Buletinul Ştiinţific al Universităţii "POLITEHNICA" din Timişoara

Seria HIDROTEHNICA
TRANSACTIONS on HYDROTECHNICS

Tom 58(72), Fascicola 2, 2013

The V-Shaped Columns

Ana-Maria TOMA[1] Aneta STANILA[1] Oana STANILA[1]

Abstract: This paper presents the usage of V shaped columns in building the supporting elements of structures. The authors underline the diversity and the structural elements of V shape used as parts of very beautiful and durable structures.
Keywords: V shape, column

1. INTRODUCTION

The aesthetic aspect of a construction is given by many elements, including the shape of the structural elements, like the V shaped column. This shape was used by structural engineers based on technical considerations, the aesthetics of it being just a plus. From the static point of view, the V shaped column follows the efforts diagram. This shape helps the structure become more alive, making it part of the environment.

This paper presents the V shaped column, pointed downwards on a punctiform support. This shape is in contradiction with the supporting columns, which have a big base and grow slim towards the top, considered the equilibrium in nature. In architecture, the V shaped column pointing to the top is a logical consequence of the statics. Compared to that, the V shaped column pointing downwards gives the impression of an exception from the statics law. Knowing that, this type of shape is built as having a very valid static point of view and becomes a piece of art in the same time.

The V shaped column can be met as being a part of a frame, as an independent column, with an eccentric support, with a cantilever, forked or as a flared support.

2. V SHAPED COLUMN TYPES

When the V shaped column is used as part of a frame, the efficiency of such a structure depends on: the strength of the materials, the rigidity of the corner hinges and the frame to be joined, preventing the displacement of the frame. As materials, the most commonly used are the steel and reinforced concrete. In case of a frame with two or three hinges the usage of V shaped columns is fair, in comparison with the frame without hinges, where they have no purpose. Next, there are some examples of structures which use the two hinges frame:

The bridge from Fig.1 has its span covered by a minimum usage of materials. As the beams of the bridge are narrower, the free height under the bridge becomes bigger and the self weight of the structure gets smaller.

Fig.1. Reinforced concrete bridge, [8]

The narrow shape of the beams is due to the rigidity of the frame corners made with the columns. The high rigidity is given by the big thickness of the columns compared to their length. It is obvious here that the bearing capacity is very high due to the fact that the bridge beam works together with the massive bridge column. Anywhere a big span or a high transversal rigidity of a high building is needed, the frame structure is the best solution. If the frame needs to have joints at the base, the V shaped columns are the best. The base of a multistory building is the right place to have frames using V shaped columns.

UNESCO Palace from Paris, designed by Nervi, contains one of the most interesting solutions of this kind, Fig. 2.

The inclination of the frame columns and the V shape underline the special function of the base floor. The superior floors are provided two rows of columns, placed inside that transmit all the loads to the base floor, in the corners of the two hinge frame.

[1] Technical University „Gheorghe Asachi" of Iasi, Department of Graphics, street Bld. Mangeron, Iasi, Romania, anetastanila@yahoo.com; anamtoma@yahoo.com; oana.stanila@yahoo.com

a

b

Fig.2. UNESCO Palace from Paris, [6]

The loads are transmitted downwards, as vertical loads, without producing important bending moments. The shape and the function of the bas floor frames are conditioned by the wind forces, for maintaining the transversal rigidity of the building. Nervi said that his every project results from the knowledge of the loads distribution and from searching a more simple and economical structural shape. In his projects mostly appear very rigorous results coming from a very clear static function, [1].

The buildings having the superior floors outside compared to the base floor have the V shaped columns with eccentric support. The shape of the building determines a bending moment that needs to be balanced with another equal moment. The resulting turning force is discharged through the anchorage in the first floor plate, which needs to be assured against lateral displacements. These are the premises of the V shaped columns with eccentric support. In order for them to be equilibrated they need to be anchored towards the back. If two V shaped columns are symmetrical, in case of vertical loading, they get to equilibrium.

Le Corbusier used this characteristic in designing of a few tall buildings.

The apartment building from Berlin, Fig.3, has the superior floors from load bearing walls which take the loads from the horizontal plates. At the base floor, the walls were transformed in V shaped diaphragms, inclined towards the interior and the exterior, alternatively, creating the feeling of space. In each and every bay there is a perfect symmetry.

Fig.3 Apartment Building from Berlin, [5]

The outward inclined supports are anchored between themselves, like the inward supports lean on each other, as support. For the wind load, all the elements of the structure work together, like a very rigid spatial construction.

The V shaped column transforms, in some cases, together with the cantilever that it sustains into a totally different structure. Its efficiency comes from its undeformed angle. The V shaped column with a cantilever is used in good conditions for building sun blinds, if there is another important building in the back, for support. When the separation between the sun blind and the building is made very clear, and the joining device is highlighted, the structure becomes very graphic and expressive, as in Fig.4.

Fig.4 V shaped columns with cantilever, [6]

The rigid joining of a V shaped column with a cantilever construction is usually used for arena roofs. If the back joint is replaced by a front support, the loads diagram and the moment distribution remains the same. Not even lowering the point of support changes the static system. The cantilever roofing together with a V shaped column constitutes a new static system.

The Caracas Stadium Arena from Venezuela uses the system presented before, as it can be seen from Fig.5.

a

b

Fig.5 Caracas Stadium Arena from Venezuela

The shape of the columns follows the bending moment diagrams and underlines the importance of the inclined beam support point. The bending of the column represents an improvement of the shape. The whole structure is based on a supporting element that provides total stability.

The Florence Stadium Arena, from Italy was designed by Nervi, Fig. 6.

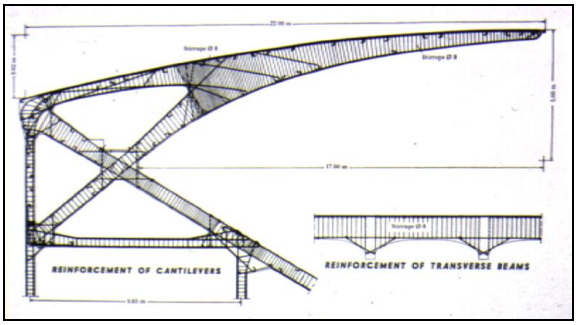

Fig.6 Florence Stadium Arena, from Italy, [1]

In this case, the V shaped column and the cantilever has been transformed into a triangular system. Having the construction as a truss system has an esthetic purpose and an economic one as well. At the corners where the trusses join into an oblique angle, the merging was problematic. The quality of the construction is good due to the structural clarity and the cooperation between the construction, shape and function.

The V shaped columns as a truss system lead to the separation of the column into two marginal bars, hence becoming the forked column.

The forked column is jointed at the base and has its fork upwards, from the constructive point of view being still a V shaped column, following the same static lows.

Architect O. Niemeyer uses the forked columns at the base floor of the multi storey buildings, as it can be seen in Fig. 7a and detail in b, [2].

The forked columns have an acute coning, they widen towards the supporting point of the fork angle and the base support becomes wider. They are strongly anchored into the foundations, [3].

a

b

Fig.7. Forked columns at the base floor of the multi storey building, [7]

Respecting the load diagram leads to a new, true structural form. The forking of the column could begin at a certain height, the ending result being a Y shape column.

The Olympia Sports Palace from Rome, Italy was designed also by Nervi and has the columns of the same structural shape, Fig.8 a and b.

a

b

Fig.8. Olympia Sports Palace from Rome, Italy, [4]

All the component elements of the columns have a conical shape. The result is that all the joints between the columns and the bars are rigid. The Y shaped columns each of them a rigid system, brought together form a spatial structure of high rigidity. In the upper side, the skylight creates a very pleasant impression. The functionality, the structure and the form creates, in this case, a unity of the purpose.

3. CONCLUSIONS

In this paper, the authors would like to underline the fact that only the artistic inspiration cannot give a trustworthy strong structure. Any inspiration should come with a rational technical background to support it. Only the research of the fundamental laws of the loads mechanics could bring to life strong and authentic structures. In the beginning, the shape of the structures was in a very strong connection with the formalism era.

REFERENCES

[1] *C., Siegel,* Structures of modern architecture, Editura Tehnica, Bucuresti, 1968.
[2] *C., Siegel,* Die Gabelstutzen am Niemeyer- Haus in Berlin, Bauvelt, 1959, pag. 9.
[3] *G., Jahel,* Das Verhalten der Fundamente beim Niemeyer- Bau, Bauvelt, 1958, pag. 132.
[4] http://www.associazioneamuse.it
[5] http://www.berlin.de
[6] http://www.flyingpioneers.com
[7] http://www.pedrokok.com.br
[8] http://www.wikimedia.org