REPEATED HORIZONTAL DISPLACEMENTS OF INFILLED FRAMES HAVING DIFFERENT STIFFNESS AND CONNECTION SYSTEMS - EXPERIMENTAL ANALYSIS

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SUMMARY

Experimental analysis presented in this report are the results of experiments conducted within the "Progetto Finalizzato Geodinamica" of the CNR (National Research Council). The aim was to study the seismic behaviour of R/C frames infilled with masonry panels in accordance with construction procedures that are widely used, expecially in Italy. The effect of a special constructive detail in view of improving the capacities for dissipating energy under important stresses was studied.

INTRODUCTION

In the last years, a great deal of theoretical and experimental research has been conducted on the seismic behaviour of framed structures. Proportionally, less attention has been given to studying the influence of non-structural elements on these structures. Often the perimetric and internal partitions of the buildings are constructed with masonry panels inserted into frame spaces. When the damages caused by earthquakes to these structures has been observed (1,2), it has always appeared that the actual behaviour of the costruction differs largely from the theoretical behaviour of the main structural system alone, which were provided for the resistance design. In view of a later study of this phenomenon, a programme of experiments on sections of frame (scale approximately 1/2) infilled with two types of masonry, was undertaken refering to construction systems most frequently used in Italy. The experiments consist of alternate repeated applications of large horizontal stresses (Low Cycle Fatigue). In this paper, the results obtained at the end of the first phase of the programme are given. Further experiments applying vertical forces, to reproduce some effects of the weight of the upper structures are planned. In (3) numerous references are indicated.

CHARACTERISTICS OF THE MODEL

In Figs.1 and 2, the characteristics of the structures subjected to the experiments are shown. The RB series is made up of partition of frame provided with stiff beams, while in the TB series the beams are thin (floor-thickness). Infilling was done with two types of brickwork shown in the Fig. 3 ("Hollow Bricks" with horizontal openings > 40%) and Fig.4 ("Semi-Solid Bricks" with vertical opening < 40%). From 4 to 8 cycles of static load were apllied, causing maximum displacements of 4 cm on each side. Infilling of

		No 1	No 2	No 3	No 4
RB	8 Ø 8 = 0.8%	frame only	hollow blocks	semi-solid blocks	semi-sol.bl. with separat.
TB	8 Ø 10 = 1.2%				

frame No 4 is made up of semi-solid blocks as for the frame No 3, but in the No 4 a separation of 6 cm between the columns (left-hand side of Fig.1 and

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2) was left. Four brackets capable of transmitting the shear force absorbing part (nearly one half) of the lateral shifting are inserted in the corners. The aim of this expedient is to reduce the shifting of the masonry, which is the most brittle part of the system, for equal applied displacements.

EXPERIMENTAL RESULTS

The force-displacements diagrams measured during the experiments are shown in the Fig. 7-14. Some important comments can be made.

1) - The large increase in maximum resistance (from 2 to 2.5 times) is obvious. The increase is almost the same for both types of masonry.
2) - The increase in resistance is balanced by brittle behaviour of the system which is particularly obvious in elements No 2 and 3. By the end of the first cycle, particularly in the No 2, resistance dropped to values comparable to the values of the single R/C frame. The behaviour of frames No 3 appeared only slightly improved, for the TB series. However especially in the No 3 elements, in successive cycles, resistance drops to values that are lower than the simple frame values. This could be explained by the larger shear failure in the columns which appear from the first cycle and which are favoured by the masonry.
3) - The device made in the No 4 elements has proved very effective. The maximum resistance is slightly lower than for the corresponding No 3 elements, but more important is that the masonry suffers less damages which makes it more efficient even in the successive cycles.
4) - The results are better illustrated if the diagrams of Fig.5 and 6 are studied. Here, the figures of the areas of the first four histeretic cycles are shown. Only with the No 4 elements was it possible to maintain a system dissipating capacities in the region of 50%, that is in the same region as for the single R/C frames.
5) - It does not seem necessary to comment on the two types of beam considered. Obviously, in the TB series the softness is greater. Perhaps, in the RB series the brittle effect connected with the shear failure of the columns is slightly greater.

In conclusion, to ignore the effect of infilling masonry (even of the Hollow-Blocks) may be dangerous for several reasons. Infilling seriously alters the supposed distribution of stiffness and resistance, while it may favour a brittle type of failure (shear in the columns). These two factors are particularly dangerous in first storey columns. In fact, in this case, the masonry is subjected to greater stresses and in the successive cycles, when it loses its resistant effect, shear type behaviour of all the floor can appear. However, the columns, which are already partly damaged must act differently from the way in which they were designed to act. On the other hand, during the seismic motion, the composite system frame-masonry may dissipate a great amount of energy. Therefore, it is important to improve this performance. The device made in the No 4 elements is an interesting expedient to obtain what may be termed a good "Sustained Ductility", also presenting advantages as regards the total resistance in successive cycles. Such an expedient could improve the reliability of the system.

ACKNOWLEDGEMENT

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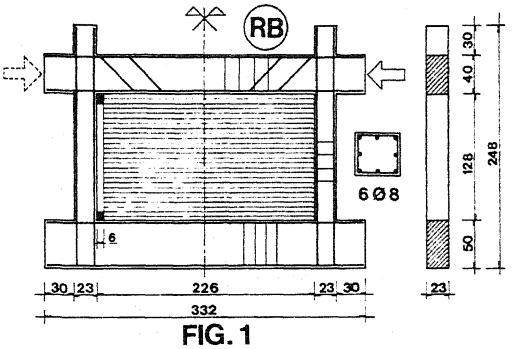


FIG. 1

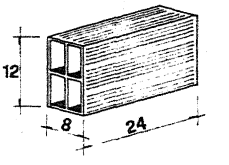
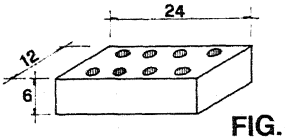


FIG. 3



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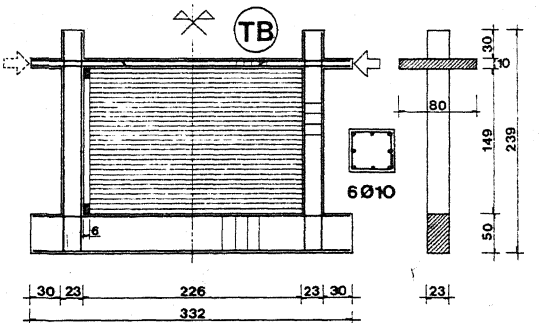
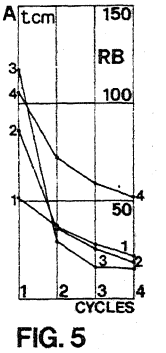


FIG. 2



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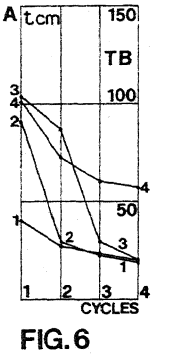


FIG. 6

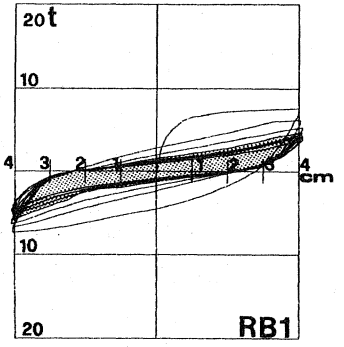


FIG.7

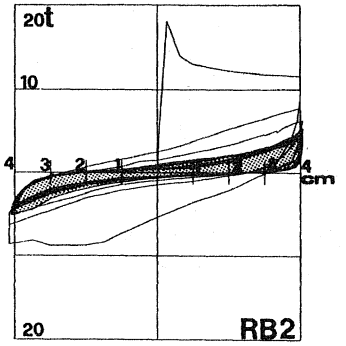
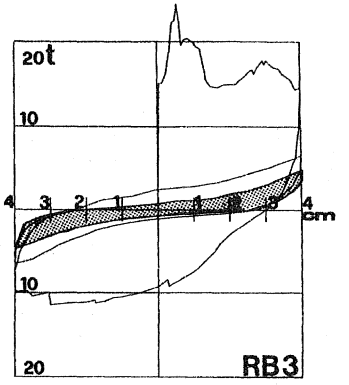


FIG.8



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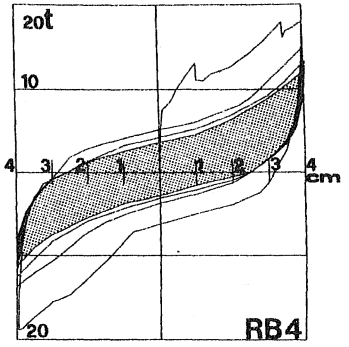

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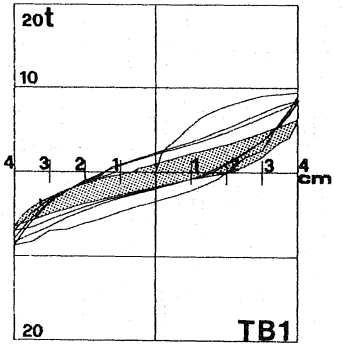

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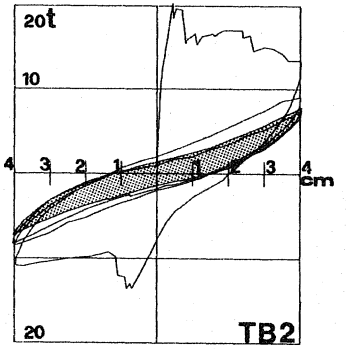

FIG.12

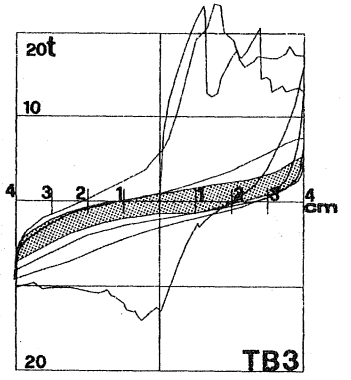

FIG.13

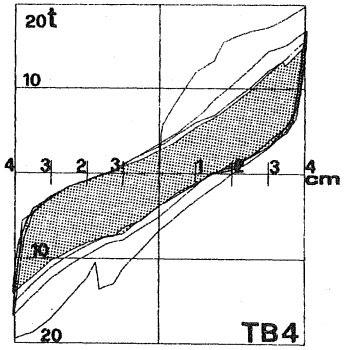

FIG.14