Alemagna motorway, Venezia-Munich: Dynamic behaviour of Fadalto viaduct

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ABSTRACT: Dynamic seismic non-linear behaviour of a major bridge of an Italian motorway is studied. The feature regards the influence of the thin walls on the top of r.c. piers that act as an ad hoc energy dissipation device. The pier base remains elastic, the walls have plastic behavior. The energy dissipation mechanism is studied.

1. INTRODUCTION
The close to completion motorway from Vittorio Veneto to Belluno is an important european link connecting Adriatic coast with the most gorgeous resort of the Dolomites area and finally with Austria and Germany. It cross an important italian seismic area of medium intensity.
Fadalto viaduct (fig.1) is an hyperstatic continuous bridge with piers 80 m high and spans 115 m long. The piers have hysteretic concrete top walls acting as energy dissipation devices. The designer is ing. Furlanetto, Italstrade, and builder is Condotte D’Acqua, Italy.

![Diagram of Fadalto viaduct](image1)

Fig 1. Schematic view of Fadalto viaduct

In fig. 2 the feature of one pier is shown. It must be noted the abrupt change in flexibility in the top part of the structure. This change is clearly intended as an energy dissipation device. It is made of two prestressed walls designed with particular care regarding detailing. In fact the low required ductility level justify this non conventional approach. Some additional questions depend on the column, not beam, plastic hinges.

![Diagram of pier detail](image2)

Fig. 2 Particular view of piers with elastoplastic device
2. METHODS

The structure is simplified as a non linear (2 DOF) elastoplastic structure under seismic excitation. An ad hoc computer program was written in order to study ductility and energy demands.

![Diagram](image)

Fig. 3. Computer model

Non-linear behaviour may be developed at the bottom of the pier and at the top (the walls). Fig. 4 a, b, shows the N-M interaction diagram for reinforced concrete sections of pier and walls.

Fig. 5 a, b, shows the non-linear calculated force displacement relationship for the bridge.

3. RESULTS

The phase diagrams (displacement vs velocity) of the two degrees of freedom is shown in fig. 6 a, b, under El Centro record.

In fig. 7 is shown the required ductility level for pier and wall, for different values of ground excitation. Columns remain elastic. The walls are plastic, for values of acceleration very low.

The required ductility is, up to .3 g, quasi linear with acceleration; from .3 g to .6 g the increase of ductility demand is very slow.

In fig. 8 is shown the ductility level for a design without the abrupt change in flexibility of the pier. It may be seen that the pier base is plastic for value of .3 g. The ductility depends quasi linearly on acceleration.

In fig. 9 different types of energies are plotted. It can be seen that the energy dissipation for damping and plasticity is similar at the end of excitation.

4. CONCLUSIONS

The abrupt change of piers flexibility (together with a particular detailing) can be seen as an ad hoc elastic plastic dissipation device.

![Diagram](image)

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Valori F-s per le pile Viadotto Fadatto Ovest P46-P50

![Diagram](image)

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Valori F-s per le lame Viadotto Fadatto Ovest P46-P50

![Diagram](image)

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Fig. 4 a, b  M-N interaction diagrams for piers and walls

Fig. 5 a, b  Force displacement relationships for the single pier, the walls and the bridge.
Fig. 6a, b  Phase diagrams (velocity vs displacement) for the two degrees of freedom.

Fig. 7. Ductility demand for piers and walls vs ground acceleration.

Fig. 8. Ductility demand for the design without dissipation devices.

Fig. 9. Various types of energies vs time.

The computer analysis shows that the ductility demand is low, and the piers remain elastic also under a strong seismic motion.

In the author opinion some care must be taken regarding the real behaviour of the walls and the difficulty of rehabilitation after a seismic motion.

REFERENCES