7. BRIDGES AND VIADUCTS: INVENTORY CHARACTERISTICS

(N. Nisticò, G. Monti)

In order to assess the structural behaviour of bridges, under the level I scenario earthquake (M≈7) for the Catania municipal area, all the available data have been collected and an inventory of bridges and viaducts has been set up. In this chapter the data collection process is briefly described while the bridge assessment procedures, and pertaining results, will be reported in chapter 12.

As a first step, a preliminary catalogue of the bridges was assembled. Bridges were classified according to the following classes:

... (I) bridges designed according to the 1981 seismic code;

... (II) bridges designed according to non seismic codes. We remind that seismic norms were adopted in Eastern Sicily (including Catania) only from 1981 onwards (Catania is classified as a 2nd category seismic zone).

Since the 1981 Italian seismic code implicitly adopts, for category II areas, a design acceleration corresponding to a PGA (Peak Ground Acceleration) of 0.25g, bridges belonging to class (I) were further subdivided in the following subclasses, based on the scenario ground motion values in the Catania municipality:

... (Ia) bridges located in areas with PGA < 0.25g;

... (Ib) bridges located in areas with PGA > 0.25g.

The PGA at each bridge site was obtained based on the map proposed in section 3; the bridges sites have been marked on the map of Figure 7.1.

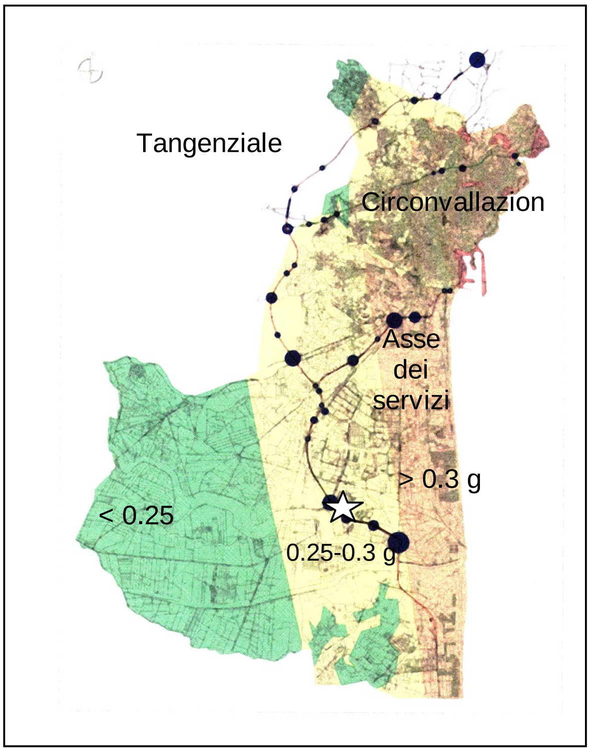

Figure 7.1: Bridges locations in the Catania area. Star indicates the location of the investigated overcrossing in sub-section 12.3.

Since bridges classified as (Ib) and (II) will probably suffer a greater seismic damage, the available geometry and material data, as reported from the original design-drawings, have been supplemented with on-site inspections and non-destructive material testing.

In the following, a brief description of the collected data, focused on road system morphology, bridge typology, materials and importance, is provided.

7.1 Catania road system morphology

Catania downtown zone has a road system characterized by narrow streets, with traffic mostly supported by some principal routes such as *Via Etnea* and few streets parallel and perpendicular to it; these allow communication with *via D'Annunzio*, located in the North side of the city, and *Viale V.Veneto* in the East side. This road system is crossed by two major transportation axes, called *Circonvallazione* and *Asse dei servizi*. The *Circonvallazione*, on the North site, is a link between the end of the water-front (*Ognina*) and the urbanized area of *Misterbianco*, while the *Asse dei servizi* connects the industrial area of *Pantano D'Arci* (South-West) with the harbour. External to the urban area is the *Tangenziale*; this represents a link betweent the South and the North and further on to the national highway system.

Almost all of the bridges in the Catania area are reinforced concrete (RC) structures and most of them belong to the *Circonvallazione*, *Asse dei servizi*, or the *Tangenziale* system. Parallel to the water-front, near the coastline, there is a masonry bridge that has not been subjected to further investigation.

7.2 Bridge typology and importance

It is well known that structural damage, together with its economical and social effects, is the basic factor in the risk evaluation for a given area. Damage depends on the bridge typology, materials, details etc, while risk depends also on the role of bridge in the transportation lifelines system of the area. A summary of the main typological features of the Catania bridges, as well as definitions of importance categories, is given in the following.

7.2.1 *Bridge importance*

The definition of the bridge importance is fundamental to set the acceptable damage level. Three importance levels were defined for Catania:

High importance (H): bridges of fundamental importance for maintaining communications in the post-event emergency and under ordinary conditions; a low level of damage is accepted but the structure has to sustain the action consequent to both emergency and ordinary traffic.

Medium importance (M): bridges that are critical only in the post-event emergency; a medium level of damage is accepted but the structure has to sustain the action consequent to emergency traffic only;

Low importance (L): bridges that are not critical either in the emergencies or for ordinary traffic; a high level of damage is accepted. However, while functional collapse is accepted, structural collapse is not.

7.2.2 *Bridge types*

7.2.2.1 *Asse dei Servizi*

Among the structures existing on this route, two bridges have been selected as representative (*Fontana Rossa* and *Scalo Ferroviario*). The importance category is "High" since the bridges serve the urban area linking the Catania airport with the harbor. A brief structural description follows.

Vertical structures: a single-bent pier is generally present; multipier bents (2 or 3 piers) are adopted in case of intersections (Fig. 7.2 and Fig. 12.3). The average pier height is ~9.0 m. The pier horizontal cross-section is circular with diameter D=3 m and is reinforced with 60 bars ϕ 24 (ρ=3.8 ‰); the lap splice length is almost 120 cm. The closed transversal reinforcement has a diameter of 12 mm and a spacing of 20 cm (ρ=0.7 ‰). The grade of longitudinal and transversal reinforcement is FeB44 (not controlled) and all the bars are deformed. The average cubic concrete strength is 45 N/mm^2.

Superstructures: the reinforced concrete deck consists of pre-stressed beams with an average length of 35 m and a constant height of 2 m. The beam are transversally connected with prestressed cables. The transversal dimension range between 7 m and 10 m.

Bearing support: the superstructure is supported by elastomeric bearings; the seating width is almost of 100 cm; transversal and longitudinal restrainers are absent.

Foundation: the footing rests on reinforced concrete piles 1.250 m diameter. The number of piles range between 4 and 8 for single pier and between 10 and 18 for multiple pier bents.

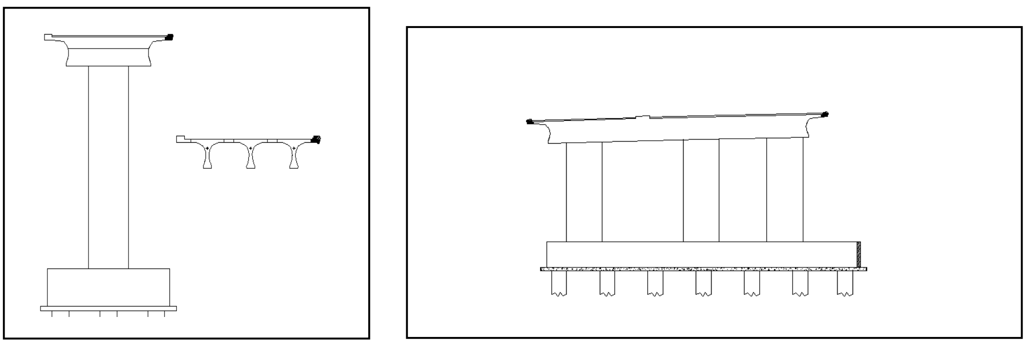

*Figure 7.2: Schematic view of single and multipier bent (*Asse dei Servizi*)*

7.2.2.2 *Circonvallazione*

Two bridges have been selected (*Ognina* and *Pordenone*); the importance category is "High" since they serve the urban area where major damage is predicted (see Section 12). The main characteristics are:

Vertical structures: a single pier (Ognina) or multiple piers (Pordenone) are adopted; see Figure 7.3 and 12.2. The average height is ~5.0 m. The pier horizontal cross-section is circular with D=2 m. Reinforcement information is not available. The average cubic concrete strength is 40 N/mm^2 in Ognina and 50 N/mm^2 in Pordenone.

Superstructures: the reinforced concrete deck consists of pre-stressed concrete beams with an average length of 22 m and a constant depth of 1 m. The transversal dimension is almost 10 m for *Ognina* and ranges between 6 and 10 for *Pordenone*.

Bearing support: the superstructure is directly supported by the cap beam; the seating widths is about 50 cm; transversal and longitudinal restrainers are absent.

Foundation: information is available only for *Pordenone.* The footing is supported by 10 reinforced concrete piles having D=0.8 m.

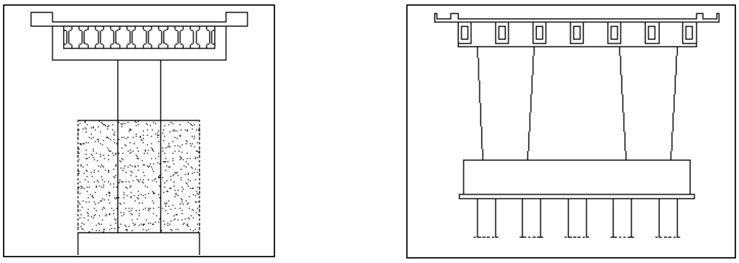

*Figure 7.3: Schematic view of single and multipier bent (*Circonvallazione)

7.2.2.3 *Tangenziale*

Six overpasses have been selected. The importance category is "Low".

Vertical structures: a single pier has been adopted (Fig. 7.4 and also Fig. 12.7 and 12.8). The average height is ~7.0 m. The pier cross-section is rectangular with variable size; the base section width ranges between 3 and 6 m depending on the deck transversal dimension. The percentage of longitudinal reinforcement is about 3.0 ‰. The non-closed transverse reinforcement has a diameter of 14 mm and a spacing of 40 cm (ρ=0.7 ÷ 1.3 ‰). The grade of longitudinal and transversal reinforcement is FeB44 (not controlled) and all the bars are of the deformed type. The average cubic concrete strength is 55 N/mm^2.

Superstructures: the reinforced concrete deck consists of pre-stressed concrete beams with depth of 2.0 m; the lateral span has a length of ~13 m and the central one of ~32 m. The transversal dimension is 5 or 10 m.

Bearing support: the superstructure is supported by elastomeric bearings; the seating widths is about 30 cm; the transversal restrainers are weak and the longitudinal ones are absent.

Foundation: The footing is supported by reinforced concrete piles with D=1.0 m. The number of piles ranges between 4 and 16, depending on the pier dimension and deck geometry.

7.2.2.4 *Buttaceto*

Two bridges have been selected.

Vertical structures: a single pier has been adopted (Fig.12.1). The average height is ~7.0 m. The pier cross-section is octagonal; the transversal dimension is ~3 m and the longitudinal 1.8 m. The section is reinforced with 54 bars ϕ 24 ($\rho \sim 4.8$ ‰). The non-closed but almost efficient transverse reinforcement has a diameter of 16 mm and a spacing of 25 cm ($\rho=1.5$ ‰). The grade of longitudinal and transversal reinforcement is FeB44 (not controlled) and all the bars are of the deformed type. The average cubic concrete strength is 50 N/mm^2.

Superstructures: the reinforced concrete deck consists of pre-stressed concrete beams with average length of 17 m and constant depth of 1.2 m. The transverse dimension is about 10 m.

Bearing support: the superstructure is directly supported by the cap beam; the seating widths is about 100 cm; transversal and longitudinal restrainers are absent.

Foundation: The footing is supported by 6 reinforced concrete piles with D=0.8 m.

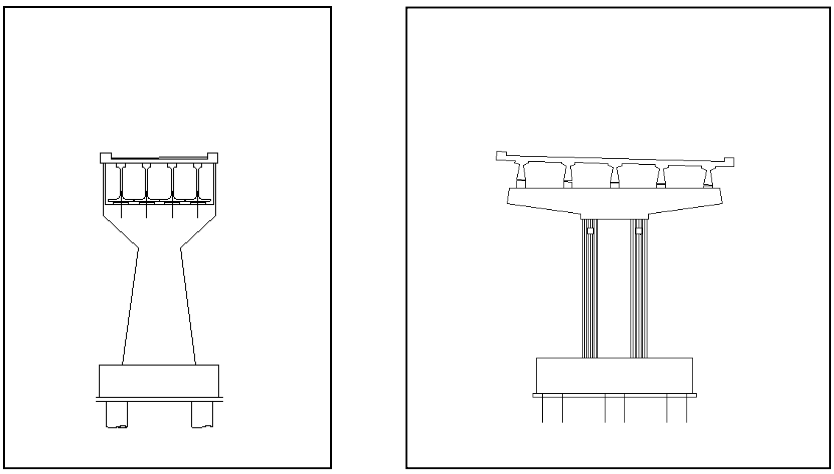

Figure 7.4: Schematic view of Tangenziale *piers*