Floating Common Foundations for Multiple Building Structures (FCF-MBS)

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Abstract

In this endeavor we proclaim a new insight into the thematic of protecting constructions against earthquakes. In this context, we develop a hopeful initiative point of view for the foundation of multilevel buildings. Thus we proceed in the restructuring of foundations of buildings composing district (urban) blocks. The principal statement of this rethinking consists of the transition from the part to the whole and results in the formation of Floating Common Foundation in relevance to Multiple Building Structures (FCF-MBS). The overall gain and advantage of this effort is the reduction of seismic stress by a critical factor $N$. The factor expresses the participation fraction of each distinct building into the compact block. Advantages and feasibility of the method with the assumption of secondary constructive agents are also cited. The evaluation of the work elucidates the points of FCF-MBS and efficiently illustrates the benefits of it.

Keywords: floating foundation, common foundation, seismic voxel, seismic differential, seismic arc.

1 Introduction

The challenging of earthquakes is one of the more ancient on Earth, with relative heavy loss of humane lives. Therefore the hopeful solutions of the earthquake frame might be equivalently enormous and huge according to their design and consequent implementation.

Earthquakes originate the field of sciences which assumes the framework of protective shield against the power of nature. Although it is common place that traditionally the object of such a transaction falls into the matter of civil engineering, the impact of diverse scientific areas on the previous framework is
evident too. Ad hoc, we may refer physics, vibration engineering, signal processing (e.g. the description of seismic waves [1]), simulation engineering etc.

Initially we may state that an attempt to completely vanish the total effects of inner earth movements is evidently impossible. Thereof we should constrain our focus on the major reduction of the undesirable effects of earthquakes.

In this context we develop by synthesis a new approach to the construction of multilevel buildings. The term ‘new’ refers both to the creation of distinct buildings along with the integration of them through the modification of the identification of multiple structures. This process results in the adoption of discrete multiple constructions with common foundation. We name this referential scheme as Floating Common Foundation for Multiple Buildings Structures (FCF-MBS). The analysis of the proposed structure -as well as the anticipated advantages of this endeavor- is cited in this paper.

2 The model of seismic forces

Throughout our propositional statement we adopt the idea of transit and substitution of seismic forces and behavior from the part to the whole.

However, throughout the history of Earthquake Sciences diverse models of Earth’s seismic activation and behavior have been proposed in bibliography [2,3]. The representation of seismic forces and the adequate forces models are established according to the variable environment of seismic action and of course due to the inherent process of earthquake genesis [4].

In order to transact our structural presentation we assume the suitable model of seismic forces’ distribution. We consider thus the underground focal place of an earthquake. This is assumed to be a concrete volume of computable extent in the inner of Earth planet. Otherwise, this area could be seen as volume differential \((dV)\) or volume element (voxel) of the Earth sphere (Fig. 1).
We introduce thus the term \textit{seismic voxel}.

The seismic forces drawn from the focal voxel are dispersed throughout the inner mass of Earth and distributed across the relative arc on the surface. Progressing so, we may say that the seismic wave (the assembly of seismic forces) forms a curved front edge with curvature depending on the depth of the focal voxel and the curvature of Earth. The surface seismic arc of this model is

\[
\alpha = \sigma * R_{\text{EARTH}}
\]  

3 The common multiple foundation

In the context of the previous paragraph, we elucidate the transition of seismic forces from the part to the whole, as a hopeful step in the vital, somewhat ambiguous and huge effort to sustain earthquakes [5].

Henceforth we invent the incubation of units into the concrete ensemble of block structures. The main conception of this innovation is given in the following description.
We promote the construction of urban building blocks using common processes. Thus, instead of using separate foundation for each building, we may assume common foundation for multiple buildings, lying in the same block (Fig. 2). This conception creates the sense of floating structures, while each building is incubated into a concrete platform on the terrestrial surface.

The most important and initiating point of this assumption is based on the dispersion of seismic forces onto the common foundation or equivalently the transition of the seismic load from one building (Fig. 2(a)) to the enormous block of buildings (Fig. 2(b)) (from the part to the whole). The seismic wave with the curved front edge crashes onto the common foundation - which has wider extent
and huge volume- instead of facing the weaker foundation of one sole building. Equivalently, the forces of the seismic wave instead of totally crashing one building they are distributed across the common foundation of multiple buildings.

In Fig. 2 we illustrate the two cases: (a) the conventional case with independent foundation for each building and (b) the proposed one which assumes common foundation. We may observe on this figure that the concrete interlaced between buildings in FCF-MBS plays the role of connective slabs for those buildings [6].

In the following section we analyse the prosperous and vital results of the aforementioned common foundation.

4 Improvement of static behaviour

The main gain of the herein proposed construction methodology is the enhancement of static behavior regarding the buildings incubated in FCF-MBS.

As a result, each (multilevel) building will face the power of seismic action not as a distinct object, thus sustaining the overall effect of this action (symbolized as F); instead, the building will suffer a total influence of seismic load which shall be a fraction of the overall seismic impact, that is \( F/m \) (m is arbitrary but measurable).

The coefficient \( m \) stands for the fraction of seismic force reduction, regarding a distinct building. Generally \( m \) should deserve thorough analysis and evaluation. Nevertheless, this coefficient could be stated that it tends to \( N \). The factor \( N \) expresses the ratio of foundation’s enlargement, i.e. the inverse of the portion of foundation belonging to the specific building. We may thus form the dynamic equation of FCF-MBS

\[
F_s = \frac{F}{N}
\]

\[
N = \frac{V_t}{V_s}
\]

The symbol \( F_s \) stands for the force stressing a distinct building [7], while \( V_t \) and \( V_s \) are the total and single foundation volumes regarding the block and a distinct building respectively.

In Fig.3 we illustrate in details the aforementioned process of seismic forces dispersion and the consequent symbolism and metrics. The given herein illustration is arbitrary, and diverse, variable forms and structural views of FCF-MBS should be anticipated, freeing consequently the critical thought and creativity of an engineer. Therefore, the inherent freedom degrees of the proposed construction statement could be exploited by the designer engineer.

5 On the feasibility of the method

Our presentation into the previous sections and paragraphs follows the scheme (Fig. 4). We have also mentioned that the enormous magnitude of the seismic
phenomenon, with the prosperous and reflectively relative losses, deserves the development of huge but realistic tools and manners in order to reduce or even overcome the discontinuous behaviour of the Nature [8]. Moreover, relatively huge should be the expenses of constructing these solutions. The latter remarks are drawn from the realistic environment of a seismic context.

![Figure 3: The dispersion of seismic forces on the common foundation.](image3)

![Figure 4: The block diagram of seismic process.](image4)

Although, the invented herein design statement for seismic protection, i.e. the FCF-MBS perspective, seems to – and it is indeed – enormous in size, we shall easily conclude that it can be feasibly implemented without dramatic increase of the overall expenses of construction. However, we proclaim that the most efficient positive results could be acquainted when a concurrent common structure of the buildings block shall be anticipated. The latter is not definitely prohibitive. Nevertheless it is feasible and evokes as a crucial definition of potential and optimal construction. However, in cases where the aforementioned, imposed common building structure is not evident –due to e.g. the existence of older buildings- the common floating foundation could be implemented by hybrid techniques. Ad hoc, the incubation of the existent structural units could be transacted into the floating foundation.
Intrinsic elements of the proposed methodology should be concerned according to the implementation of it. Moreover, additional secondary statements, provisions or elements should be examined, negotiated, adopted and connected to it.

Among these profound characteristics of FCF-MBS, we might concern the increase of flexibility according to the optimisation of floating aspects in common foundation. We may thus propose into this context, the complementary use of polymers or caoutshouk which should wrap the part of the common foundation belonging to a distinct building. These secondary agents enhance the term and the identity of floating. Additionally they introduce major flexibility and tolerance for each structural unit, while they provide increasing isolation to Earth’s actions. Therefore, two choices of FCF-MBS implementation are formed: (a) concrete common foundation sustaining and dispersing the seismic action of Earth, and (b) floating common foundation with wrapping polymer agents, giving isolation and flexibility to each structural unit.

6 Conclusion

The herein presented thematic of constructions incorporates the following stages:

(1) Assumption of the seismic voxel in the force model.
(2) Inaugural compact massive foundation of building blocks.
(3) Common consideration of multiple multilevel structures.

Furthermore, designers and constructors may adopt additional secondary and profound use of structural cooperative elements. The latter agents could enhance the flexibility of each building and the overall floating characteristics of the proposed methodology. The assumption of common structural foundation exploits the principle of unification which results to the distribution of violent, undesired seismic forces. The anticipated major advantage is the increase of structures’ tolerance against seismic actions.

References

