height.

But the new situation of Iraq which is leading to rapidly expansion in towns and cities in south of Iraq due to huge plans to develop the oil areas, increase the income of local families and local business, rapidly increasing in land parcel, construction, rent and buildings costs, rapidly increase in population and etc, push to get optimum use or benefit from available areas. Thus with this economical improvements and increasing the demand on offices, apartments, modern hotels and people tendency to construct new buildings similar to that in surround regional countries , all these factors create new direction in both government and private sectors to start with high-rise buildings (more that 30 m in height)

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for governmental and private functional buildings like offices, malls, hotels, apartments, especially with new Iraqi Investment Law that allow for regional and international investors to start their business in Iraq. From engineering point of view for this new direction, the high-rise buildings are more efficient with innovations in architectural treatment, increase in the strength of materials , advances in methods of analysis and with steady environment of south of Iraq. But these high-rise buildings are lighter and subjected to lateral deflection or sway under wind loadings.

This paper is focused on wind effects in civil engineering activities in Maysan province with main consideration is taken for multi-story reinforced concrete buildings which the most common construction in south of Iraq due to local advantages of concrete structures in comparison with steel structures (steel buildings seldom in south of Iraq). Thus this paper will be good reference for designers and construction companies (especially foreign ones) that have plans to design or construct projects in south of Iraq; in oil , commercial, industrial and another business fields , also its good reference for local student and researchers in the wind field and its effects on structures.

ASCE7-05 provisions [3] are used to obtain design wind loads and a detailed procedure is presented with special attention has been given in determination of ASCE7-05 determination factors that suitable for south of Iraq environment, then a summarized steps of procedure are presented. The basic wind speed to be used in design is based on Iraqi standards. An Excel sheets are programmed to get auto-calculations of wind loads in SI units , a design tables are presented and finally the conclusions are drawn.

II. RELATED WORK

The wind action on building is studied by many researchers and they deal with different topics of this subject, in this section only previous works related to the present study is reviewed. Zhou et al, 2002 [4], presented a comprehensive assessment of the source of the scatter exists among the wind effects predicted by the various codes and standards under similar flow conditions, through a comparison of the along-wind loads and their effects on tall buildings recommended by major international ASCE 7-98, AS1170.2-89, NBC-1995, RLB-AIJ-1993, and Eurocode-1993. They noted that the scatter in the predicted wind loads and their effects arises primarily from the variations in the definition of wind field characteristics in the respective codes and standards. Holmes et al, 2009 [5], described a comparison of wind load calculations on buildings using fifteen different wind loading codes. Three buildings were studied the low-rise building (steel portal-framed industrial warehouse building) , the medium-height building (a 48-metre high office building) and the high-rise building (a 183 metres high). The comparisons showed varying degrees of agreement between codes, in which ASCE7-05 procedure gave reasonable results in comparison with the other codes. Shilu and Patel, 2011[6],developed a computational tool using MS Excel to wind pressure and forces on a multistory commercial complex according India Codes. Suresh et al, 2012 [7], studied the influence of diagonal braces in RCC multi-storied frames under wind loads. The wind loads was calculated using static and gust factor method presented by India Code IS 875 Part III. A sixteen storey high rise building is analysed in STAAD Pro and results are compared with respect to drift, they found that X- bracings reduces the amount of drift and bending moments in the structure. Srikanth and Krishna, 2014 [8], analyzed a tall building frame 20 to 80 stories for wind load analysis. Equivalent static wind loads are computed using the provisions of IS: 875- 1987 PART-III. They concluded that gust factor method, should be considered for the computation of wind loads in the case of very tall frames and structures, and there is need to considered the wind effects in the case of frames having more than 20 storey particularly in serve wind climate to arrive at the critical values for design. Weerasuriya and Jayasinghe, 2014 [ ], studied a high-rise building of height 183 m to evaluate similarities and differences of wind load calculations done by using five major wind codes and standards. The codes used are AS/NZS 1170.2:2002, AS 1170.2:1989, CP 3 Chapter V: Part 2:1972, EN 1991-4:2005 and BS 6399.2:1997. They concluded that Australian Code AS 1170.2:1989 yield higher wind loads and drift than other codes.

III. WINDS IN MAYSAN PROVINCE

Winds and earthquakes represent the major environmental loads on structures in Maysan province. Maysan province climate is warm to hot so there is no any snow may effect on structures.There are two main winds in south of Iraq, North and North-Western winds and South and south-Eastern winds. The North winds prevail in south of Iraq during all seasons of the year and its dry and hot at summer while dry and cool at winter. The East winds are relatively warm

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and with high humidity. In additional to above two common winds, Iraq as a whole be under the effect of 120 weak cyclones per year, these cyclones disturb the flow air and lead to winds with variation directions. There are no good understand whether these weak winds in different directions have any effects on structures, thus for very dynamic sensitive structures or the structures that may suffer from resonance phenomenon these weak cyclones may need to be checked.

Due to boundary layer above earth's surface induced by viscosity, the wind velocity is not constant but is zero at the surface and increases exponentially to a limiting maximum speed known as the gradient wind speed v_g which is constant over gradient height z_g. The gradient height z_g is height above ground at which the movement of air is no longer affect by ground roughness and it is a function of ground roughness. The power law is generally used in engineering fields to represent the variation of wind speed with height, its an empirical equation gives as [10]:

$$v_z = v_{10}\left(\frac{z}{10}\right)^{\frac{2}{\alpha}} \qquad \text{for } z < z_g \qquad (1)$$

$$v_z = v_g \qquad \text{for } z > z_g$$

Where v_{10} is the wind velocity at height of 10 m which called basic wind speed and its measured by anemometer located at height 10 m in open terrain, and v_z is wind velocity at height z, v_g is v_z at $z=z_g$, z_g and α are defined in Table 3 , and they depend on exposure as will explained in section 4.1.

IV. BASIC WIND SPEED, V

In all codes wind speed is used to calculate the loadings of wind on structures, which is calculated from Eq (1) and based on basic wind speed, which is measured at height 10 m in open terrain (Exposure C). For design purposes there are contour maps for each country accomplished by meteorologists and climatologists to find this basic wind speed. The basic wind speeds in Iraq is determined from zoning maps presented by Iraqi specifications IQ 301 (Iraqi Code for forces and loadings) [11] , which is corresponds to the 3 second-gust speed at 10 m above ground in open terrain. The basic design wind speeds for Iraq is shown in Fig.(1) from which its clearly that basic wind speed for Maysan province is 42 m/sec.

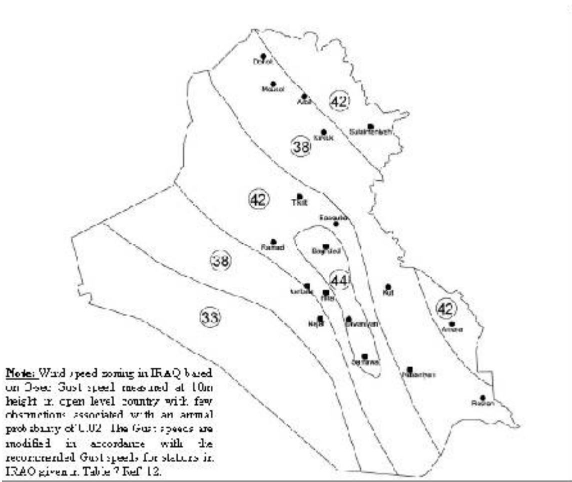

Fig. 1. Contour map for basic wind speeds of Iraq, [11].

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V. DETERMINATION OF DESIGN WIND LOADS BY ASCE7-05 PROCEDURE

ASCE [3] presents three approaches or methods to determine the design wind loads on different buildings or structures:

A- Static approach: in which wind force is replaced by equivalent static force , in this approach two methods could be used:

Method 1: Simplified Procedure (ASCE7-05 section 6.4)

Method 2: Analytical Procedure (ASCE7-05 section 6.5)

B- Dynamic approach: which is done by using Wind tunnel testing and presents as method 3

Method 3: Wind tunnel procedure (ASCE7-05 section 6.6)

Choice of any one from above methods is depend on the structure properties and surround environment characteristics. In general, static approaches are appropriate for all buildings and structures except for buildings or structures that have geometrically complex shapes, or slender or vibration-prone or subjected to sever environment conditions. For these exceptional cases dynamic approach should be used [10,12,13].
Here with common shapes of reinforced concrete buildings and with southern Iraq environment the static approaches are adequate to determine design wind loads. In static approaches the dynamic effect is accounted through the use of gust factor. Thus analytical approach (method 2) is the most suitable approach to determine the design wind loadings on high-rise concrete buildings in south of Iraq, as method 1 is limited to low rise buildings only.

VI. VALIDATION OF MAYSAN PROVINCE CONDITIONS FOR ASCE7-05 PARAMETERS

1. Exposure Categories

ASCE7-05 classifies the exposure into three categories B, C, and D depending on ground roughness and surrounding obstructions. These categories are summarized in Table 1 with their applicability for south of Iraq exposures.

Table 1: Exposure categories and their applicability for Maysan province

Exposure (ASCE7-05) definitions	Category	Applicability in Maysan province
Urban , dense sub-urban and wooded areas, that satisfy : 792 m or 20 H continuous roughness H: height of building	B	Cities and towns only. Palm trees seldom satisfy the conditions of this category due to their distribution as narrow width lines parallel to rivers
Open terrain	C	Marsheslands, open country, villages, grassland and agriculture lands.

From Table 1, the buildings in urban areas of Maysan province (district and subdistrict) are considered of exposure B and building outside urban areas as in oil field or marshland areas are consider as exposure C.

2. Buildings Categories

The buildings in Maysan province can be classified directly into four categories I , II , III and IV according to the nature of occupancy as presented by ASCE7.

3. Enclosure Classifications

For the purpose of determining design pressure of wind (internal pressure coefficients) all buildings should be classifies as enclosed , partially enclosed or open as follow (ASCE7-05 section 6.5.9):

i. Open building: A building having each wall at least 80 % open, namely:

$$A_o \geq 0.8 * A_g \qquad (2)$$

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Where A_o : Total area of openings in a wall receiving positive external pressure

A_g : The gross area of that wall in which A_o is identified.

ii. Paritially Enclosed Building: A building that comply the two following conditions:

$$A_o \geq 1.1 * A_{Oi} \text{ OR } A_o > 0.37 \text{ m}^2 \text{ OR } A_o > 0.01 A_g \text{ Whichever is smaller} \quad (3)$$

$$\text{and } \frac{A_{Oi}}{A_{gi}} \leq 0.2 \quad (4)$$

Where A_{Oi} : The sum of areas of openings in the exterior walls and roof (building envelope) not included A_o

A_{gi} : The sum of gross surface areas of the exterior walls and roof (building envelope) not included A_g

iii. Enclosed Buildings: A building that does not comply with the requirements for open or partially enclosed buildings.

4. Height of Buildings:

The buildings classified according to their heights to :

1- Low-rise Buildings : which satisfy the following two conditions

a- Mean roof height , h is less than or equal to 18 m (60 ft)

b- Mean roof height , h does not exceed least horizontal dimension (width)

2- High-rise Buildings : all another buildings

5. Types of Structures:

In the design procedure of ASCE7-05 , the structural parts or system considered as:

a- Main Wind-Force Resisting System , MWFRS

Defined as the assemblage of structural elements assigned to provide support and stability for overall structure (namely the main frame of building). Here "structural frames" is used here to represent main wind force resistance system MWFRS.

b- Components and Claddings C & C :

The secondary elements of the building envelope that do not qualify as part of MWFRS like parapet , glass and plastic sheets used in windows, doors and skylight.

The present study deal with design of main buildings, thus only MWFRS tables and figures in ASCE7-05 will be used.

6. Sign Convention

Positive pressure acts toward the surface and negative pressure acts away from the surface.

7. Building Envelope

The envelope of building consisting from windward walls, leeward walls , side walls , windward roofs and leeward roofs as shown in Fig (2).

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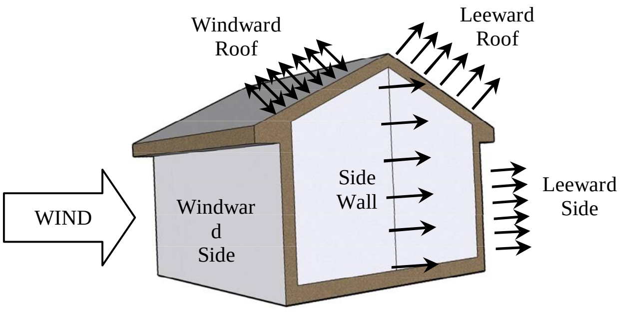

Fig.2. Wind Effects on Building Envelope

VII. DETERMINATION OF WIND DESIGN LOADS BY ANALYTICAL PROCEDURE OF ASCE7-05 (METHOD 2)

The wind loads that determined by equivalent static methods are based on the assumption that structural frames and components/cladding behave elastically in strong winds.
To use this method there are two limitations should be satisfied:

i. Regular shape buildings
ii. No dynamic wind effects (like vortex shedding or across wind effects)

These conditions are applicable for common concrete buildings and wind characteristics in Maysan province. In all codes wind speed is used to calculate the pressure of wind on structures by using Bernoulli's equation [10,12,13]:

$$q=\frac{1}{2}\rho v^2 \qquad (5)$$

Where q = wind pressure, $\rho=$ massd density of air , v = velocity of air, thus with $\rho=1.225\ kg/m^3$ which corresponds to a temperature of 15^o C , Eq. (5) is rewritten as

$$q=0.613\ v^2 \qquad (6)$$

The above pressure is called velocity pressure or dynamic pressure or stagnation pressure, in ASCE7 and here it will be called velocity pressure.
For design purposes, the velocity pressure at any height z is calculated by the following equation (ASCE7-05 section 6.5.10):

$$q_z=0.613\ K_z\ K_{zt}\ K_d\ V^2\ I \qquad (N/m^2) \qquad (7)$$

Where

$K_z =$ Velcity pressure factor

$K_{zt} =$ Topographic effect factor

$K_d =$ Wind directionality factor

$K_d = 0.85$ for all buildings (8)

I= importance factor

These factors are determined as follow:

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1. Importance Factor, I

This factor accounts for the degree of hazard to human life and damage to property. Importance factor is determined from Table 3 (Table 6-1 of ASCE7-05) which depends on building category that defined in Table 2.

Table 2: Importance Factor, I (Table 6-1 of ASCE7-05)

Category	Non-Hurricane Prone Regions and Hurricane Prone Regions with V = 85-100 mph	Hurricane Prone Regions with V > 100 mph
I	0.87	0.77
II	1.00	1.00
III	1.15	1.15
IV	1.15	1.15

2. Topographic Factor , Kzt

This factor account for greater wind speed if the structure is located on a hill (elevated site). Its computed by the following equation:

$$K_{zt} = (1 + K_1 K_2 K_3)^2 \quad (9)$$

Where K_1, K2 and K_3 are determined from Fig 6-4 of ASCE7-05.

K_{zt} = 1.0 for structures located on level ground. (10)

As the south of Iraq mostly flat terrain , thus always K_{xt}= 1.0 , except for elevated ground or hills at the east (Humreen Hills) parallel to Iraq-Iran borders , which may have oil or industries activities in future.

3. Velocity Pressure Factor, K_z

This factor depends on building height and exposure category as in Table 1, which reflect the variation of wind speed with elevation and with roughness of site ground. K_z factor could determine using Table 6.3 of ASCE7-05 or use the following equations:

$$\text{For } 4.6\text{ m} \le z \le z_g \quad \rightarrow \quad K_z = 2.01\,(z/z_g)^{\frac{2}{\alpha}} \quad (11)$$

$$\text{For } z < 4.6\text{ m} \quad \rightarrow \quad K_z = 2.01\,(4.6/z_g)^{\frac{2}{\alpha}} \quad (12)$$

$K_h = K_z$ at $z = h$, where h is mean roof height. Where z_g and α are determined from Table 3 depending on exposure category. z_g is called gradient height and represent the height after which the wind speed do not affected by distance (height) from ground.

Table 3: values of z_g and α for each exposure category

Exposure Category	z_g , m	α
B	366	7
C	274	9.5
D	213	11.5

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5.4 Gust Effect Factor, G

Gust factor accounts for the additional loading effects of wind turbulence over the basic wind speed and dynamic amplification of structures. As the basic wind speed is based on a 3-second gust , thus these gust adjustments (gust factor) reduce the effect of an assumed distributed load over large surface.
Due to gust factor is applied to account the dynamic effects of winds, thus to compute this factor G it should be specify if the structure rigid of flexible.
Flexible structures are dynamic sensitive structures with a fundamental natural frequency less than 1 Hz (or time period, T > 1 sec). Thus analytical procedure is applicable for regular shapes flexible structures, but irregular shapes flexible structures and sever wind conditions should be designed by wind tunnel procedure [10,14].
Rigid structures are structures with a fundamental natural frequency greater than 1 Hz (or time period, T < 1 sec) , which mean that rigid structures are away from resonance phenomenon, the massive structures clear example. For design calculations, the structure is assumed rigid if the ratio of height to least horizontal dimension (width) not exceeding 4 [14], i.e:

$$\text{If} \quad \frac{H\ (\text{Height})}{B\ (\text{Width})} < 4 \quad \rightarrow \quad \text{Rigid Structure} \qquad (13)$$

Thus most high rise concrete buildings in south Iraq could be considered as rigid structures. Thus for Rigid Structures gust factor is:
Gust Factor = G = 0.85 (14)

VIII. DESIGN WIND PRESSURE, P

For rigid buildings the design wind pressure is determined from the following equations:

1- For Windward Side:

$$p = q_z * G * C_p - q_h * GC_{pi} \qquad (15)$$

2- For Leeward side, Side walls and roofs

$$p = q_h * G * C_p - q_h * GC_{pi} \qquad (16)$$

For all cases

$$p \geq p_{min} \quad , \quad p_{min} = 0.48\ KN/m^2 \qquad (17)$$

Where

$q_h = q_z$ evaluated at $z = h$, G : Gust effect factor, C_p : External Pressure Coefficient and GC_{pi} : Internal pressure Coefficient. The above coefficients are determined as follows:

1. Internal Pressure coefficient GC_{pi}

This factor is determined from table 6-5 of ASCE7-05 , $GC_{pi} = \pm 18$ for enclosed buildings.

2. External Pressure Coefficients C_p

This factor determines from Fig 6-6 of ASCE7-05, in which fives values for C_p are presented: C_p for Windward walls, C_p for Leeward walls, C_p for Side walls, C_p for Windward roofs, and C_p for Leeward roofs.

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IX. PARAPETS EFFECTS ON WIND FORCES ON BUILDINGS

The design wind pressure for the effect of parapets on main buildings (MWFRS) is determined by the following equation:

$$P_p = q_p * (GC_{pn}) \tag{18}$$

Where q_p : velocity pressure evaluated at the top of the parapet, P_p : combined net pressure on the parapet, and GC_{pn} : combined net pressure coefficient for parapet = +1.5 for windward parapet and = - 1.0 for leeward parapet. The force on parapet of building can be determined by the following formula

$$F = P_p * H_p \tag{19}$$

where H_p : Height of parapet. This force F should be applied on the windward parapet and leeward parapet.

X. DESIGN WIND LOAD, F

Wind load on structural frames is divided into two parts

a- Horizontal wind load on structural frames (leeward or suction)

b- Roof wind loads on structural frames (uplift)

High-rise buildings have flat roof namely $\theta < 10^o$, therefore there is no leeward roof action and then, there is no values for C_p corresponds to leeward roofs. The wind loads must be calculated for the roofs and walls. Windward and leeward sides of the buildings must be analyzed, considering wind directions normal and parallel to the roof. Loads must also be calculated for positive and negative internal pressure.

After all of the scenarios are determined then the worst case is used in design. To achieve this concept, ASCE7-05 [3] requires that any building should be designed for wind load cases that defined in Fig 6-9 which listed here as Fig (3) in which CASE1 consider wind act normal to building faces , CASE 3 if the wind act with angle on building while CASE2 and CASE3 are previous cases respectively but with torsional moment.

For practical design wind may treated as horizontal or lateral loads, although wind often generate significant uplift (vertical) forces that required special attention to vertical restraint and lateral support for members in reverse bending, also uplift wind forces can be important in precast concrete construction as in the design of connections [1]. Thus in flat, monolithic construction (cast-in-site), multistory buildings of the vertical or uplift roof loads are commonly neglect but it may be critical for some types of structures as mentioned previously.

For design purposes the wind pressures assumed to be applied to the gross area of the vertical projection of walls and for roofs are applied to area of roof projection on horizontal plan, in general the wind pressures assumed to be applied to projected area of building perpendicular to the wind direction. Thus wind force is calculated from the following equation:

$$F = p * A \tag{20}$$

Where A is the projected area perpendicular to the wind direction. In design pressure equations (Eqs.15-16), for each value of C_p there are two values for GC_{pi} (as in Table 5), thus at any level these equations present two values for design pressure p. In design practice the average value of these two values p_{ave} is used to calculate wind force F, i.e.:

$$p_{ave} = \frac{p(+GC_{pi}) + p(-GC_{pi})}{2} \tag{21}$$

$$F = p_{ave} * A \tag{22}$$

The main quantities that needed in high-rise building design due to wind loads are, overturning moment, total lateral shear, uplift roof forces, and lateral wind forces at different elevations of building.

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The analysis and sometimes design of high rise buildings are accomplished by computer structural programs or softwares like STAAD, SAP and etc, these softwares are commonly based on finite element method to idealize the structure in which all forces should be subjected at nodes or members (or elements). Thus wind design loads along the building is summarized in tables below as pressure units, which can be easily to transformed to nodes of members or elements.

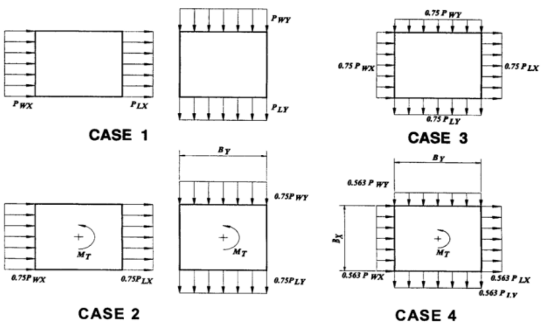

Fig. 3. Load Cases to find Critical Wind Design Loads

XI. SUMMARIZED STEPS OF DESIGN WIND LOADS PROCEDURE

The steps of calculation design wind speed on high-rise concrete building are listed below and also illustrated by flow-chart in Figure (4).

1- Determine the exposure category B, C or D according to Table 1.
2- Determine Building Classifications I, II, III or IV according to ASCE7-05.
3- Determine enclosure classification open, enclosed or partially enclosed Eqs. (2-4)
4- Determine the basic wind speed
5- Determine the velocity pressure (q_z or q_h) from Eq.7 in which the factors are determined from:
a- Directionality factor , K_d =0.85
b- Importance factor I , from Table 2.
c- Topography factor , K_{zt} =1.0
d- Velocity pressure coefficients K_z and K_h from Eqs.(11-12)
6- Determine whether the building rigid or flexible , from Eq.(13)
7- Determine Gust effect factor G, for rigid building G = 0.85
8- Determine design wind pressure ,p from Eqs. (15-17), in which the pressure factors are determined as follow:
a- Internal pressure factor , GC_{pi} .
b- External pressure factor, C_p (for windward sides, leeward sides, side walls, and windward roof) from Fig 6-6 of ASCE7-05. .
9- Determine the force, F on parapet of building if any, from Eqs.(18-19) for both windward and leeward parapets.
10- Determine the vertical wind load by using design wind load cases in Fig. (3).

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XII. LOAD COMBINATIONS

In strength design method of concrete structures , the services loads are multiplied by load factors, the possible combinations of different loads are presented in ACI-Code 2014 [15]. The major design loads of high-rise reinforced concrete buildings in south of Iraq are:

i. Gravity loads , dead and live loads (vertical loads)
ii. Wind loads (lateral or sway loads)

ACI Code [15] in section 5.3, presents three the following cases to combine above loads namely dead load D, live load L, L_r roof live load, E earthquake load and wind load W to find ultimate design load U as follow (In which the critical case (the larger) should be used in design.)

$$
\begin{aligned}
U &= 1.4D \\
U &= 1.2D + 1.6L + 0.5L_r \\
U &= 1.2D + 1.6L_r + (1.0L \text{ or } 0.5W) \\
U &= 1.2D + 1.0W + 1.0L + 0.5L_r \\
U &= 1.2D + 1.0E + 1.0L \\
U &= 0.9D + 1.0W \\
U &= 0.9D + 1.0E
\end{aligned}
\qquad (23)
$$

XIII. DESIGN TABLES

The design tables are for wind design loads quantities is based on the following data:

1- Exposure: The building is located in Amarah City (Urban area) so Exposure B is used.
2- Building classification: The building function is office space. It is not considered an essential facility or likely to be occupied by 300 persons in a single area at one time. Therefore building category II is appropriate. Namely importance factor, I=1.0
3- Enclosed classification: the building is enclosed according to original design.
4- Basic wind speed , V = 42 m/s
5- The buildings are considered rigid building, namely H/B<4.Since the ratio of height to least horizontal dimension is less than 4, the fundamental natural frequency is judged to be greater than 1 Hz.
6- All buildings assumed have a parapet wall of height = 1m.

The wind load calculations are done using Excel Sheet developed for this purpose in SI units. Tables are provided wind pressure distribution and wind design forces for four elevations 18, 24, 48 and 72m which cover the range of building in Maysan province nowadays in the near future. The interpolation can be used for elevations between listed values.
Tables 4, 6, 8, and 10 cover the design wind pressure distribution along building of height 18 m, 24, 48 and 72m respectively for both wind direction namely normal to building length (⊥L) or normal to building width (⊥B) . This design pressure may be used for analysis and design RC buildings in Maysan province.
Tables 5, 7, 9, and 11 cover the wind design forces for building of height 18 m, 24, 48 and 72m respectively. The wind design forces include: Maximum horizontal force, Maximum base moment, Maximum building upward force, and Maximum building torsion force. These forces are calculated for different scenarios of wind direction and inclination. Interpolation is allowed for values not listed in tables.

XIV. CONCLUSIONS

Although the climate of south of Iraq is considered as steady and quiet, but wind effects have considerable effects on civil engineering structures especially high-rise, slender , complex shape structures. Thus wind effects should be

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considered for all buildings design in south of Iraq either to that which consider as low-rise buildings. A design tables are developed that cover most possible dimensions and elevations of building in Maysan province nowadays and in near future, These design tables considers a useful tool for researchers, designers, engineers and local authorities that have attention in the field of construction, development and risk analysis in Maysan province. The tables provide design values for the following quantities: pressure distribution along building elevation, Maximum horizontal force, Maximum base moment, Maximum building upward force, and Maximum building torsion force. Interpolation is allowed for values not listed in tables.

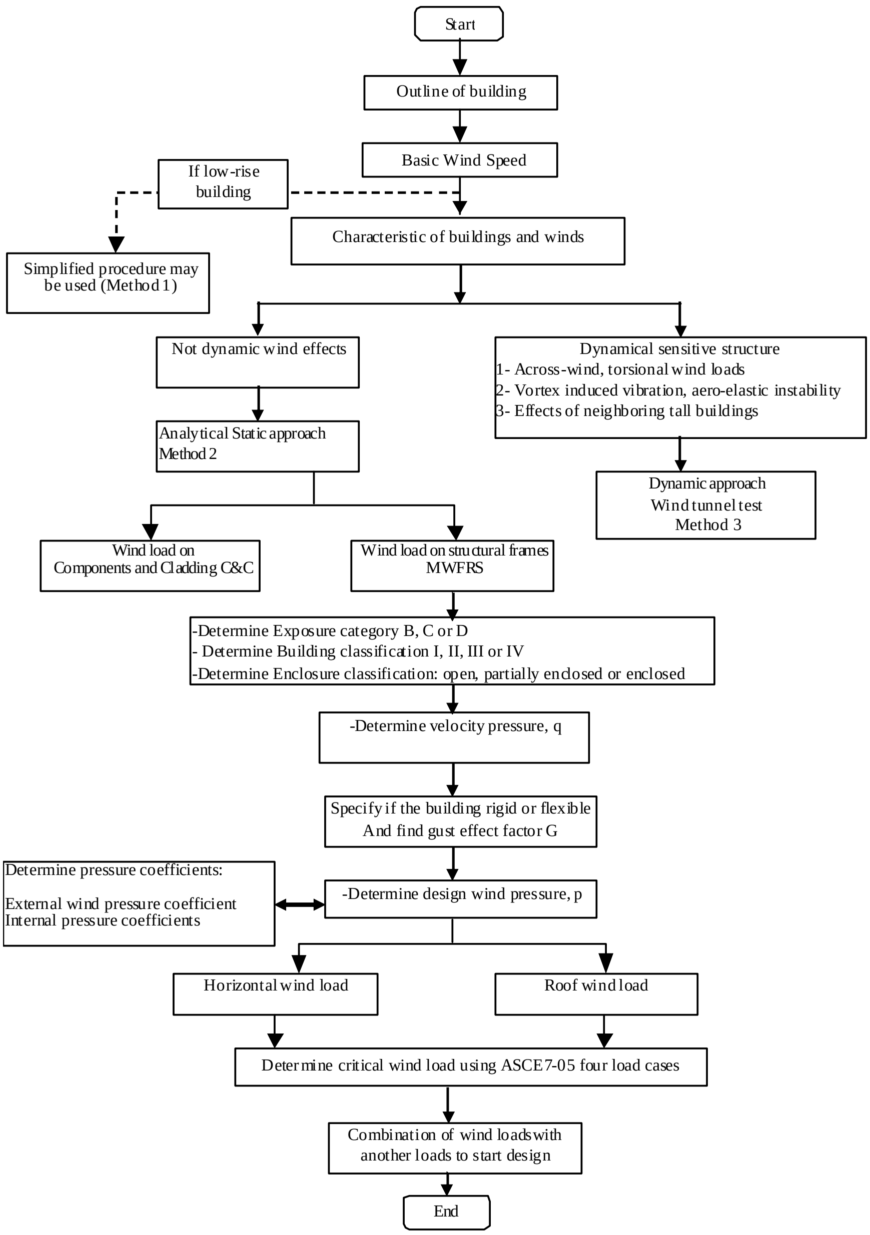

Fig. 4. Flow chart for estimation of design wind load

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Vol. 6, Issue 7, July 2017

Table 4: Pressure distribution along building of height = 18 m (6 Stories)

Building Plan, m		Height, m		Height from the base, m		
L	B	H	Wind Direc-tion	7.6	12.2	19
20	15	18	⊥L	0.75	0.81	0.88
			⊥B	0.70	0.77	0.83
30	15	18	⊥L	0.75	0.81	0.88
			⊥B	0.61	0.68	0.74
40	15	18	⊥L	0.75	0.81	0.88
			⊥B	0.59	0.65	0.72
20	20	18	⊥L	0.75	0.81	0.88
			⊥B	0.75	0.81	0.88
30	20	18	⊥L	0.75	0.81	0.88
			⊥B	0.68	0.74	0.81
40	20	18	⊥L	0.75	0.81	0.88
			⊥B	0.61	0.68	0.74
50	20	18	⊥L	0.75	0.81	0.88
			⊥B	0.60	0.66	0.72
30	30	18	⊥L	0.75	0.81	0.88
			⊥B	0.75	0.81	0.88
40	30	18	⊥L	0.75	0.81	0.88
			⊥B	0.70	0.77	0.83
50	30	18	⊥L	0.75	0.81	0.88
			⊥B	0.66	0.72	0.79
60	30	18	⊥L	0.75	0.81	0.88
			⊥B	0.61	0.68	0.74
70	30	18	⊥L	0.75	0.81	0.88
			⊥B	0.60	0.67	0.73
40	40	18	⊥L	0.75	0.81	0.88
			⊥B	0.75	0.81	0.88
50	40	18	⊥L	0.75	0.81	0.88
			⊥B	0.72	0.78	0.84
60	40	18	⊥L	0.75	0.81	0.88
			⊥B	0.68	0.74	0.81
70	40	18	⊥L	0.75	0.81	0.88
			⊥B	0.65	0.71	0.77
80	40	18	⊥L	0.75	0.81	0.88
			⊥B	0.61	0.68	0.74
50	50	18	⊥L	0.75	0.81	0.88
			⊥B	0.75	0.81	0.88
60	50	18	⊥L	0.75	0.81	0.88
			⊥B	0.72	0.78	0.85
70	50	18	⊥L	0.75	0.81	0.88
			⊥B	0.70	0.76	0.82
80	50	18	⊥L	0.75	0.81	0.88
			⊥B	0.67	0.73	0.79

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Table 5: Wind Design forces for building of height = 18 m (6 Stories)

Building Plan, m		Height, m	Wind Direc-tion	Max. horizontal force	Max. base moment	Max. building upward force	Max. building torsion force
L	B	H					
20	15	18	⊥L	298.2	3422.6	269.6	859.9
			⊥B	210.9	2578.9		
30	15	18	⊥L	447.3	5133.8	382.6	1602.7
			⊥B	185.3	3095.5		
40	15	18	⊥L	596.5	6845.1	483.5	2684.0
			⊥B	178.9	3961.7		
20	20	18	⊥L	298.2	3600.6	348.9	1007.4
			⊥B	298.2	3600.6		
30	20	18	⊥L	447.3	5400.9	494.4	1824.1
			⊥B	272.6	4370.5		
40	20	18	⊥L	596.5	7201.3	623.7	2849.3
			⊥B	247.0	5363.3		
50	20	18	⊥L	745.6	9001.6	741.2	4193.8
			⊥B	240.6	7094.1		
30	30	18	⊥L	447.3	6920.5	698.2	2266.7
			⊥B	447.3	6920.5		
40	30	18	⊥L	596.5	9227.4	877.7	3439.5
			⊥B	421.7	8531.2		
50	30	18	⊥L	745.6	11534.2	1039.5	4820.9
			⊥B	396.2	10975.5		
60	30	18	⊥L	894.7	13841.0	1201.3	6411.0
			⊥B	370.6	13419.8		
70	30	18	⊥L	1043.8	16147.9	1363.1	8323.1
			⊥B	364.2	16046.4		
40	40	18	⊥L	596.5	11699.1	1099.2	4029.6
			⊥B	596.5	11699.1		
50	40	18	⊥L	745.6	14623.9	1297.2	5558.6
			⊥B	570.9	15039.2		
60	40	18	⊥L	894.7	17548.7	1495.3	7296.2
			⊥B	545.3	18379.3		
70	40	18	⊥L	1043.8	20473.5	1693.3	9242.4
			⊥B	519.7	21719.4		
80	40	18	⊥L	1192.9	23398.2	1891.3	11397.3
			⊥B	494.1	25059.5		
50	50	18	⊥L	745.6	19103.0	1525.6	6296.3
			⊥B	745.6	19103.0		
60	50	18	⊥L	894.7	22923.6	1753.9	8181.5
			⊥B	720.0	23338.9		
70	50	18	⊥L	1043.8	26744.2	1982.2	10275.2
			⊥B	694.4	27574.8		
80	50	18	⊥L	1192.9	30564.7	2210.6	12577.6
			⊥B	668.8	31810.7		

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Table 6: Pressure distribution along building of height = 24 m (8 Stories)

Building Plan, m		Height, m	Wind Direction	Height from the base, m			
L	**B**	**H**		**7.6**	**12.2**	**18**	**24.4**
20	15	24	⊥L	0.78	0.84	0.90	0.95
			⊥B	0.73	0.79	0.85	0.90
30	15	24	⊥L	0.78	0.84	0.90	0.95
			⊥B	0.63	0.69	0.75	0.80
40	15	24	⊥L	0.78	0.84	0.90	0.95
			⊥B	0.61	0.67	0.73	0.78
20	20	24	⊥L	0.78	0.84	0.90	0.95
			⊥B	0.78	0.84	0.90	0.95
30	20	24	⊥L	0.78	0.84	0.90	0.95
			⊥B	0.71	0.77	0.82	0.87
40	20	24	⊥L	0.78	0.84	0.90	0.95
			⊥B	0.63	0.69	0.75	0.80
50	20	24	⊥L	0.78	0.84	0.90	0.95
			⊥B	0.61	0.68	0.73	0.78
30	30	24	⊥L	0.78	0.84	0.90	0.95
			⊥B	0.78	0.84	0.90	0.95
40	30	24	⊥L	0.78	0.84	0.90	0.95
			⊥B	0.73	0.79	0.85	0.90
50	30	24	⊥L	0.78	0.84	0.90	0.95
			⊥B	0.68	0.74	0.80	0.85
60	30	24	⊥L	0.78	0.84	0.90	0.95
			⊥B	0.63	0.69	0.75	0.80
70	30	24	⊥L	0.78	0.84	0.90	0.95
			⊥B	0.62	0.68	0.74	0.79
40	40	24	⊥L	0.78	0.84	0.90	0.95
			⊥B	0.78	0.84	0.90	0.95
50	40	24	⊥L	0.78	0.84	0.90	0.95
			⊥B	0.74	0.80	0.86	0.91
60	40	24	⊥L	0.78	0.84	0.90	0.95
			⊥B	0.71	0.77	0.82	0.87
70	40	24	⊥L	0.78	0.84	0.90	0.95
			⊥B	0.67	0.73	0.79	0.84
80	40	24	⊥L	0.78	0.84	0.90	0.95
			⊥B	0.63	0.69	0.75	0.80
50	50	24	⊥L	0.78	0.84	0.90	0.95
			⊥B	0.78	0.84	0.90	0.95
60	50	24	⊥L	0.78	0.84	0.90	0.95
			⊥B	0.75	0.81	0.87	0.92
70	50	24	⊥L	0.78	0.84	0.90	0.95
			⊥B	0.72	0.78	0.84	0.89
80	50	24	⊥L	0.78	0.84	0.90	0.95
			⊥B	0.69	0.75	0.81	0.86

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Table 7: Wind Design forces for building of height = 24 m (8 Stories)

Building Plan, m		Height, m	Wind Direc-tion	Max. horizontal force	Max. base moment	Max. building upward force	Max. building torsion force
L	B	H					
20	15	24	⊥L	422.1	6195.3	311.9	1216.6
			⊥B	298.3	4534.5		
30	15	24	⊥L	633.1	9292.9	449.7	2267.0
			⊥B	261.7	4700.1		
40	15	24	⊥L	844.1	12390.5	575.0	3798.6
			⊥B	252.6	5696.8		
20	20	24	⊥L	422.1	6350.6	400.4	1425.7
			⊥B	422.1	6350.6		
30	20	24	⊥L	633.1	9526.0	576.3	2580.6
			⊥B	385.5	6723.9		
40	20	24	⊥L	844.1	12701.3	735.6	4030.2
			⊥B	348.9	7748.0		
50	20	24	⊥L	1055.2	15876.6	884.4	5935.3
			⊥B	339.8	9202.6		
30	30	24	⊥L	633.1	10771.4	828.2	3207.9
			⊥B	633.1	10771.4		
40	30	24	⊥L	844.1	14361.9	1055.0	4866.6
			⊥B	596.5	12536.1		
50	30	24	⊥L	1055.2	17952.3	1266.0	6819.9
			⊥B	560.0	14432.3		
60	30	24	⊥L	1266.2	21542.8	1453.4	9067.9
			⊥B	523.4	17814.4		
70	30	24	⊥L	1477.2	25133.3	1640.8	11772.7
			⊥B	514.3	21539.2		
40	40	24	⊥L	844.1	17324.2	1341.0	5702.9
			⊥B	844.1	17324.2		
50	40	24	⊥L	1055.2	21655.3	1605.9	7865.4
			⊥B	807.6	20004.8		
60	40	24	⊥L	1266.2	25986.4	1839.4	10322.5
			⊥B	771.0	24666.6		
70	40	24	⊥L	1477.2	30317.4	2072.8	13074.3
			⊥B	734.4	29328.4		
80	40	24	⊥L	1688.3	34648.5	2306.2	16120.7
			⊥B	697.9	33990.2		
50	50	24	⊥L	1055.2	25577.3	1919.6	8910.8
			⊥B	1055.2	25577.3		
60	50	24	⊥L	1266.2	30692.7	2193.8	11577.0
			⊥B	1018.6	31518.8		
70	50	24	⊥L	1477.2	35808.2	2468.0	14537.9
			⊥B	982.0	37460.3		
80	50	24	⊥L	1688.3	40923.6	2742.2	17793.5
			⊥B	945.5	43401.8		

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Table 8: Pressure distribution along building of height = 48 m (16 Stories)

Building Plan, m		Height, m	Wind Direc-tion	Height from the base, m						
L	**B**	**H**		**7.6**	**12.2**	**18**	**24.4**	**30.5**	**42.7**	**49**
20	15	48	⊥L	0.85	0.92	0.97	1.02	1.06	1.12	0.47
			⊥B	0.80	0.86	0.91	0.96	1.00	1.06	1.09
30	15	48	⊥L	0.85	0.92	0.97	1.02	1.06	1.12	0.47
			⊥B	0.68	0.74	0.80	0.85	0.88	0.95	0.97
40	15	48	⊥L	0.85	0.92	0.97	1.02	1.06	1.12	0.47
			⊥B	0.65	0.71	0.77	0.82	0.85	0.92	0.94
20	20	48	⊥L	0.85	0.92	0.97	1.02	1.06	1.12	0.47
			⊥B	0.85	0.92	0.97	1.02	1.06	1.12	1.15
30	20	48	⊥L	0.85	0.92	0.97	1.02	1.06	1.12	0.47
			⊥B	0.77	0.83	0.88	0.93	0.97	1.03	1.06
40	20	48	⊥L	0.85	0.92	0.97	1.02	1.06	1.12	0.47
			⊥B	0.68	0.74	0.80	0.85	0.88	0.95	0.97
50	20	48	⊥L	0.85	0.92	0.97	1.02	1.06	1.12	0.47
			⊥B	0.66	0.72	0.77	0.82	0.86	0.92	0.95
30	30	48	⊥L	0.85	0.92	0.97	1.02	1.06	1.12	0.47
			⊥B	0.85	0.92	0.97	1.02	1.06	1.12	1.15
40	30	48	⊥L	0.85	0.92	0.97	1.02	1.06	1.12	0.47
			⊥B	0.80	0.86	0.91	0.96	1.00	1.06	1.09
50	30	48	⊥L	0.85	0.92	0.97	1.02	1.06	1.12	0.47
			⊥B	0.74	0.80	0.86	0.91	0.94	1.01	1.03
60	30	48	⊥L	0.85	0.92	0.97	1.02	1.06	1.12	0.47
			⊥B	0.68	0.74	0.80	0.85	0.88	0.95	0.97
70	30	48	⊥L	0.85	0.92	0.97	1.02	1.06	1.12	0.47
			⊥B	0.66	0.73	0.78	0.83	0.87	0.93	0.96
40	40	48	⊥L	0.85	0.92	0.97	1.02	1.06	1.12	0.47
			⊥B	0.85	0.92	0.97	1.02	1.06	1.12	1.15
50	40	48	⊥L	0.85	0.92	0.97	1.02	1.06	1.12	0.47
			⊥B	0.81	0.87	0.93	0.98	1.02	1.08	1.10
60	40	48	⊥L	0.85	0.92	0.97	1.02	1.06	1.12	0.47
			⊥B	0.77	0.83	0.88	0.93	0.97	1.03	1.06
70	40	48	⊥L	0.85	0.92	0.97	1.02	1.06	1.12	0.47
			⊥B	0.72	0.78	0.84	0.89	0.93	0.99	1.02
80	40	48	⊥L	0.85	0.92	0.97	1.02	1.06	1.12	0.47
			⊥B	0.68	0.74	0.80	0.85	0.88	0.95	0.97
50	50	48	⊥L	0.85	0.92	0.97	1.02	1.06	1.12	0.47
			⊥B	0.85	0.92	0.97	1.02	1.06	1.12	1.15
60	50	48	⊥L	0.85	0.92	0.97	1.02	1.06	1.12	0.47
			⊥B	0.82	0.88	0.94	0.99	1.03	1.09	1.11
70	50	48	⊥L	0.85	0.92	0.97	1.02	1.06	1.12	0.47
			⊥B	0.78	0.85	0.90	0.95	0.99	1.05	1.08
80	50	48	⊥L	0.85	0.92	0.97	1.02	1.06	1.12	0.47
			⊥B	0.75	0.81	0.87	0.92	0.95	1.02	1.04

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Vol. 6, Issue 7, July 2017

Table 9: Wind Design forces for building of height = 48 m (16 Stories)

Building Plan, m		Height, m	Wind Direc-tion	Max. horizontal force	Max. base moment	Max. building upward force	Max. building torsion force
L	B	H					
20	15	48	⊥L	991.1	28088.6	413.6	2856.3
			⊥B	700.0	20005.4		
30	15	48	⊥L	1486.6	42132.8	601.9	5320.4
			⊥B	613.4	18186.9		
40	15	48	⊥L	1982.2	56177.1	774.9	8919.8
			⊥B	591.7	18208.6		
20	20	48	⊥L	991.1	28088.6	551.5	3347.9
			⊥B	991.1	28088.6		
30	20	48	⊥L	1486.6	42132.8	802.5	6057.8
			⊥B	904.5	26371.4		
40	20	48	⊥L	1982.2	56177.1	1033.2	9458.5
			⊥B	817.9	24985.5		
50	20	48	⊥L	2477.7	70221.4	1264.5	13937.2
			⊥B	796.2	25422.7		
30	30	48	⊥L	1486.6	42740.3	1166.6	7532.8
			⊥B	1486.6	42740.3		
40	30	48	⊥L	1982.2	56987.0	1500.2	11425.0
			⊥B	1400.0	41722.5		
50	30	48	⊥L	2477.7	71233.8	1834.8	16008.0
			⊥B	1313.4	41052.0		
60	30	48	⊥L	2973.3	85480.5	2162.1	21281.6
			⊥B	1226.8	43775.7		
70	30	48	⊥L	3468.8	99727.3	2468.5	27629.9
			⊥B	1205.1	48432.5		
40	40	48	⊥L	1982.2	58459.5	1926.6	13391.6
			⊥B	1982.2	58459.5		
50	40	48	⊥L	2477.7	73074.4	2354.4	18466.1
			⊥B	1895.6	58272.9		
60	40	48	⊥L	1808.9	62611.8	2772.4	24231.4
			⊥B	1808.9	62611.8		
70	40	48	⊥L	3468.8	102304.1	3162.5	30687.3
			⊥B	1722.3	67406.2		
80	40	48	⊥L	3964.3	116919.0	3535.2	37833.9
			⊥B	1635.7	72485.3		
50	50	48	⊥L	2477.7	75493.8	2875.7	20924.3
			⊥B	2477.7	75493.8		
60	50	48	⊥L	2973.3	90592.6	3384.7	27181.2
			⊥B	2391.1	81447.9		
70	50	48	⊥L	3468.8	105691.3	3858.8	34128.8
			⊥B	2304.5	87971.5		
80	50	48	⊥L	3964.3	120790.1	4311.2	41767.0
			⊥B	2217.9	94850.9		

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Table 10: Pressure distribution along building of height = 72 m (24 Stories)

Building Plan, m		Height, m	Wind Direc-tion	Height from the base, m							
L	B	H		7.6	12.2	18	24.4	30.5	42.7	54.9	73
20	20	72	⊥L	0.91	0.97	1.02	1.07	1.11	1.17	1.22	1.28
			⊥B	0.91	0.97	1.02	1.07	1.11	1.17	1.22	1.28
30	20	72	⊥L	0.91	0.97	1.02	1.07	1.11	1.17	1.22	1.28
			⊥B	0.81	0.87	0.93	0.98	1.01	1.08	1.13	1.18
40	20	72	⊥L	0.91	0.97	1.02	1.07	1.11	1.17	1.22	1.28
			⊥B	0.71	0.77	0.83	0.88	0.91	0.98	1.03	1.09
50	20	72	⊥L	0.91	0.97	1.02	1.07	1.11	1.17	1.22	1.28
			⊥B	0.68	0.75	0.80	0.85	0.89	0.95	1.00	1.06
30	30	72	⊥L	0.91	0.97	1.02	1.07	1.11	1.17	1.22	1.28
			⊥B	0.91	0.97	1.02	1.07	1.11	1.17	1.22	1.28
40	30	72	⊥L	0.91	0.97	1.02	1.07	1.11	1.17	1.22	1.28
			⊥B	0.84	0.90	0.96	1.01	1.05	1.11	1.16	1.22
50	30	72	⊥L	0.91	0.97	1.02	1.07	1.11	1.17	1.22	1.28
			⊥B	0.77	0.84	0.89	0.94	0.98	1.04	1.09	1.15
60	30	72	⊥L	0.91	0.97	1.02	1.07	1.11	1.17	1.22	1.28
			⊥B	0.71	0.77	0.83	0.88	0.91	0.98	1.03	1.09
70	30	72	⊥L	0.91	0.97	1.02	1.07	1.11	1.17	1.22	1.28
			⊥B	0.69	0.75	0.81	0.86	0.90	0.96	1.01	1.07
40	40	72	⊥L	0.91	0.97	1.02	1.07	1.11	1.17	1.22	1.28
			⊥B	0.91	0.97	1.02	1.07	1.11	1.17	1.22	1.28
50	40	72	⊥L	0.91	0.97	1.02	1.07	1.11	1.17	1.22	1.28
			⊥B	0.86	0.92	0.98	1.03	1.06	1.13	1.18	1.23
60	40	72	⊥L	0.91	0.97	1.02	1.07	1.11	1.17	1.22	1.28
			⊥B	0.81	0.87	0.93	0.98	1.01	1.08	1.13	1.18
70	40	72	⊥L	0.91	0.97	1.02	1.07	1.11	1.17	1.22	1.28
			⊥B	0.76	0.82	0.88	0.93	0.96	1.03	1.08	1.13
80	40	72	⊥L	0.91	0.97	1.02	1.07	1.11	1.17	1.22	1.28
			⊥B	0.71	0.77	0.83	0.88	0.91	0.98	1.03	1.09
50	50	72	⊥L	0.91	0.97	1.02	1.07	1.11	1.17	1.22	1.28
			⊥B	0.91	0.97	1.02	1.07	1.11	1.17	1.22	1.28
60	50	72	⊥L	0.91	0.97	1.02	1.07	1.11	1.17	1.22	1.28
			⊥B	0.87	0.93	0.99	1.04	1.07	1.14	1.19	1.24
70	50	72	⊥L	0.91	0.97	1.02	1.07	1.11	1.17	1.22	1.28
			⊥B	0.83	0.89	0.95	1.00	1.03	1.10	1.15	1.20
80	50	72	⊥L	0.91	0.97	1.02	1.07	1.11	1.17	1.22	1.28
			⊥B	0.79	0.85	0.91	0.96	0.99	1.06	1.11	1.16

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Table 11: Wind Design forces for building of height = 72 m (24 Stories)

Building Plan, m		Height, m	Wind Direc-tion	Max. horizontal force	Max. base moment	Max. building upward force	Max. building torsion force
L	B	H					
20	20	72	⊥L	1645.8	69633.2	615.8	5559.4
			⊥B	1645.8	69633.2		
30	20	72	⊥L	2468.7	104449.7	923.7	10058.9
			⊥B	1501.7	64374.2		
40	20	72	⊥L	3291.5	139266.3	1214.0	15704.8
			⊥B	1357.6	59543.9		
50	20	72	⊥L	4114.4	174082.9	1471.6	23143.6
			⊥B	1321.6	59453.8		
30	30	72	⊥L	2468.7	104449.7	1385.5	12508.7
			⊥B	2468.7	104449.7		
40	30	72	⊥L	3291.5	139266.3	1821.0	18971.2
			⊥B	2324.6	99833.7		
50	30	72	⊥L	4114.4	174082.9	2207.3	26580.3
			⊥B	2180.5	96411.8		
60	30	72	⊥L	4937.3	208899.5	2593.7	35335.8
			⊥B	2036.4	92989.9		
70	30	72	⊥L	5760.2	243716.1	2980.0	45876.7
			⊥B	2000.4	93512.2		
40	40	72	⊥L	3291.5	140123.6	2392.7	22237.6
			⊥B	3291.5	140123.6		
50	40	72	⊥L	4114.4	175154.5	2899.1	30663.3
			⊥B	3147.5	137314.0		
60	40	72	⊥L	4937.3	210185.4	3405.4	40235.5
			⊥B	3003.4	134504.4		
70	40	72	⊥L	5760.2	245216.3	3911.7	50954.1
			⊥B	2859.3	131694.8		
80	40	72	⊥L	6583.1	280247.2	4422.2	62819.3
			⊥B	2715.2	134433.7		
50	50	72	⊥L	4114.4	178216.2	3509.0	34746.3
			⊥B	4114.4	178216.2		
60	50	72	⊥L	4937.3	213859.5	4119.0	45135.1
			⊥B	3970.3	176019.0		
70	50	72	⊥L	5760.2	249502.7	56670.3	56670.3
			⊥B	3826.3	173821.7		
80	50	72	⊥L	6583.1	285146.0	5344.0	69352.1
			⊥B	3682.2	178560.0		

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REFERENCES

[1] Frederick S. Merritt and Jonathan T. Ricketts, "Building Design and Construction Handbook", 6th Edition, McGraw-Hill Companies , Inc., 2001.
[2] Stafford Smith, B and Coull, A " Tall Building Structures; Analysis and Design" By John Wiley and Sons, Inc. 1991.
[3] ASCE/SEI 7-05," Minimum Design Loads for Buildings and Other Structures", American Society of Civil Engineers, 2005.
[4] Zhou, Y., Kijewski, T.,and, Kareem, A.,"Along-Wind Load Effects on Tall Buildings: ComparativeStudy of Major International Codes and Standards", ASCE, Journal of Structural Engineering, Vol. 128, No. 6, 2002.
[5] Holmes, J. D., Tamura, Y., and Krishna, P., "Comparison of wind loads calculated by fifteen different codes and standards, for low, medium and high-rise buildings", 11th Americas Conference on Wind Engineering, San Juan., Puerto Rico, June 22-26, 2009.
[6] Shilu,N. G., and, Patel, H. S., " Computational Tool For Wind Pressure And Forces On A Multistory Commercial Complex", JERS, Journal of Engineering Research and Studies, Vol. II, Issue IV,pp.84-87, 2011.
[7] Suresh, P., Panduranga, R. B., Kalyana, R. J. S., " Influence of diagonal braces in RCC multi-storied frames under wind loads : A case study", International Journal of Civil and Structural Engineering, Volume 3, Issue 1, 2012.
[8] Srikanth, I., and, Krishna, B., V.," Study on The Effect of Gust Loads on Tall Buildings", IJSCER, International Journal of Structural and Civil Engineering Research, Vol. 3, No. 3, August 2014.
[9] Weerasuriya, A. U., and, Jayasinghe M.T.R.," Wind Loads on High-Rise Buildings by Using Five Major International Wind Codes and Standards", Engineer: Journal of the Institution of Engineers-Sri Lanka, Vol. XLVII, No. 03, pp. 13-25,2014.
[10] Tony Yang, "Lecture Notes on Wind Loads" University of California, Berkeley, 2004.
[11] Iraqi Standards IQ.301 , " Iraqi Code for forces and loadings ", Iraqi Ministry of Building and Construction, 2014.
[12] Oral Buyukozturk ," Calculation of Wind and Earthquake Loads on Structures According to ASCE 7 & IBC " Lectures Notes, 2003.
[13] Ted Stathopoulos " Wind Codes and Standards : Fundamentals behind their Provisions" Concordia University, Montreal, Quebec, Canada
[14] Kishor G. Mehta and James Delahay " Guide to the Use of Wind Load Provisions of ASCE7-02" Published by ASCE, 2004.
[15] ACI-Code , "Building Code Requirements For Structural Concrete (ACI 318M-14)", American Concrete Institute, 2014.