On the Application of the New Italian Bridge Guidelines: The Case of Sardinia Region

Marco Zucca(✉), Flavio Stochino, Mario Lucio Puppio, and Giovanna Concu

Department of Civil, Environmental Engineering and Architecture, University of Cagliari, 09123 Cagliari, Italy
marco.zucca2@unica.it

Abstract. Considering the collapses which have involved several existing bridges in Italy during the last years, specific new guidelines on risk classification and management, safety assessment and monitoring of existing bridges have been issued in 2020. These guidelines are organized in six levels (from level 0 to 5), that are characterized by different activities: (i) level 0 is defined by the census of the fundamental properties of the bridge, (ii) level 1 involves the visual inspection of the structure to obtain defects and the main geometric parameters of the viaduct, and the hydraulic and geo-morphological properties of the site, (iii) level 2 defines the Class of Attention of the bridge calculated considering the hazard, the vulnerability and the exposure parameters obtained from the previous levels, (iv) level 3 is a preliminary assessment of the bridge to evaluate the need to proceed with the level 4 analyses, (v) level 4 is characterized by an accurate evaluation of the structural elements of the viaduct according to the Italian Design Code and (vi) level 5 concerns the evaluation of the robustness of the road network.

In this paper, the application of the first three levels of analysis of the new guidelines to a stock of bridges located in Sardinia is presented. The census analysis, visual inspection and the definition of the Class of Attention of bridges were performed. The results obtained are analyzed from a critical point of view in order to highlight the limitations of the proposed procedure.

Keywords: Existing Bridges · Italian Bridge Guidelines · Class of Attention

1 Introduction

During the last 10 years, the total or partial bridges collapses occurred in Italy have caused the death of 52 people and the injury of 38 other people [1]. In particular, after the well-known collapse of Polcevera viaduct, that led to the death of 43 people, the management and maintenance of existing bridges has become a topic of considerable interest [2, 3].

It is important to highlight that the identification process of infrastructures maintenance interventions has always been more widespread in North America than in Europe. In fact, in North America the AASHTO Commonly Recognized Standard Element System general rules are well defined and implemented in PONTIS software [4] while

© The Author(s), under exclusive license to Springer Nature Switzerland AG 2026
O. Gervasi et al. (Eds.): ICCSA 2025 Workshops, LNCS 15897, pp. 183–196, 2026.
https://doi.org/10.1007/978-3-031-97660-5_14

in Europe most of the highway management companies have developed their bridge management procedures, but they do not offer the acquired knowledge and developed products for commercial use [5]. Only a part of them have developed a national Bridge Management System (BMS) such as DANBRO in Denmark. Moreover, these BMSs are useful only for the collection of data of the considered bridges but they are not useful to define the risk level of bridges. Large-scale approaches which take into account the main intrinsic characteristics of bridges and the degradation level are generally used to define the maintenance interventions scheduling [6–8].

In Italy there are about 60 k motorway bridges and most of these were built between 1960s and 1970s in reinforced concrete (RC) and consequently require several interventions to maintain an adequate safety levels both under static and dynamic loads. It is important to highlight that the viaducts are generally handled by different companies who may not have detailed information about all their assets.

For these reasons, in 2020 the Italian Ministry of Sustainable Infrastructures and Mobility (MIT) has released the new Italian Bridge Guidelines (IBGs) for the classification and the risk management, safety evaluation and monitoring of existing bridges [9]. The guidelines were updated in 2022.

The guidelines are characterized by a multi-level approach which develops at 6 different levels characterized by the following activities:

- Level 0. Definition of the most important properties of the bridge and verification of existing design documentation.
- Level 1. Running of a series of visual inspections of the structure useful for identifying the presence of: (i) defects, (ii) the structural and geometric properties of the bridge and (iii) the geo-morphological and hydraulic characteristics of the area.
- Level 2. Evaluation of the Class of Attention (CoA) of the bridge considering the definition of hazard, vulnerability and exposure parameters obtained from previous levels. The definition of the different CoAs (Structure and Foundation (CoA-SF), Seismic (CoA-S), Landslide (CoA-L) and Flood (CoA-F)) can be high, medium-high, medium, medium-low and low. Starting from the evaluation of the Classes of Attention, different actions are applicable as a function of the CoAs level. Specific inspections plans will have to be scheduled for structures having medium or medium-high CoAs while a deep structural assessment is needed for bridge having high CoAs.
- Level 3. Structure preliminary assessment useful to identify the aspects useful to perform a Level 4 analysis. The numerical analysis required at Level 3 aim to evaluate the minimum resistance ensured by the codes at the time of construction of the bridge compared with the resistance required by the present code Italian Design Code (NTC2018) [10].
- Level 4. Detailed assessment of the structure considering as reported in NTC18.
- Level 5 is related to the evaluation of the robustness of the road network but currently it is not described in the guidelines.

In this paper, the application of the first three levels of the IBGs to a stock of existing bridges located in Sardinia have been presented. Taking into account the results obtained from the visual inspections, the CoAs of the analyzed bridges have been obtained to define the management of the interventions.

The main goal of this research work is to analyze the different steps of the qualitative evaluation process proposed by the IBGs, in order to highlight the possible critical aspects that may influence the correct safety evaluation of the analyzed existing bridges.

2 Italian Bridge Guidelines

Based on the risk analysis theory, the fundamental parts useful for the evaluation of the CoAs of the viaduct are: (i) hazard, (ii) vulnerability and (iii) exposure. It is possible to classify each risk parameter as high, medium-high, medium, medium-low or low. Table 1 summarizes the primary and secondary parameters that regulate the definition of these components.

Table 1. Parameters that regulate structure-foundation and seismic risks.

CoA	Component	Primary Parameters	Secondary Parameters
Structure-foundation	Hazard	Expected traffic loads, frequency of commercial vehicles	
	Vulnerability	Level of defectiveness, static behavior, number and length of the spans, type of material	Degradation speed, design code
	Exposure	Average daily traffic, mean span length	Road alternative, bypassed entity
Seismic	Hazard	PGA (Peak Ground Acceleration)	Soil class
	Vulnerability	Level of defectiveness, static scheme, number and length of the spans, material	Seismic design criteria
	Exposure	Exposure obtained for structure-foundation CoA	Importance of the bridge

2.1 Structure-Foundation CoA

The parameters which influence the hazard that defines the structure-foundation risk are: (i) the maximum permissible mass of vehicles and (ii) the frequency of transits of commercial vehicles. The influence of the vehicle mass is related to the possible presence of vehicles with a tow characterized by an important weight which causes greater risk than a same bridge but used only for ordinary traffic. Considering the maximum permissible mass of vehicles, the IBGs divide viaducts into five classes: A, B, C, D, and E. The maximum mass for bridges in class A is obtained according to the NTC 2018 requirements for new bridges which is represented by double axe concentrated loads equal to 600 kN.

The classes B, C, D and E are defined by a mass equal to 73%, 43%, 13% and 6% of that obtained for class A, respectively. According to the IBGs, it is possible to classify the frequency of transits of commercial vehicles per lane as low, medium or high. The frequency is considered low if lower than 300 vehicles/day and high if higher than 700 vehicles/day. The hazard class is calculated through a table that depends on the class of the road determined considering the maximum permissible mass and on the frequency of transits of commercial vehicles.

The vulnerability depends on: (i) the defectiveness level, (ii) the rate of degradation, (iii) the design code used (also considering the seismic design criteria), (iv) the static behavior, the materials and the maximum span length.

Considering the defects observed during the execution of the visual inspections, the level of defectiveness of the bridge is defined as a function of the importance, the rate of intensity of the identified defects.

The rate of degradation is calculated as a function of the level of defectiveness related to the construction period of the structure. The definition of the bridge construction period is significant if the structure has never undergone important maintenance interventions. However, if the bridge was subjected to important maintenance interventions that have influenced the degradation process, the year of the last significant maintenance intervention should be considered. Three different categories are defined considering the bridge construction period or the time of the execution of the last important maintenance intervention: (i) prior to 1945, (ii) from 1945 to 1980 and (iii) later than 1980.

The vulnerability level is strictly related to the hypotheses used during the design phase, in particular by the considered traffic load models. In fact, it is important to highlight that the evolution of the Italian design code has led to a variation in traffic load schemes over the years. For this reason, it is possible to divide the first category bridges, designed in the past considering the transit of civil and military vehicles, from the second category bridges, designed considering only the presence of civil vehicles. It is important to highlight that the effects of the civil vehicles considered up to 1980 have been much less severe than now reported within the NTC2018, while the effects of the military vehicles considered from 1952 onwards are about equal to the loads currently used. The influence of the traffic loads on the structural behavior of the analyzed bridge is regulated by different parameters such as the characteristics of the span and the width of the deck. Without more accurate evaluation, the IBGs identify three different classes (A, B or C) defined by the design period, the category of the bridge and the span length.

Moreover, vulnerability is influenced by the most important structural properties of the bridge. The fundamental parameters considered in the IBGs are the redundancy of the static layout, the susceptibility of the formation of brittle collapse mechanisms and the possible development of the materials degradation phenomena. Also in this case, after the definition of the static scheme, the material that characterizes the deck and the maximum span length, it is possible to obtain the vulnerability level of the structure with a table that considers the related main structural characteristics. The class of vulnerability is defined through a flow-chart which summarizes the results of the previously discussed aspects.

Exposure is obtained considering the effects of the following primary and secondary parameters: (i) the average daily traffic and the average span length and (ii) the presence

of alternative routes and the type of the bypassed subject. In particular, the expected traffic volume, defined considering the Average Daily Traffic (ADT), is obtained by means of specific evaluation or using the data obtained from the management company. The IBGs classify the ADT level as high, medium and low. The low level presents an ADT not higher than 10,000 vehicles/day while the high level is characterized by an ADT not lower than 25,000 vehicles/day. Another parameter which influences the exposure is the average length of the span (ASL). Considering this aspect, IBGs define three classes of bridges having long spans (ASL higher than 50 m), medium spans (ASL higher than 20 m and lower than 50 m) and low spans (ASL lower than 20 m). The effects of ADT and ASL are considered using a table presents within the IBGs.

Closure or traffic restriction generates disruptions and economic losses. In the evaluation of the exposure, according to the IBGs, have to consider the possible presence and the adequacy of road alternatives in the case of bridge closure. The class of exposure obtained considering the combination of the ADT and ASL effects increases if no alternative routes are possible. Another aspect to consider is the type of the bypassed entity defined by means of three different classes: high, medium and low. The class of exposure which characterizes the viaduct is calculated through a flow chart considering the above-defined parameters.

The final structure-foundation CoA of the bridge is obtained by means tables considering the classes of vulnerability and exposure.

2.2 Seismic CoA

The hazard related to the seismic risk is regulated by (i) the value of the PGA and the topographic category of the site and (ii) by the subsoil category. In particular, the PGA is evaluated considering rigid soils and a probability of exceedance equal to 10% in 50 years. Five hazard classes (high, medium-high, medium, medium-low, low) are considered for PGA and topographic category. The determination of the subsoil category is based on the execution of special surveys if there is no detailed evaluation in the design documents. On the contrary, if it is impossible to obtain the above-mentioned information, the subsoil category is assumed to be the worst possible for the area under consideration. The hazard class is calculated through a table as a function of the classes considering these primary and secondary parameters. In this case, the vulnerability for the seismic risk is defined considering (i) the level of defectiveness, (ii) the use of seismic design criteria and (iii) the static behavior, the materials and the maximum span length.

The defectiveness level is determined considering the results of visual inspections of Level 1 but focusing attention on the structural elements that influence the seismic behavior of the analyzed structure. Also in this case, the IBGs identify five distinct levels of defectiveness, according to what was done for the evaluation of structure-foundation vulnerability class but taking into account the seismic behavior of the structure.

The seismic behavior of a bridge is related to the redundancy of the static layout, on the type and number of elements vulnerable to the seismic action and on the mass of the bridge. Also in this case, the IBGs consider five different classes of vulnerability that depend on static behavior, span length and material.

Moreover, the dynamic performance of existing viaducts is strictly related to the design code used during the design phase. In fact, it is important to distinguish between

bridges designed considering seismic action and bridge designed only to resist vertical loads. The class of vulnerability is evaluated through a flow chart that considers the results of the previously mentioned parameters.

The exposure to seismic risk is obtained considering as obtained for the structure-foundation risk and the strategic importance of the structure when a seismic event occurs. The IBGs consider the importance of bridges that must guarantee their operability during seismic events for civil protection purposes. In fact, the level of seismic exposure is increased by one level with respect to those obtained for the structure-foundation risk if the bridge is defined as being of strategic interest for emergencies following an earthquake.

The seismic CoA of the bridge is obtained using tables related to the classes of vulnerability and exposure.

3 Case Studies in Sardinia

The stock of bridges analyzed in this research work is composed of ten existing bridges located in north Sardinia.

Figure 1 shows the location of the bridges under study.



Fig. 1. Localization of the 10 bridges.

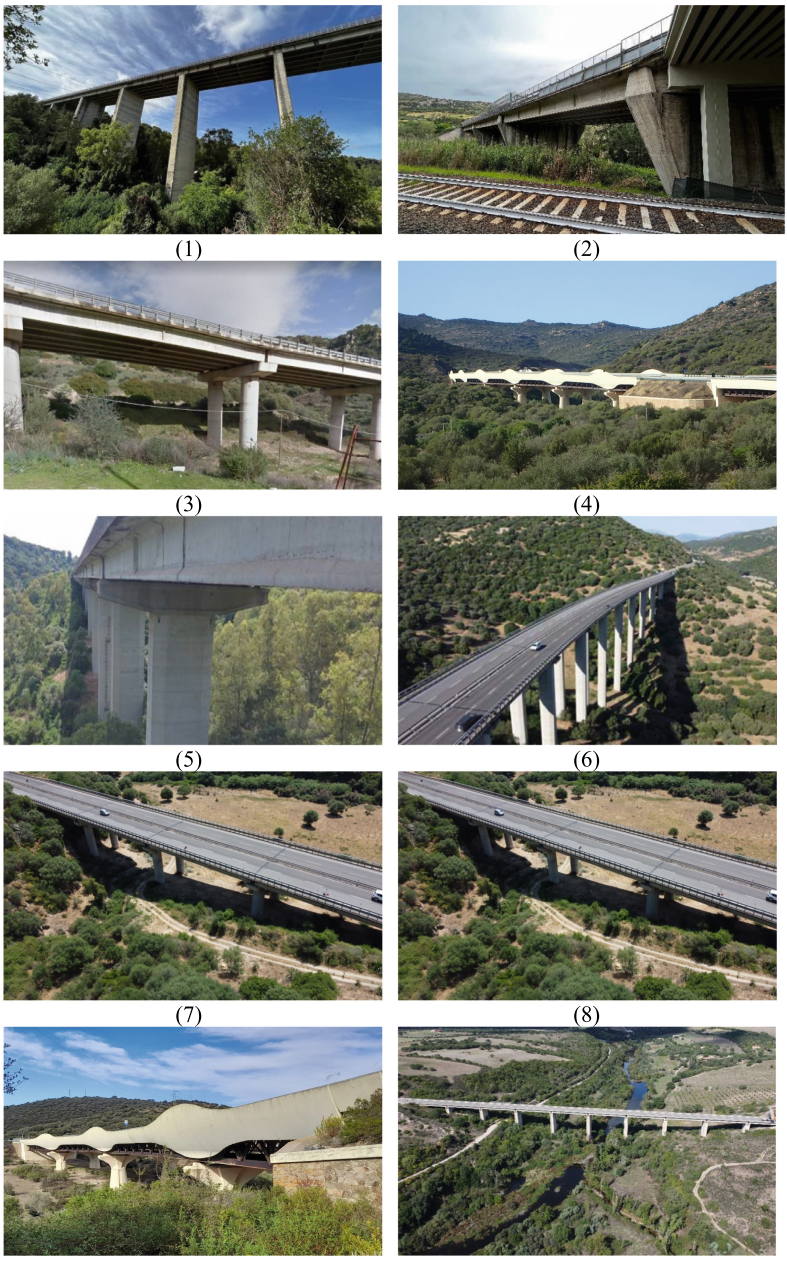

Fig. 2. (1) Giuncheddu bridge, (2) PO_SS131_202 + 501, (3) Rio Mulino bridge, (4) Nibbaru III, (5) PO_SS131dir-centr_51 + 986, (6) PO_SS131dir-centr_54 + 020, (7) PO_SS131dir-centr_56 + 447_DX, (8) PO_SS131dir-centr_56 + 447_SX, (9) Nibbaru Mannu, (10) Rio Coghinas bridge.

In particular, three of these bridges (Giuncheddu bridge, PO_SS131_202 + 501 and Rio Mulino bridge) are part of the main highway of Sardinia that connects Cagliari to Sassari (SS 131) while other seven (Nibbaru III, PO_SS131dir-centr_51 + 986, PO_SS131dir-centr_54 + 020, PO_SS131dir-centr_56 + 447_DX, PO_SS131dir-centr_56 + 447_SX, Nibbaru Mannu) are located in a recent branch of the same highway called SS 131 DCN. Only, Rio Coghinas bridge is in correspondence to SS 672 highway. Figure 2 shows the considered case studies, selected by the High Council of Public Works (CSLLPP).

As shown in Fig. 3, five of these bridges are characterized by simply supported spans while the other five are long span bridges. As reported in previous Sect. 2, another important aspect that influences the CoA of the bridge is the materials that characterize the main structural elements. In this case, only two bridges (Nibarru III and Nibarru Mannu) present a deck realized in mixed steel-concrete structure while the other eight analyzed bridges are characterized by a deck composed of prestressed longitudinal concrete I-beams and prestressed transverse rectangular beams with a 0.20 m concrete slab (Fig. 4).

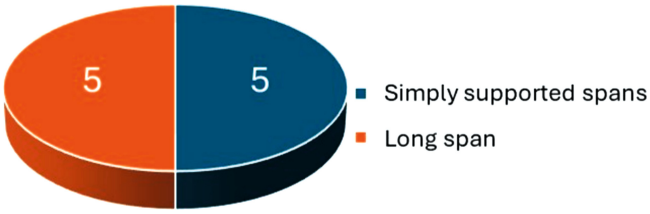

Fig. 3. Static scheme subdivision.

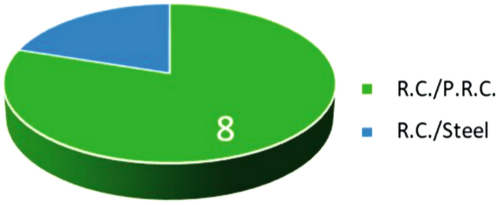

Fig. 4. Bridges materials subdivision.

Figures 5 and 6 report the relative frequency of the maximum girder length and of the maximum piers' height, respectively. It is possible to notice that the maximum value of girder length ranging between 68 m and 31 m. In particular, the maximum values of girder length (68 m and 60 m) characterize the two bridges having the deck realized by a mixed steel-concrete structure. The distribution of the relative frequency of the maximum values of the height of the piers shows appreciable differences, showing values ranging from 9.8 m and 58.08 m.

3.1 Structure and Foundation Risk

Hazard. The hazard related to the structure-foundation risk is evaluated considering the maximum permissible vehicles mass and the frequency of transits of commercial vehicles.

The value of the maximum permissible vehicles mass is determined considering the state of conservation of the structure and it is defined by the highway management company. Considering the analyzed case studies, the maximum permissible mass of vehicles is taken equal to as reported in the Italian Design Code [10] for the new bridges and consequently are in class A.

To evaluate the frequency of transits of commercial vehicles, in terms of number of commercial vehicles per day on single lane, the data obtained from specific traffic studies have been considered. In particular, Nibarru Mannu, Nibarru III, Rio

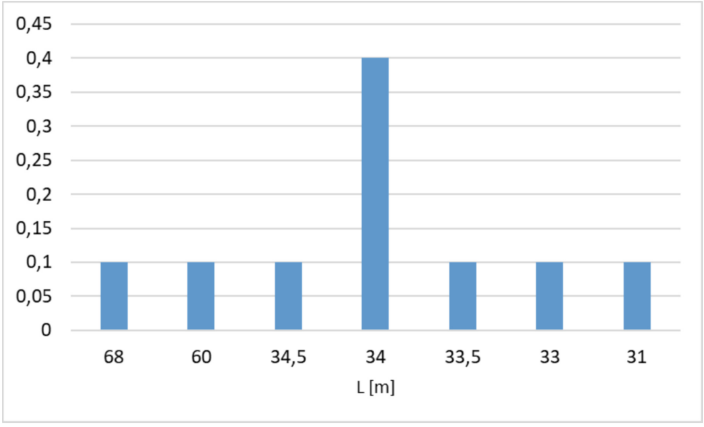

Fig. 5. Maximum girder length relative frequency.

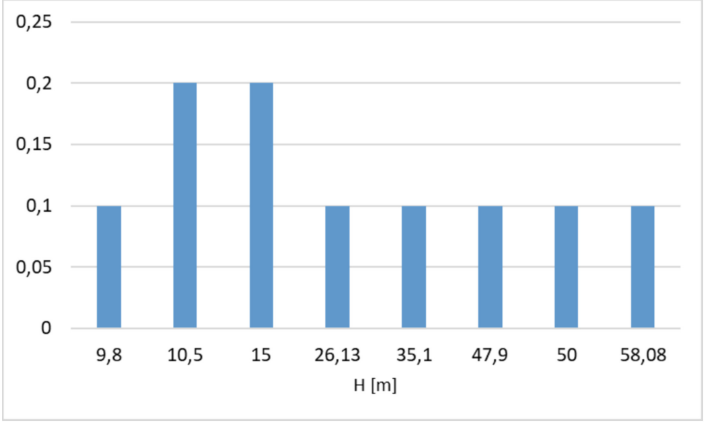

Fig. 6. Maximum piers height relative frequency.

Coghinas, PO_SS131dir-centr_56 + 447_DX and PO_SS131dir-centr_56 + 447_SX are characterized by low traffic frequency (≤300 vehicles/day), PO_SS131dir-centr_51 + 986, PO_SS131dir-centr_54 + 020 and Rio Mulino have a medium traffic frequency (300 ≤ vehicles/day <700) while Giuncheddu and PO_SS131_202 + 501 present a high traffic frequency (≥700 vehicles/day).

Vulnerability. The vulnerability useful for the definition of the structure-foundation risk depends on defectiveness level, rate of degradation, design code used, static behavior, maximum span length and material. In particular, the defectiveness level represents a fundamental parameter for the definition of the vulnerability level. According to as reported in the IBGs, if the defectiveness level is high, the vulnerability is also defined as high. As mentioned before, the defectiveness level is defined considering the results of the visual inspections, considering the criteria listed in Fig. 7.

Defectiveness level	Classification criteria
High	*"Defects with high or medium–high grade (G = 5 or G = 4) and any intensity grade on critical elements or presence of critical conditions"*
Medium-High	*"Defects with high or medium–high grade (G = 5 or G = 4) and high intensity grade on elements whose failure can undermine the statics of the bridge"*
Medium	*"Defects with high or medium–high grade (G = 5 or G = 4) and high intensity grade on elements whose failure cannot undermine the statics of the bridge or defects with high importance grade (G = 5) and medium–low intensity grade"*
Medium-Low	*"Defects with medium–high grade (G = 4) and medium–low intensity grade or many defects with either medium or low grade (G = 3, 2 or 1) and any intensity grade"*
Low	*"A few defects with either medium or low grade (G = 3, 2 or 1) and any intensity grade"*

Fig. 7. Definition of defectiveness level.

The IBGs introduce different types of forms depending on the type of analyzed element (e.g. beams, piers, bearings, slabs, joints, etc..). Each row of the form reports the code, the detailed description and the assigned grade ($1 \leq G \leq 5$) of the observed defect. Furthermore, the different forms are characterized by the presence of several checkboxes which can flag or not by the inspector. These checkboxes define if the considered defect is present in the analyzed element and if this defect compromises or not the load-bearing capacity of the structure. For each identified defect, the inspector must define the related extension (k_1) and intensity (k_2) grade, assigning a value equal to 0.2, 0.5 or 1. For some defects, k_1 and/or k_2 are defined directly by the IBGs.

Moreover, the IBGs identifies a series of critical elements that are considered as important and extended damage states or elements particularly prone to degradation phenomena. These elements (e.g. half-joints, prestressing tendons, etc.) if subject to important degradation can significantly affect the structural capacity of the bridges both under static and dynamic loads. The presence of damage in one critical element leads to a high level of defectiveness, according to as reported in previous Table 2.

Focusing attention on the analyzed case studies, three of them are characterized by a Medium-High defectiveness level, one presents a Medium defectiveness level while the other seven are defined by a Medium-Low defectiveness level. The structural elements that show the most critical defects are the R.C. piers, the P.R.C beams and the bearings.

The degradation rate is defined as a function of the defectiveness level and the construction period of the bridge. According to the IBGs application, eight of the analyzed bridges have been built from 1945 to 1980 while for the other two (Nibarru Mannu and Nibarru III) the construction period is subsequent to 1980.

Another important aspect for the definition of the vulnerability is the design code in force during the bridge design phase or to design the most recent significant structural interventions. Considering the classification of the IBGs, all the bridges fall into class B, that is characterized by first category bridges designed using design code in force from 1952 to 1990 and having spans of $<$10 m or designed with design code in force from 1952 to 2005 and having spans longer than 10 m.

All the bridges present maximum span length greater than 25 m. As reported in Fig. 3, eight of these are characterized by P.R.C. structures while the other two are realized with mixed steel-concrete structure.

Exposure. The exposure of the structure-foundation risk is defined as a function of the average daily traffic and the average span length, the possible presence of alternative routes and the entity of the bypassed element.

Considering to as reported in the IBGs, the average daily traffic (ADT) can be classified as high, medium or low in relation to the number of commercial vehicles transiting each day on the entire width of the carriageway. Considering as obtained from the highway management company, the ADT is low for all the viaducts.

Regarding the average span length (ASL) of the bridge, as can be seen in previous Fig. 4, eight of the bridges present a medium ASL value (20 m $<$ ASL $<$ 50 m) while the other two are characterized by a high ASL value (ASL $>$ 50 m).

The presence of alternative routes and the type of bypassed entity are two fundamental aspects that regulate the possible social and economic consequences due to the interruption of the traffic. Alternative routes are present for five of the analysed bridges. The class that defines the importance of the bypassed entity can be high, medium or low, according to as reported in the IBGs. Seven of the bridges are interested by bypassed entity classified as low. The bypassed entity of the other three bridges as classified as medium for two bridges and high for the other.

3.2 Seismic Risk

Similarly, to was what reported for structure-foundation risk, the seismic risk has been evaluated starting from the definition of hazard, vulnerability and exposure.

Hazard. The hazard related to the seismic risk is defined starting from the PGA value that characterize the site where the bridge was built. As mentioned before, all the bridges are located in Sardinia which is a low seismic risk area. For this reason, a PGA $\leq$0.05 g has been considered for the ten bridges. Other important parameters that regulate the hazard are the topographic category and the soil class.

The topographic category is defined according to as reported in [10] and in this case four bridges are in areas characterized by a topographic category equal to T1, other four in sites with T2 topographic category while the last two are realized in zones having T3 topographic category.

The soil class that characterizes the sites is defined according to Eurocode 8 [11]. Seven of the case studies are built in areas with A soil class while the other three are realized in sites having soil class equal to B.

Vulnerability. The vulnerability of the seismic action is strictly related to the defectiveness level, the possible use of design codes taking into account seismic action, the static layout, the maximum length of the span and the material.

Also in this case, the defectiveness level is calculated considering the results of the visual inspection with the only difference that the critical elements that influence the seismic performance of the structure are slightly different compared to those considered for the evaluation of the structure-foundation risk.

The IBGs divide bridges designed only considering vertical loads from those designed to resist seismic loads. Considering the age of the analysed bridges, all the case studies fall into the first group.

The other parameters which influence the vulnerability to seismic action are like those already defined for the evaluation of the vulnerability of the structure-foundation risk. The only difference is the definition of the static layout that is related to the number of spans of the bridge. Also in this case, the IBGs evaluate the vulnerability related to the structural characteristics by means of a table.

Exposure. The exposure useful to define the seismic risk is obtained considering the results of the structure-foundation risk that are corrected taking into account the strategic function of the considered viaduct when a seismic event occurs. All the analysed bridges are considered as strategic structures.

3.3 Definition of the CoA

Figure 8 summarizes the Class of Attention obtained considering the structure-foundation risk and the seismic risk of the ten case studies.

Bridge	Structure-foundation CoA	Seismic CoA
1	Medium-High	High
2	High	High
3	Medium-High	Medium
4	Medium-High	Low
5	Medium	Low
6	Medium	Low
7	Medium-High	Medium
8	Medium-High	Medium
9	Medium	Low
10	Medium-High	Medium

Fig. 8. Structure-foundation and seismic CoA.

It is possible to notice that all the bridges are characterized by a structure-foundation CoA ranging between Medium and High due to the defectiveness level obtained considering the results of the visual inspections. A more particular aspect is related to the evaluation of the seismic risk CoA, which is high for two bridges, even if Sardinia region is an area with low seismic risk. Also in this case, this result is due to the identified defectiveness level influenced by the state of conservation of the bearings.

4 Conclusions

In this paper, the application of the first three level of the new guidelines on risk classification and management, safety assessment and monitoring of existing Italian bridges is discussed focusing attention on the case of Sardinia. In particular, ten case studies located in north Sardinia have been analyzed in order to evaluate the Class of Attention related to the structure-foundation and the seismic risk.

The influence of the different parameters which regulate the evaluation of the abovementioned CoAs have been described in detail in order to define the most critical aspects of the IBGs approach.

All the considered case studies are characterized by a structure-foundation risk ranging between medium and high due to the defectiveness level obtained from the visual inspection results.

Also, in the case of seismic risk evaluation some of the bridges fall into a high CoA, even if Sardinia is characterized by a very low seismic risk. This result is influenced by the state of conservation of the bearings that are defined as critical elements in the evaluation of the seismic behaviour of the bridge. For this reason, the IBGs approach developed for the evaluation of the seismic risk could be in some cases overly penalizing. This aspect represents a critical issue for the correct evaluation of the safety level of the existing bridges located in low seismicity zones such as Sardinia. In fact, the seismic risk assessment carried out in this way can lead to an incorrect assessment of the maintenance interventions scheduling process.

Acknowledgments. The studies presented here were carried out as part of the activities envisaged by the Agreement between the High Council of Public Works (CSLLPP) and the ReLUIS Consortium implementing Ministerial Decree 578/2020 and Ministerial Decree 204/2022. The contents of this paper represent the authors' ideas and do not necessarily correspond to the official opinion and policies of CSLLPP.

Disclosure of Interests. The authors have no competing interests to declare that are relevant to the content of this article.

References

1. Palmisano, F., Asso, R., Chiaia, B., Marano, G.C., Pellegrino, C.: Structural assessment of existing R.C. half-joint bridges according to the new Italian guidelines. J. Civil Struct. Health Monit. **13**, 1–25 (2022)

2. Calvi, G.M., Moratti, M., O'Reilly, G., Scattarreggia, N., Monteiro, R., Malomo, D., Calvi, P.M., Pinho, R.: Once upon a time in Italy: the tale of the Morandi bridge. Struct. Eng. Int. **29**, 198–217 (2019)
3. Nuti, C., Briseghella, B., Chen, A., Lavorato, D., Iori, T., Vanzi, I.: Relevant outcomes from the history of Polcevera Viaduct in Genova, from design to nowadays failure. J. Civ. Struct. Heal. Monit. **10**, 87–107 (2020)
4. Thompson, P.D., Small, E.P., Johnson, M., Marshall, A.R.: The Pontis bridge management system. Struct. Eng. Int. **8**, 303–308 (1998)
5. Rossi, P.P., Spinella, N., Recupero, A.: Experimental application of the Italian guidelines for the risk classification and management and for the safety evaluation of existing bridges. Structure. **58**, 105387 (2023)
6. Pregnolato, M.: Bridge safety is not for granted—a novel approach to bridge management. Eng. Struct. **196**, 109193 (2019)
7. Zucca, M., Crespi, P., Stochino, F., Puppio, M.L., Coni, M.: Maintenance interventions period of existing RC motorway viaducts located in moderate/high seismicity zones. Structure. **47**, 976–990 (2023)
8. Costantino, G., Messina, D., Recupero, A., Rossi, P.P., Spinella, N.: A web platform for management and analysis of existing bridges. Procedia Struct. Integr. **44**, 1220–1227 (2023)
9. Italian Ministry of Sustainable Infrastructures and Mobility (MIT): D.M. 17 December 2020. Linee guida per la classificazione e gestione del rischio, la valutazione della sicurezza ed il monitoraggio dei ponti esistenti (2020)
10. Italian Ministry of Public Works: D.M. 17 January 2018. Nuove Norme tecniche per le costruzioni. Gazzetta Ufficiale, vol. 42 (in Italian) (2018)
11. CEN: EC8-Part 1: Eurocode 8. Design provisions for earthquake resistance of structures. In: Part 1–1: General Rules—Seismic Actions and General Requirements for Structures. ENV 1998-1. CEN, Brussels (2005)