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## **WHICH IS THE DIFFERENCE BETWEEN SEISMIC FORCES AND WIND FORCES?**

### **1. Introduction**

A difference of the vertical forces acting on a structure (due to their weight and use), the wind forces and seismic forces act horizontally. If so, is there any difference between each other? The answer is yes and there is a vast difference between each other. This short article seeks to clarify these differences in the simplest way possible. First of all remember that it is a structure.

### **2. What is the function of a structure?**

The function of a structure is to transmit forces. In other words, the forces "travel" through the structure from its point of application to the ground (Figure 1).

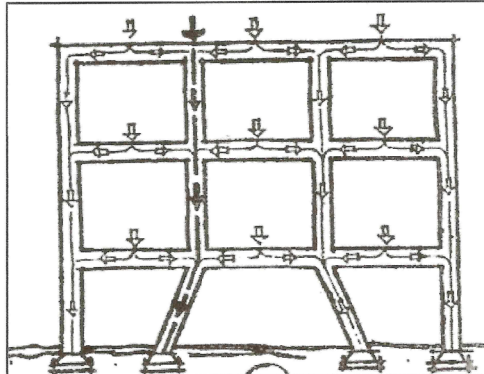


Figure 1<sup>(1)</sup>. Transmission of forces in a structure

### **3. Types forces**

A structure is subjected to many kinds of forces. In simplified form could be grouped into two types:

- **Vertical forces**, which are due, for example, to the weight of the structure and because it don't move are called dead loads (Figure 2.1) and those due to persons, goods, that being mobile, are called live loads (Figure 2.2).

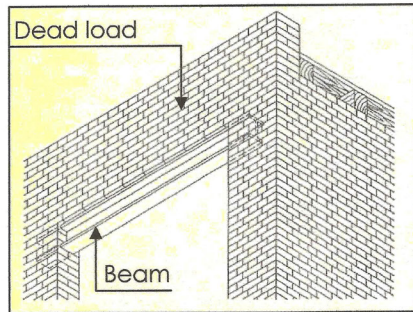


Figure 2.1

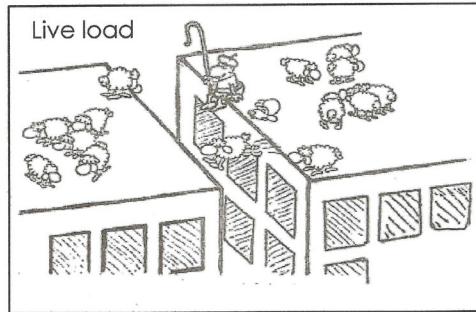


Figure 2.2

Figura 2<sup>(2)</sup>. Vertical forces

- Horizontal forces, which are due, among others, to the wind (Figure 3.1) or earthquakes (Figure 3.2).

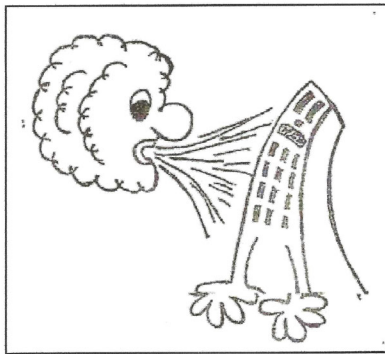


Figure 3.1. Due to wind

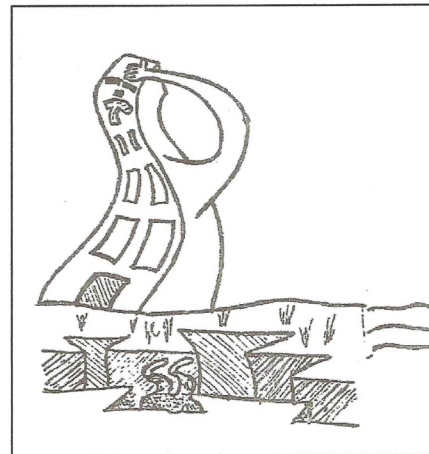


Figure 3.2. Due to earthquake

Figure 3<sup>(2)</sup>. Horizontal Forces

#### **4. How are these horizontal forces determined ?**

Although the calculation of the magnitude of the forces specified is complex, in order to understand their determination we will express them in terms of the principal parameter:

The horizontal forces due to earthquakes are proportional to the weight  $W$  of the structure:  $F_s \propto W$  (1)

The horizontal forces due to the wind are proportional to the effective area  $A$ , i.e. the area exposed to the wind:  $F_w \propto A$  (2)

#### **5. What differentiates these forces?**

The most important is to observe that in, equations (1) and (2), the seismic forces  $F_s$  mainly dependent of the weight " $W$ " of the building, but not so the wind forces  $F_w$ , which have nothing to do with the weight of the structure but the area that is exposed to the wind " $A$ ". Although the distribution of forces due to wind is complex (Figure 4<sup>(3)</sup>), the building codes, in simplified form, specify equivalent uniform loads applied to be considered on all exposed (Figure 5<sup>(4)</sup>).

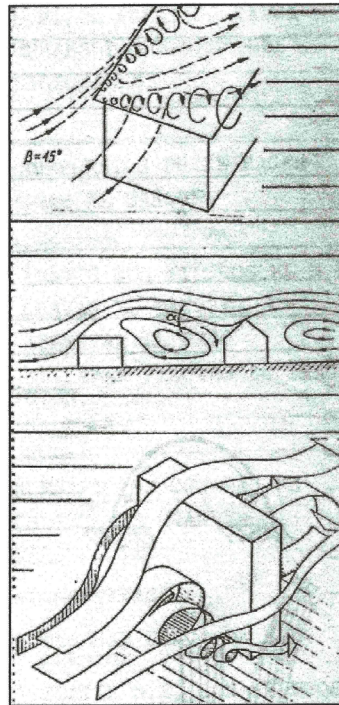


Figura 4<sup>(3)</sup>. Wind effect on structures

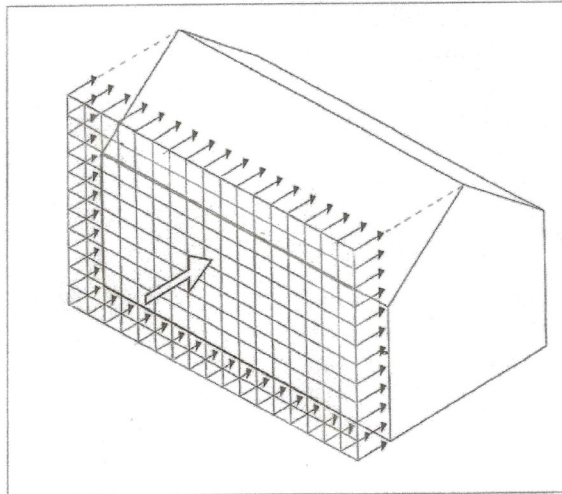


Figure 5(4). Uniform load due to wind force acting on a structure

At this point it is worth to mention a situation we've all experienced when the wind is strong. Intuitively, knowing nothing of structures, we curve us and what we're looking for, there is nothing different to reduce the area exposed to the wind and thereby, reduce the force that the wind exerts on us.

Having understood the difference between the seismic forces and wind forces, occasionally the question arises if in an earthquake zone, should be or not considered the stresses due to wind. The following example tries to provide answers to this question.

#### **6. Object lesson**

To understand the above concepts, consider the case of a tower for advertising in a mall. The project included placing the advertising of the mall at the top of the tower as shown in Figure 6.1, which was designed structurally for that condition. Over the years, it was decided to make a seasonal promotion that would involve all the stores and decided that he was going to "cover" the structure with a very light and durable plastic, which should contain the names of warehouses and other commercial messages. (See Figure 6.2)

A quick review of the structural engineer showed the project to cover the tower could not be done. Designers puzzled asked what was the reason, if the fabric weighed very little and the answer is simple: Indeed from a security standpoint, seismic issues are not a problem, because the increase in weight due to the fabric is extremely small and therefore variation in seismic forces are negligible and are covered by the safety factors. But, with the forces due to wind, the situation is different, because the area exposed to the wind, which was use for the design of the tower, was  $6.0 \text{ m} \times 2.5 \text{ m} = 15.0 \text{ m}^2$  and with tower covered the exposed area would become  $28.0 \text{ m} \times 2.5 \text{ m} = 70.0 \text{ m}^2$ . In this way in simplified form, we can write

the following relation:

$$\frac{\text{wind force acting on the tower in seasons}}{\text{wind force acting on the tower according structural design}} \propto \frac{70,0 \text{ m}^2}{15,0 \text{ m}^2} = 4,6!$$

In other words, the force that would act on the covered tower would be 4.6 times that of the tower design and inevitably will fail, since this increase exceeds safety factors.

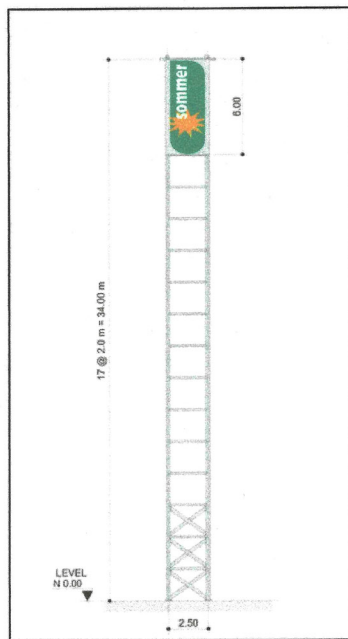


Figure 6.1. Initial situation

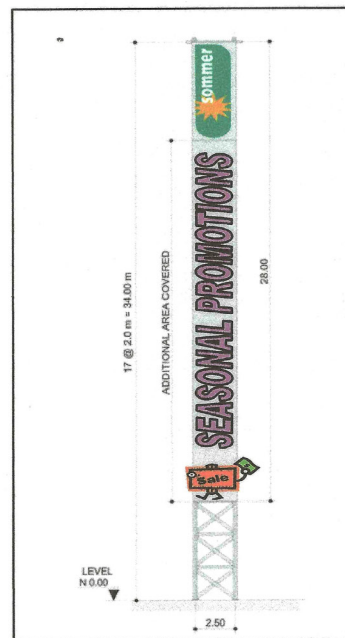


Figure 6.2. Situation in seasons

(Note: Sommer and Sale, are images taken from the Internet)

## 7. Conclusion

Seismic forces and wind are very different in nature, and therefore, for each project both must be considered and analyzed to find which control the design.

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