

Impact of Wind Load on Large Plate Billboards

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Abstract:

This article describes how to analyze the impact of air loads on billboards, how to determine and modify input data, and how to determine the coefficients of iteration loop conversion in calculation of air loads between Vietnam and foreign standards. Show. In addition, this article provides information on calculating the various criteria for determining air cargo according to Vietnamese standard TCVN 27371995, European standard EN 1991-14 and American ASCE / SEI 705 billboard advertising with MathCad. Show calculation process. calculation software. Statistics for certain symbols are displayed.

Keywords: Large plate board construction, air load, texture, failure, standard I.

1. INTRODUCTION

With the current strong economic development, the construction of large boards is an effective and current way to market products to consumers. In our country of big cities and highways, national roads, ... overcrowding of big boards is being planned continuously due to the development of the advertising market. However, at the construction levels of our country, only the calculation of this type of construction has dropped to the standard, not to mention its features where under the influence of all kinds of load and impact, especially the impact of air load. That leads to the effect that after major storms, large plate boards, although elaborately designed and expensive, are still damaged and crumble, causing significant losses in many respects. Therefore, it is necessary to mention the special effects of distinct types of loads and impacts, especially the effect of air loads on this type of construction. First, it is necessary to redefine the construction of a large plate board. According to QCVN 17: 2013 / BXD, large board boards have a surface area of 40 m² or more [2]. Figure 1 shows an example of this type of construction.



Figure 1. Example of a large plate billboard

The construction of a large board is usually designed in the form of a two- or three-sided plate, one or two columns. In any type of building, this construction also has certain features where under the influence of the load, especially the air load due to the large air space, the small structure. In general construction structures and billboards, the impact of air loads is not the result of a single load but a combination of aerodynamic events, including consistent effects and dynamic effects. [3]

Strong impact creates instability, constant stress, and instability. Variable effects include limited amplitude oscillation and self-oscillating amplitude with increasing amplitude. Variations due to limitations include Vortex - vibration caused, rain - wind - vibration caused, oscillation due to gas buffeting and oscillation at the end of the wind (vibration caused by rising). A self-propelled oscillator group with an amplitude that increases indefinitely, means that in this vibration form the reaction produces an unusual gas energy that makes the structural reaction larger, generating unusual gas energy. and building demolition. The self-oscillating oscillator consists of two parts: oscillating for galloping and self-winding (flutter).

Vortex-induced vibration (Vortex - induced vibration) is a common type of vibration with large pieces of structure such as cable, chimney, tower, or circle. In a few cases, it causes oscillation due to the vortex gas working on the metal chimneys ... fluctuations in this will be influenced by phase formation over time [6]

Oscillation due to vortex may occur if:

- A piece structure has a cross section 10 to 15 times the width of the structure.
- A thin structure can be affected by eddy rotation if placed near buildings of overweight size.

Buffeting disorder is a random change in time and space. In large structures such as large plate boards, fluctuations due to vortex and wave motion significantly affect construction and need to be calculated separately for testing. Indeed, the impact of these events. However, the content of the article reflects only the statistical considerations in terms of standards and procedures for calculating standards but does not state the effect of these components on the carrying capacity of the advertising board.

1.1 THEORY

A. Correlation of parameters when calculating according to different standards

Currently, when calculating and designing large plate boards, it is found that this function is affected by several types of loads such as body structure, load during suspension, forced evacuation of bearings, storm loads and special types of loads such as explosives, earthquakes, etc. However, for the types of impacts, the impact of storms and wind loads significantly affects the features of the project. arranged in open spaces, on highways, on national highways. In the standard TCVN 2737: 1995, there are instructions for calculating specific air freight for diverse types of operations, however on large boards, some calculation parameters are not yet clear and specifically,

the effect of air load on this project should be compared with performance based on external standards. When using external metrics to calculate, it is necessary to properly understand the data input and the need to modify the data to suit the calculation features of each level used as a measure of wind speed, repetitive cycle, location, ...

1) Local form

Comparison of topographic form between TCVN 2737: 1995, EN 1991-1-4 and ASCE / SEI 7-05 (Table 1), found that there is a difference in the number of spatial forms, however, there are also common points, based on the description of the types of spaces according to standards, the form of the calculation of the board boards is a topographic C (ASCE) form. / SEI 7-05), form Terrain II (EN 1991-1-4) corresponds to type B (TCVN 2737: 1995), because large plate boards are located on highways, highways, and in open, airy, unprotected or protected by larger distances.

Table 1. Comparison of the types of terrain specified in different standards

GEOGRAPHIC FORM					
STANDARDS	TCVN2737: 1995	A Empty, no, or very few obstacles H<1,5m		B Empty, sparse obstacles <H<10m	C Mostly shielded, many obstacles H>10m
	EN1991-14: 2005	0 Sea, coast	I Lake, flat area, unobstructed	II Grass, single obstacles, separated from each other about> 20H	III Grass, single obstacles, separated from each other <20H
	ASCE/SEI 7-05	D Airy, beach		C Airy, rural H<9,1m	B City

1) Speed of winds

Determine the wind speed by region, then apply to calculate the impact of wind load on the project under consideration in that area. Wind speed depends on time, so the average time of wind speed and the period of recurrence of the cycle will affect the average wind speed value.

Different standards regulate the time taken for the average wind speed and the repeat cycle to calculate the average wind speed value.

The basic wind speed V_0 is the average velocity over a period of 3 seconds that exceeds 1 time within 20 years (TCVN 2737: 1995); 10 minutes - 50 years (Eurocode EN 1991-1-4), 3 seconds - 50 years (USA, Australia).

According to the Durst curve (Figure 2), figure C6-4, ASCE / SEI 7-05 can convert the average 10-minute wind speed to the 3s wind speed as follows: From this curve we have: $k_{v_{10mins}}=1.065$; $k_{v_{3s}}=1.525$

$$k_{cd} = \frac{1.065}{1.525} = 0.698$$

So inferred the relationship between the average wind speed over a period of 10 minutes and 3 seconds is:

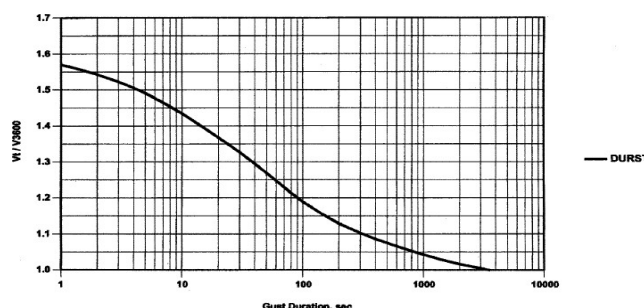


FIGURE C6-4 MAXIMUM SPEED AVERAGED OVER t_g TO HOURLY MEANS SPEED

Figure 2. Convert the maximum average wind

spe
ed
in

2) Cycle loop

According to QCVN 02-209 BXD, we have a table to

convert wind speed from a cycle of 50 years to other iteration

cycles as shown in Table 2.

Thus, the relation of wind speed with the repetition cycle of 20 years and the cycle of 50 years is as follows:

$$v_{50y} = \frac{1}{0.91} \cdot v_{20y} \quad (3)$$

Where, v_{50y} - the average wind speed over a period of 3 seconds with the cycle of 50 years (ASCE/SEI 7-05).

Average wind speed over a 10-minute period with a 50-year iteration cycle (EN 1991-1-4):

$$v_{50y_10mins} = v_{50y} \cdot k_{cd} \quad (4)$$

Table 2. Coefficient of conversion of wind speed from 50-year repeat cycle to other iteration cycles [2]

Repeating cycle (year)	5	10	20	30	40	50	100
Transfer factor	0.78	0.85	0.91	0.95	0.98	1.00	1.06

From (4) there is a change in the average wind speed value from TCVN 2737: 1995 to EN1991-1-4 and ASCE / SEI7-05 presented in Table 3

Table 3. Conversion of average wind speed value from TCV 2737: 1995 to EN1991-1-4 and ASCE / SEI7-05

Wind pressure zone on the map		I		II		III		IV	V
		IA	IB	IIA	IIB	IIIA	IIIB		
Speed (m/s)	TCVN 2737:1995	29.95	32.56	36.8	39.37	42.36	45.16	50.29	54.94
	ASCE/SEI7-05	32.91	35.78	40.44	43.26	46.55	49.62	55.26	60.37
	EN 1991-1-4	22.99	24.99	28.24	30.21	32.51	34.66	38.59	42.16

B. . Some notes when calculating the effect of wind loads on large billboards according to EN1991-1-4 standards and ASCE / SEI 7-05

1) According to EN1991-1-4 standards

Standard EN 1991-1-4 defines the coefficient of wind pressure change according to altitude and topography based on the logarithmic wind speed profile and considers many distinct factors such as:

* Terrain coefficients o_r (formula 4.5) and intensity of tangles $I_v(z)$ at the height of the project:

* Structural coefficient c_{scd} , formula 6.1:

$$c_{scd} = \frac{1 + 2 \cdot k \cdot I(z) \sqrt{B^2 + R^2}}{1 + 7 \cdot I(z)} \quad (5)$$

$$p = q \cdot G \cdot C_p - q_i \cdot (G C_{pi}) \quad (6)$$

- Low-rise building, determined by the formula:

$$p = q_h [(G \cdot C_{pf}) - (G C_{pi})] \quad (7)$$

- Soft texture, determined according to the formula:

$$p = q \cdot G_f \cdot C_p - q_i \cdot (G C_{pi}) \quad (8)$$

- Retaining wall, calculated according to the formula:

$$p_p = q_p \cdot G \cdot C_{pm} \quad (9)$$

Standard ASCE / SEI 7-05 defines high-rise buildings or structures with a height of 4 times the horizontal dimension or the cause of natural oscillation frequency less than 1Hz (small oscillation cycle more than 1s) is considered a soft

structure, so billboards will be calculated according to the formula (6-19) of the ASCE / SEI 7-05 standard.

When calculating the standard wind load, note the following factors:

+ The peak coefficient, determined by the ratio between the maximum value of the reaction part and its standard deviation, formula B.4;

+ The ratio of tangled length indicates the average shock strength of natural winds $L(z)$, determined according to formula B.1;

+ Base coefficient B , regardless of the relationship has not been considered pressure on the surface texture, B.3.

+ Coefficient of resonant response, regardless of the resonant oscillation form turbulence with consideration of the structure, formula B.6

2) According to ASCE / SEI 7-05 standards

Standard ASCE / SEI 7-05 stipulates that the designed wind load is specified for each type of structure, different works and divided into 4 types of construction.:

Stiffness structure with all types of height, determined by the formula :

* I_z , turbulent wind density at high level $z = 0.6h$ (h - work height)

* GC_{pi} , Wind pressure coefficient in the house, based on the type of construction cover.

* C_p , the external pressure coefficient depends on the wind direction acting on the building.

* R , resonant component of texture top displacement.

* The coefficient refers to the effect of wind gusts G_f ((The first individual oscillation frequency is less than 1), is considered depending on the type of stiffness structure or elastic structure.

Thus, the standard EN1991-1-4 and ASCE / SEI 7-5 calculate the impact of wind on billboards in particular and construction works in general, including many parameters and accuracy of the characteristics of wind load impacts than TCVN 2737: 1995.

C. Block diagram of wind load calculation according to TCVN2737: 1995, EN1991-1-4 and ASCE / SEI 7-05 with MathCad programming software

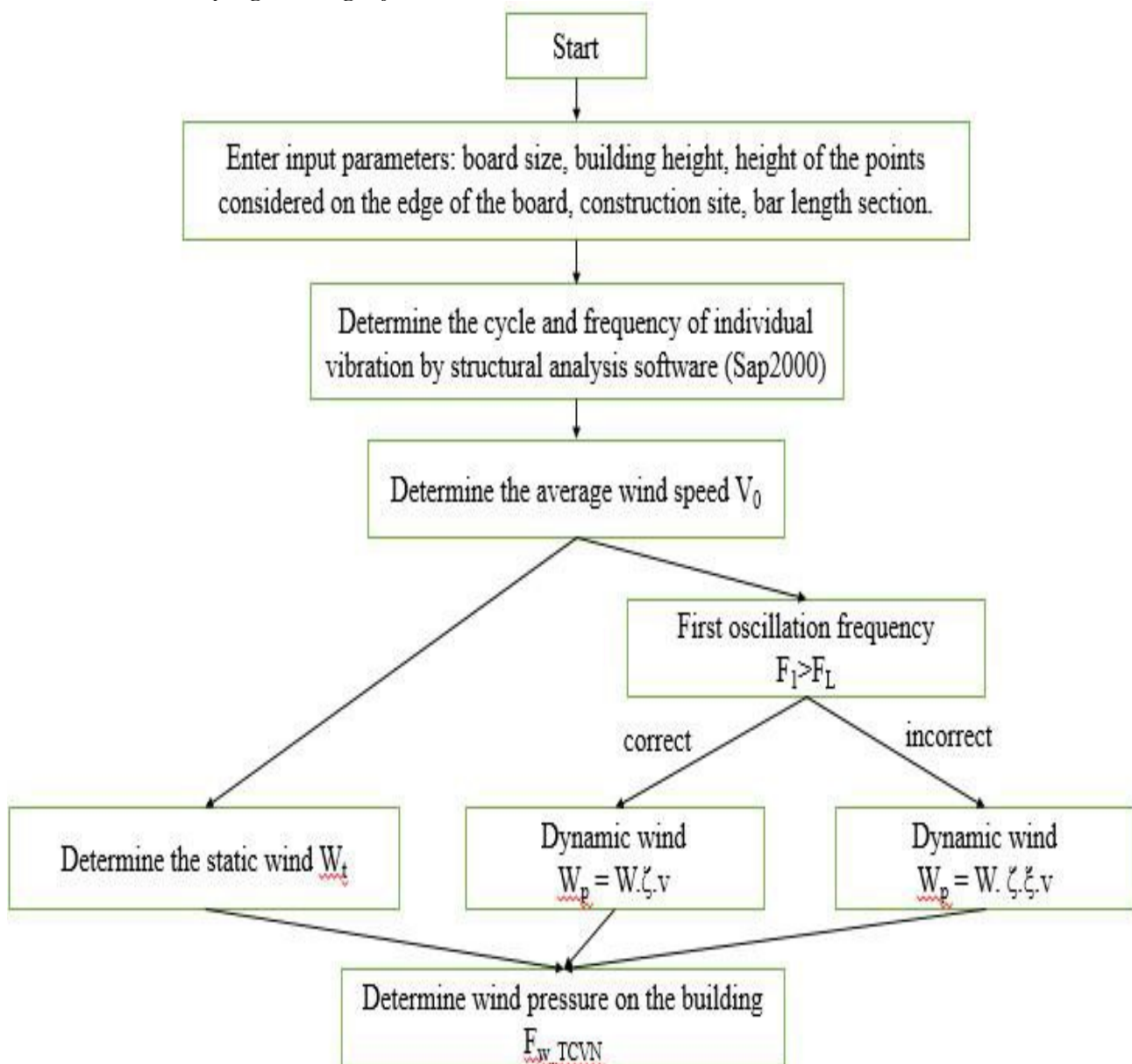


Figure 3. Block diagram for calculating wind pressure on billboards according to TCVN 2737: 1995 by MathCad software

Similarly, set up a block diagram to calculate wind pressure on billboards according to EN1991-1-4 and ASCE / SEI 7-05 standards with MathCad software shown in Figure 4 and Figure 5.

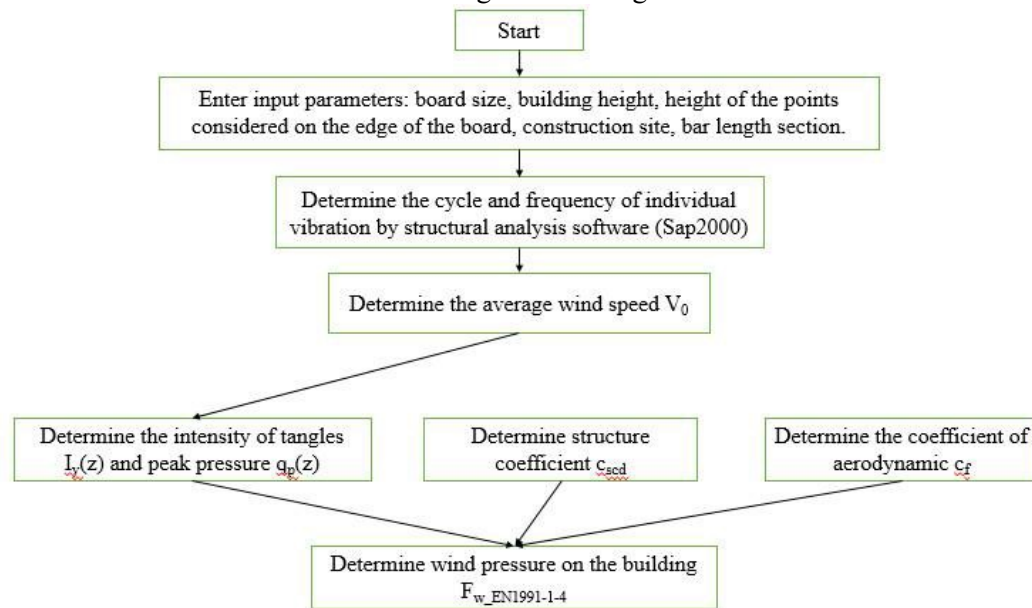


Figure 4. Block diagram for calculating wind pressure on billboards according to EN1991-1-4 by MathCad software

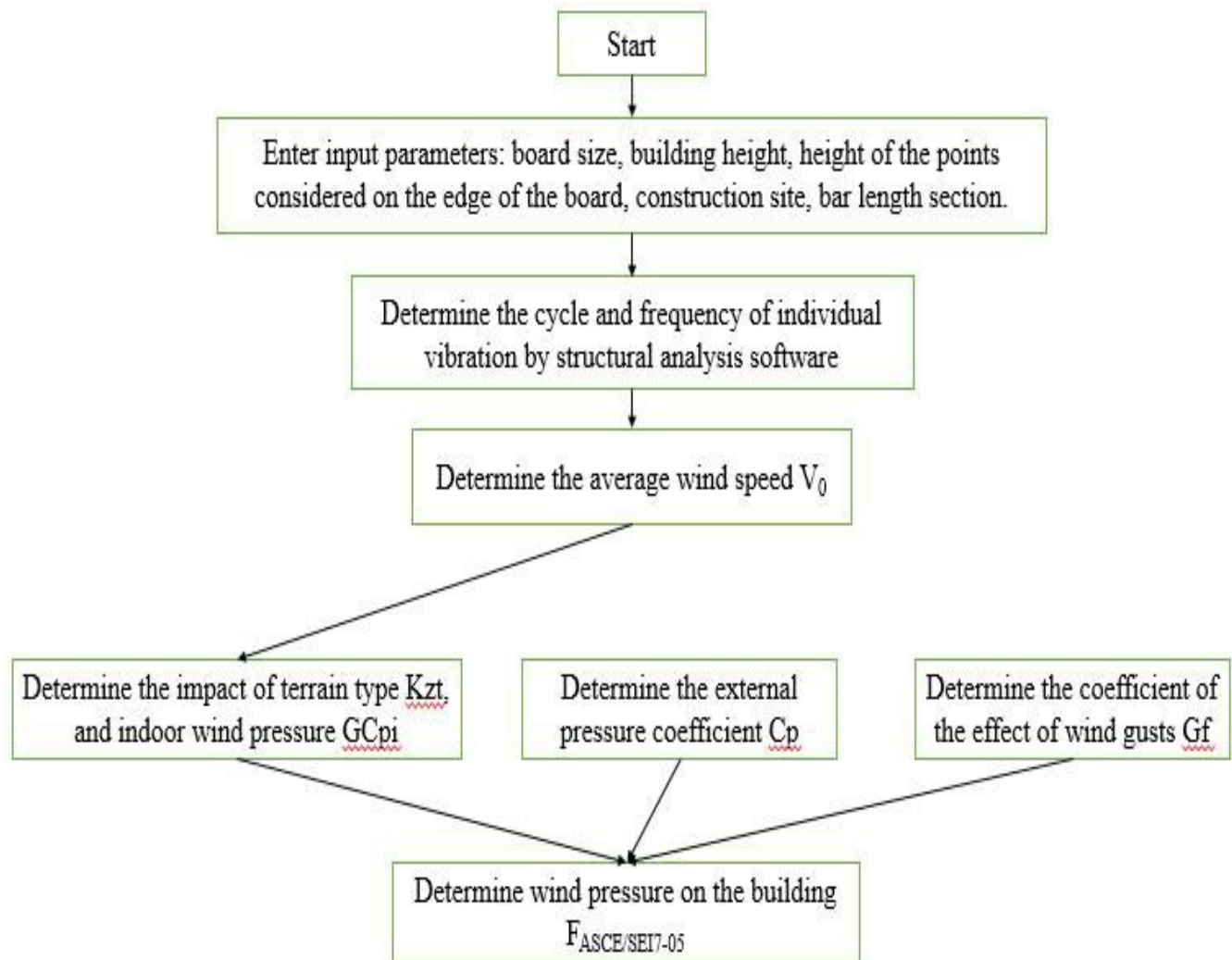


Figure 5. Block diagram for calculating wind pressure on billboards according to standard ASCE / SEI 7-05 with MathCad software

2.0 RESULT AND DISCUSSION

According to the order of calculating the wind pressure on billboard works shown as block diagram as shown in Figure 3 and Figure 4, the author has conducted the billboard construction with the size of 18x9m, height of 27.2m, and location Construction site in Da Nang city, wind zone IIB, billboard structure is shown in Figure 6.

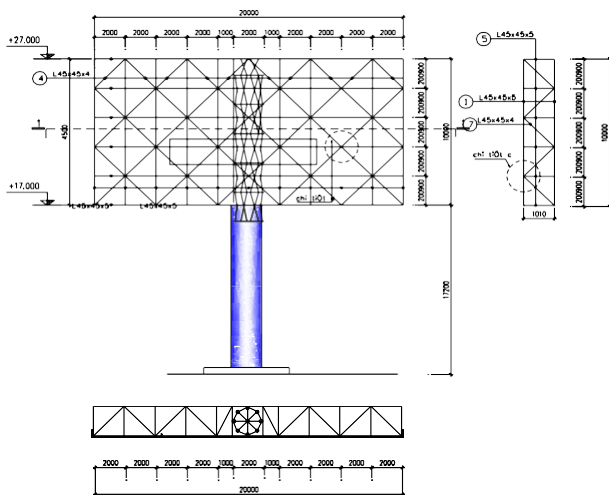


Figure 6. Example of a billboard

Based on the subprogram set by MathCad calculation software. Calculation results are shown in Figure 7.

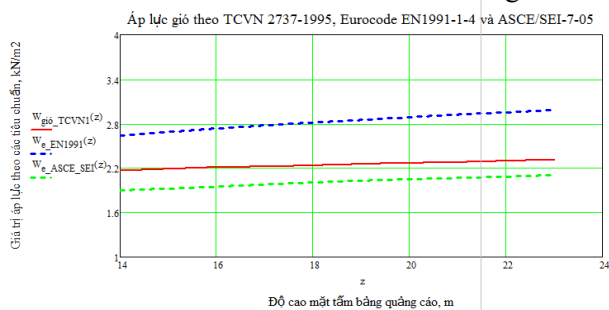


Figure 7. Results of calculating wind pressure on a billboard according to standards re

From the calculation results, it is found that the value of calculated wind pressure according to TCVN2737: 1995 and according to EN1991-1-4, ASCE / SEI7-05 is different due to European standards EN1991-1-4 and pepper American standard ASCE / SEI 7-05 considers many characteristics of wind load than TCVN 2737: 1995.

When calculating the wind load on a billboard project, according to EN1991-1-4, depending on the size of the construction, the change in wind pressure according to height and terrain type will be adjusted to each height section of the construction based on reference values. In TCVN 2737: 1995 and ASCE / SEI 7-05 does not consider this factor, so the distribution of wind load acting on the construction according to height according to EN1991-1-4 is more different than that of TCVN 2737: 1995 and ASCE / SEI 7-05.

TCVN 2737: 1995 when calculating wind load separately separated static and dynamic components. With standards EN1991-1-4, ASCE / SEI 7-05, in addition to static components have considered the impact of dynamic components by including the formulas for calculating the impact coefficient depending on the type of terrain and characteristics in the dynamic reaction of the structure.

3.0 CONCLUSION

The article provides some contents related to calculating the impact of wind load on billboards, when applying foreign standards to calculate for this type of construction, it is necessary to convert the parameters accordingly. The article presents the calculation results according to TCVN2737: 1995, EN1991-1-4 and ASCE / SEI 7-05 in the subprogram established by Mathcad programming software and the wind pressure calculated standards have significant differences. Therefore, when calculating the design for large plate billboards under the impact of wind load, there must be a Comparison between different standards to have more accurate assessment which will bring higher reliability in the process of designing and calculating buildings

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