European Transport \ Trasporti Europei (2023) Issue 94, Paper n° 6, ISSN 1825-3997

https://doi.org/10.48295/ET.2023.94.6

Applicative experience of Italian Guidelines for safety and monitoring of existing bridges

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Abstract

Bridges are vital for transportation systems, as their collapse can pose serious threats to modern communities' safety, well-being, and economy. Recently, specific Guidelines for the classification and risk management, safety assessment, and monitoring of existing bridges have been issued in Italy as mandatory code. The Guidelines need to be applied and tested to identify any drawbacks and highlight the main factors influencing their results. This paper proposes a reasoned application of the Guidelines in a provincial context. A representative sample of concrete structures located in the province of Parma under the management of a single entity was considered. The determination of the structural attention class allowed for considerations on some applicative difficulties of the Guidelines. Particular attention was given to the analysis of the most recurrent pathologies of the structures.

Keywords: Bridges, Bridge Management System, structure decay, road management.

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1. Introduction

The collapse of more than ten bridges in Italy since 2013, with almost always deadly accidents involving structures in various regions of the peninsula, has highlighted the extent of the problem at a territorial level and the vulnerabilities of an aging and poorly maintained infrastructure system (F. Pinotti, 2018, Di Prisco et al., 2018, Zizi et al., 2023). The collapse of the Morandi Bridge in 2018 has brought to the public and lawmakers' attention the increasingly pressing problem of proceeding in a systematic and coordinated manner with the safety assessment and maintenance of infrastructure (Calvi G.M. et al, 2019). With the Decree of July 1, 2022, the Ministry of Infrastructure and Transport has released Guidelines for the classification and management of risk, safety evaluation, and monitoring of existing bridges. The Guidelines aim to provide a national framework for classifying and managing the risk and consistently evaluating the safety of existing bridges and viaducts. The objective is to establish a Bridge Management System (BMS)

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at a national level, which is a tool to assist the managing entities in choosing the optimal improvements to the network of bridges that are consistent with the agency's policies, long-term objectives, and budget constraints (Ryall, 2001, Scutaro et al., 2018). By 2026, the Guidelines must be applied by all public and private bridge and viaduct managers, including Anas, highway concessionaires, provinces, and municipalities.

This study aims to provide a critical analysis of the proposed working methodology in the Guidelines, through the application of Code to a sample of concrete bridges on a provincial network. The choice of a secondary road context is aimed at evaluating the response of the decision-making processes implemented in the document, in relation to a highly diversified context in terms of the type of structures involved, construction periods, and state of conservation. The study aims to deepen and comment on the key steps for a suitable framing of the health status of a structure and its consequent optimal management, highlighting strengths and operational difficulties where encountered. Finally, the elaboration of data collected from the sample has allowed for some considerations to be drawn regarding the most common causes of deterioration of the analysed structures.

2. Synthesis of the Italian Guidelines

The Guidelines provide a procedure for evaluating the safety of existing bridges. The document is divided into three parts, dealing with the inventory and classification of structures, the safety evaluation of the structures, and the monitoring and surveillance activities of the network. For the management of existing bridges, a multi-level approach based on six different levels is proposed. The complexity, level of details, and cost of the investigations increase progressively from level to level. At the same time, the number of structures on which to apply in-depth investigation tends to decrease. The proposed levels are not necessarily sequential and can be activated depending on the evaluations of the administrator. This allows for the optimization of resources available in terms of human and economic capital. The levels include: inventory of structures (Level 0), visual inspections and data collection (Level 1), determination of attention classes for the bridges (Level 2), preliminary safety evaluation (Level 3), accurate safety evaluation (Level 4), and network resilience evaluation (Level 5). The relationships between the various levels of the approach and their respective degrees of depth are summarized in the diagram in Figure 1.

The keystone of the entire method is represented by Level 2. The data collected during the inventory and inspections are catalogued and processed in order to obtain an overall attention class for each structure. Given the centrality of this step, it is necessary to delve into the nature of the processes that lead to its determination and the application of the subsequent phases of the method. The Guidelines propose a simplified estimation by classes and logical operators of the main risks related to bridges. They identify four attention classes: structural and foundation, seismic, landslide and hydraulic. Each class of attention can be identified by the following values: High, Medium-High, Medium, Medium-Low and Low. Operationally, the document identifies a series of parameters for the approximate estimation of hazard, vulnerability, and exposure associated with each class of attention. At a hierarchical level, a distinction is made between primary and secondary parameters. The latter has a corrective function on the level of judgment expressed by the primary parameter. The determination of each class of attention is achieved according to the logical flow proposed in Figure 2.

The classes of structural and foundational attention, seismic, landslide and hydraulic attention, are further combined to obtain the overall attention class of the bridge, an analytic decision on the possible vulnerabilities of the structure in relation to its context. This judgement allows to define a priority order for the programming of investigations, verifications and in-depth controls on the bridge, as well as the planning of resources aimed at maintaining the network in a continuous and adequate state of efficiency. Depending on the type of bridge and its overall attention class the minimum frequencies of periodic checks to be carried out are established, with intervals that tend to intensify as the attention class associated with the structure increases. For bridges with a Medium or Medium-High attention class, the so-called preliminary evaluations provided for in Level 3 of the method can be activated. These provide a simplified evaluation of the adequacy of the structure in relation to design loads. The interpretation of the results obtained can lead the entity to adopt a cautious management of the asset and the application of restrictive measures in terms of capacity, to the execution of higher-level analyses or the planning of extraordinary inspections. For bridges in the Medium-High class, continuous monitoring is provided. This option is also implemented for bridges falling into the High class that have shown structural fragility following visual inspections. For such structures, a safety assessment is also available, to be carried out according to the provisions of the current Technical Standards for Construction. The attention class is a dynamic data and must be redefined after each control or maintenance intervention carried out on the bridges, in order to establish almost in real time the priorities of the network.

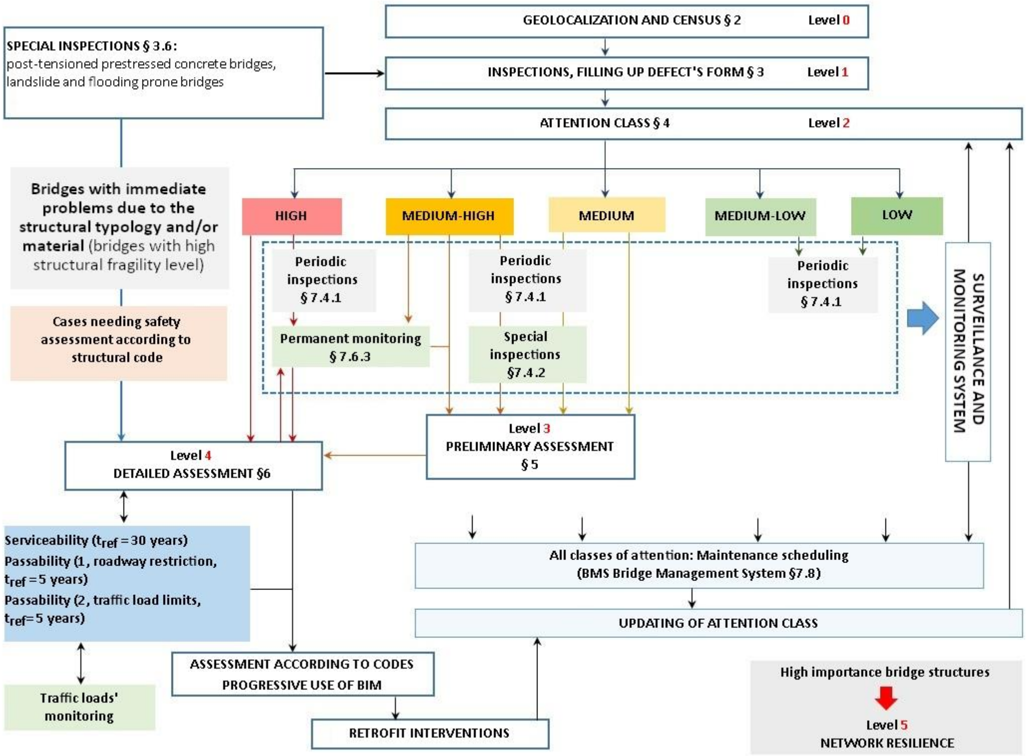

Figure 1: Multilevel approach and relationships between analysis levels.
Source: Santarsiero G. et al., 2021.

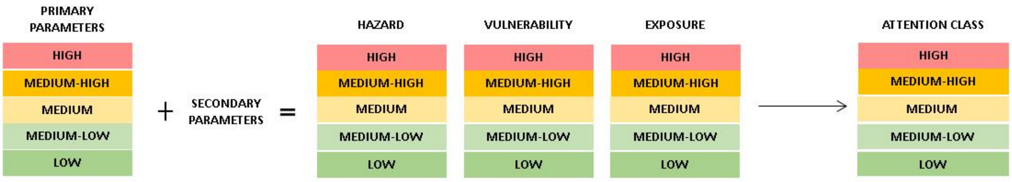

Figure 2: Logical flow for determining the attention class.

3. The investigated sample

The analysed bridges are located in the Province of Parma (Figure 3). The province has a flat territory in the northern zone, which gradually becomes hilly and mountainous as you move southwest towards the Apennines. The varied topography is also influenced by the interaction with the Po River and other watercourses belonging to its basin. One fact that highlights its territorial complexity is the number of crossings managed by the provincial authority: it is estimated that there are more than 800 bridges along over a thousand kilometres of roads. The indications proposed by the Guidelines are tested on a sample of 50 bridges, selected after an inspection activity carried out in collaboration with the Province of Parma in the three-year period 2018-2020, which concerned over 250 bridges located within the provincial territory (Freddi et al., 2020). To homogenize the sample as much as possible, attention was limited to reinforced concrete structures, both ordinary and pre-stressed. Each bridge was the object of a specific inspection and subsequent visual investigation, aimed at obtaining preliminary knowledge of the infrastructure and its correct location and structural description. For each bridge, the main geometric dimensions and the structural dimensions and articulation of the individual constituent elements were defined. The material and structural characteristics of each element were investigated - through direct inspections or documentary research. All the damage and degradation identifiable visually were mapped and catalogued, exhaustively representing the situation of the structures and the materials constituting the structure, thus providing an overview of the ongoing deterioration phenomena.

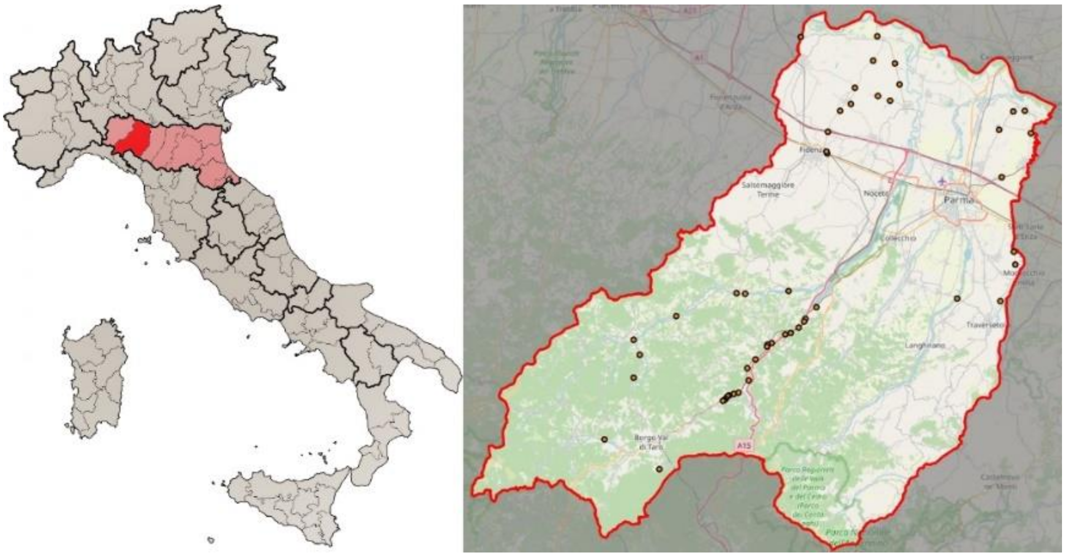

Figure 3: Geographic framing of the sample.

As expected from a context of secondary roads, the total lengths of the crossings are contained: more than half of the sample have a length of less than 50 meters, one-third of the crossings have a length between 50 and 200 meters. The remaining part exceeds 200 meters (Figure 4). The longest viaduct has a length of 341 meters, distributed over 11 spans.

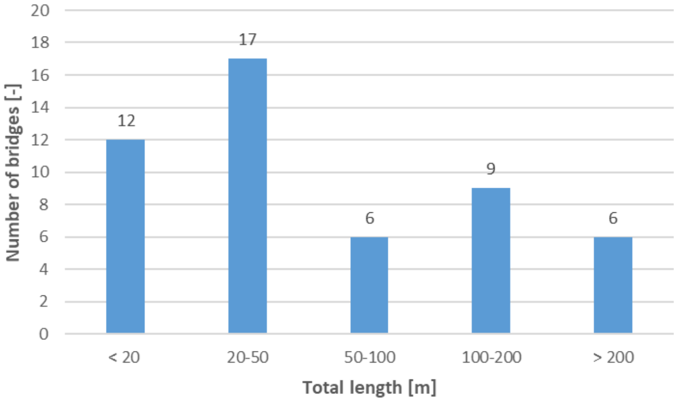

Figure 4: Distribution of the sample based on the total length of the bridge.

As shown in Figure 5, the most common static scheme is the simply supported beam, followed by continuous beams and slabs, both supported and framed. In addition, the sample also includes three arch bridges and two Gerber beam bridges.

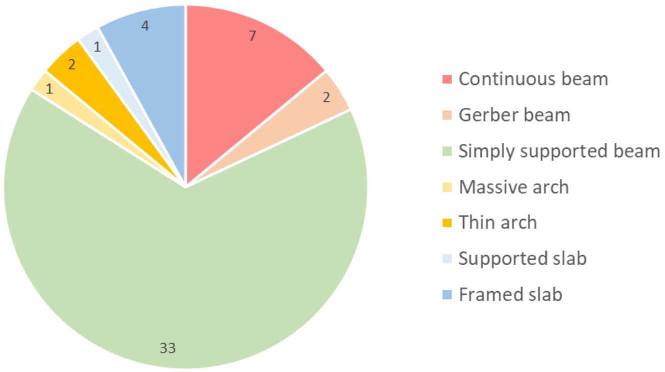

Figure 5: Sample distribution ad a function of the static scheme.

Despite the efforts made, documentary research has not always produced satisfactory results. Often, the documentation found has been incomplete as far as it difficult to determine the exact year of construction of the artifact. The data has been defined with absolute certainty only for 13 bridges, for which graphic, descriptive, accounting and testing documents have been found.

In the absence of exhaustive design documentation, a reasoned estimate of the data was made, based on the comparison between the type and construction details adopted in the realization phase of the structure and recurring solutions in different decades from the beginning of the 20th century to the present day. In some cases, the estimate was based on the year of construction of the roadway of the bridge (Figure 6).

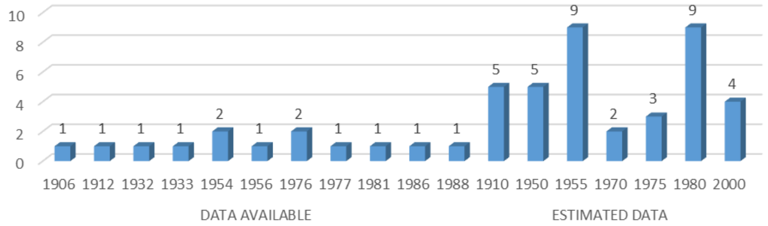

Figure 6: Sample distribution following the estimation of the year of construction.

4. Structural and foundational attention class

The success of Level 2 is largely dependent on a weighted evaluation of the structural and foundational Attention Class. Given the centrality of this step in the entire workflow, the present study aims to analyse the parameters that influence its success by applying normative indications to the investigated sample. Operationally, the Guidelines identify the main parameters that influence the structural behaviour of a structure under normal operating conditions (Table 1).

Table 1: Parameters influencing structure and foundations risk.

Risk component	*Primary parameters*	*Secondary parameters*
Hazard	Extent of loads expected with special reference to the transit of exceptional transport.	-
Vulnerability	Level of degradation Static scheme, max span length, material and number of spans.	Degradation speed Design standard
Exposure	Average daily traffic and mean span length	Road alternatives Entity bypassed Transport of dangerous goods

The risk level is defined based on two factors: the maximum allowable mass and the frequency of commercial vehicles (with a load capacity of over 3.5 tons) for a single travel lane. The sample under examination was analysed based on a history of data stored in the portal of the Emilia-Romagna region relating to 2019. The frequency of commercial vehicle transit was found to be low (≤ 300 vehicles/day) for 54% of the sample and medium (300 < vehicles/day < 700) for 18%. For the remaining 28%, it was not possible to find any data on the intensity of heavy traffic flows. For these bridges the data was estimated through comparative evaluations with flows detected on roads with similar characteristics. For these structures, the frequency of commercial vehicle transit was found to be low.

Moreover, the standard introduces the maximum allowable mass as a classification of the road where the bridge is located. It is provided that the definition of this parameter is responsibility of the manager of the network. Five classes are introduced to assign to the road denominated by letters from A to E depending on the loads expected on the route.

The definition of the parameter for highway contexts, homogeneous in characteristics, is simple. Conversely, estimating a unique parameter for secondary roads, which are heterogeneous in type, complexity, and conservation status of the structures involved, can be difficult. In this study, the provincial routes of interest were analysed and divided into segments with similar characteristics. Each identified section was properly classified based on the maximum allowable mass. In defining homogeneous segments, any punctual load limitations present on individual structures were also taken into account. Out of the total of investigated bridges, 21 showed no load limitations, 28 fell into category B, and 1 fell into category C. By crossing the road class with data on the frequency of significant mass traffic, the hazard class of each bridge in the sample was identified (Figure 7).

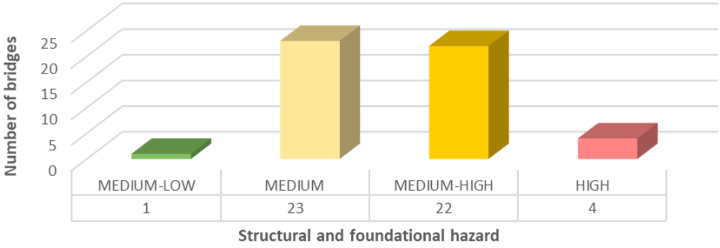

Figure 7: Sample distribution as a function of structural and foundational hazard.

The vulnerability factor is related to the conservation status of a structure and its structural design in terms of static scheme, number of spans, and materials. The year of construction, the design norm used, and the history of planned maintenance interventions on the bridge since it was put into operation are also relevant.

The health of the bridge is assessed through the defectiveness level. A high defectiveness level leads to a high vulnerability. The level of defectiveness is not considered sufficient for estimating the vulnerability of a bridge. According to the standard, the rate at which degradation has occurred has to be evaluated. For a long-lived structure whose service life is close to the expected design working life, certain levels of degradation appear to be physiological. Conversely, if detected on recently designed and constructed structures, the same levels of degradation can be even alarming. The concept of the rate of degradation evolution is correlated with the year of construction of the structure or the year of the last significant maintenance intervention. Three categories of interventions are identified: before 1945, between 1945 and 1980, and after 1980. Belonging to one of the mentioned categories implies a more or less severe correction degree on the level of defectiveness. Further correction is made considering the design standard of the structure. The technician is required to have a greater awareness of the assumptions underlying the design of the structure, which mainly concern the actions and traffic patterns for which the structure was designed, as well as the design approaches used in the calculation. The goal is to determine whether, compared to the current regulations, any variations in the load of the structure can or cannot lead to an intensification in the vulnerability of the bridge. The Guidelines study the evolution of traffic loads provided by past regulations, analyse and compare the effects of the formulations contained therein, and introduce in a simplified way a classification of the bridge based on the year of design and its predisposition to the transit of only civilian (2nd category bridges) and/or military (1st category bridges) loads.

After applying the corrections established by the secondary parameters at the level of defectiveness, a final combination is made with a primary parameter related to the intrinsic vulnerabilities of the structure. With this step, it is emphasized how some vulnerabilities already manifest themselves in the design phase. In fact, the construction material determines a propensity of the structure to specific types of degradation. The definition of the geometry, the idealization of the functioning of the structure with a precise static scheme, and the use of some construction details (for example the Gerber dapped-end), entail a greater or lesser sensitivity of the structure to stresses and settlements and its natural predisposition to brittle or ductile collapses. For the simplified estimation of these aspects, the standard provides a series of tables for which, once the static scheme is identified and the maximum span and the material of the deck are determined, the vulnerability class to be associated with the structural characteristics of the bridge under evaluation is obtained. The logical flow of Figure 8 proposes the steps for determining the Vulnerability Class of the bridge. If the bridge has more than three spans, the vulnerability class is increased by one level, otherwise it remains unchanged.

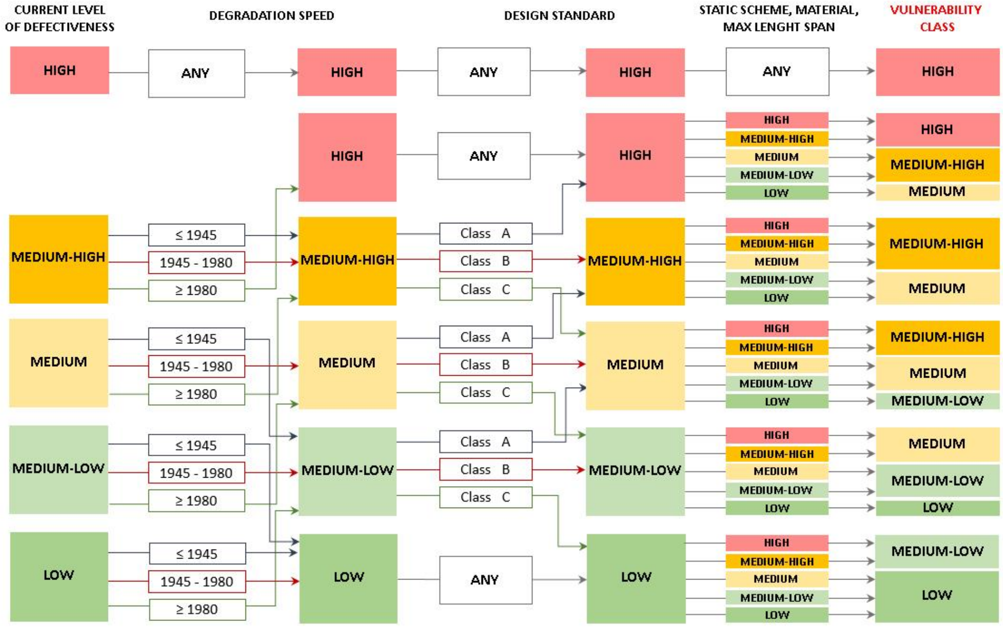

Figure 8: Determination of the structural and foundational vulnerability class.

The processing of the data collected from the visual inspection campaign of the sample bridges allowed determining a level of defectiveness for each of the 50 structures. The results obtained are summarized in Figure 10.a. At this stage, it was also possible to conduct an analysis of the most recurrent defects within the sample, whose evidence is discussed and commented on in the following paragraph. As highlighted in the presentation of the sample, for 37 bridges, the available documentation did not allow to confidently determine the year of construction of the structure and identify a history of significant maintenance interventions. For these structures, a reasoned estimate of the data was provided according to the criteria previously introduced. Its uncertainty affects the degree of accuracy with which the rate of degradation evolution of these structures is established. Based on the assumptions introduced and the evidence found for the remaining part of the sample: 9 bridges fall into the category for interventions prior to 1945, 25 fall into the category for interventions between 1945 and 1980, and 16 fall into the category for interventions after 1980. The distribution of the sample is represented in Figure 9. The lack of original design documentation has made it difficult to confidently trace the design calculation methodologies and schemes. To overcome the limitations imposed by the documentation scarcity, where conditions allowed, the data was hypothesized after documentary research that involved an in-depth analysis of the normative indications proposed in the texts that came into force over the years and the consultation of manuals used in different historical periods in professional practice. In the absence of credible assumptions, as suggested by the guidelines, the structures were considered as second class, sized for the transit of only civil loads. In light of this consideration, according to the design standard, 18 bridges in the sample fall into Class A and 32 into Class B. Figure 10.a represents the distribution of the sample according to the defectiveness level only. Figure 10.b highlights the evolution of the parameter following the corrections imposed by the secondary parameters affected by the discussed uncertainties. There is a general increase in the level of defectiveness, partly due to the low level of knowledge reached on the sample.

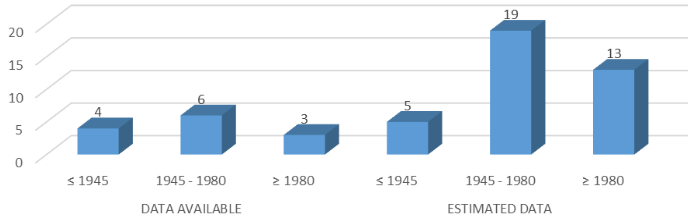

Figure 9: Sample distribution as a function of the rate of degradation evolution.

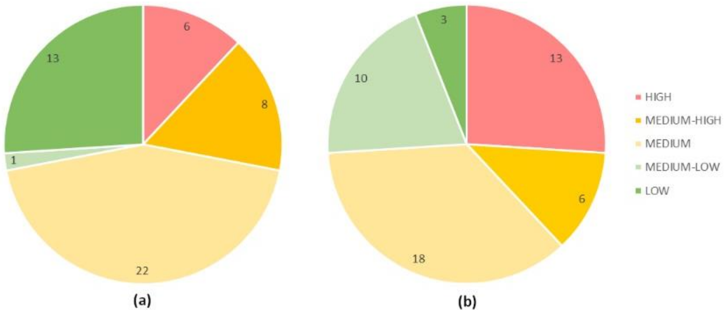

Figure 10: Sample distribution as a function of: (a) level of defectiveness; (b) level of defectiveness corrected by secondary parameters.

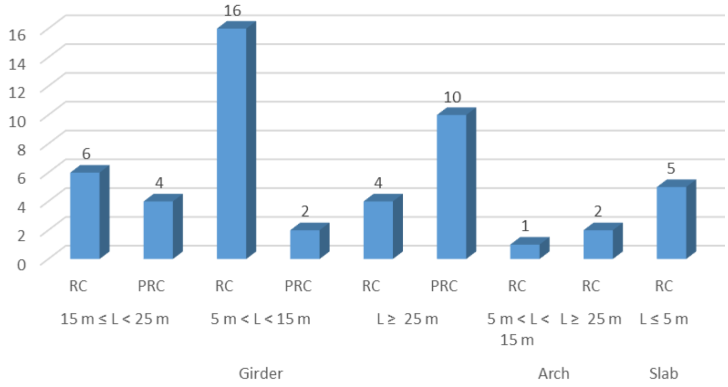

Figure 11: Sample distribution as a function of static scheme, span, and material.

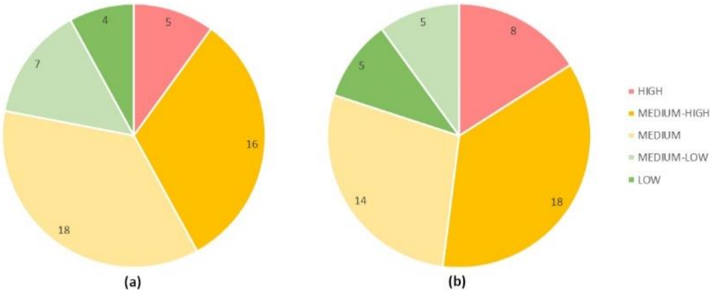

Figure 12: Vulnerability due to static scheme, construction material, and length of the longest span.

In Figure 12.a, intrinsic vulnerabilities of the bridges were estimated based on static scheme, maximum span, and material of construction. The combination of primary parameters allowed for the determination of the Vulnerability Class. Figure 12.b includes the additional correction factor for bridges with more than three spans, which was applied to 16 bridges within the sample.

The level of exposure assesses the consequences of a potential service interruption of the road network due to the collapse of one of its element. Simulating possible scenarios due to the collapse of a bridge inevitably involves estimating damages in terms of human and economic capital. The latter aspect is associated with marked margins of uncertainty, as it is inextricably linked to the times and methods of restoring the connection. Depending on the extent of the event, the restoration time can be estimated in months or years and has a negative impact on economic activities in the areas affected by the effects of the interruption. For this reason, the estimation of the level of exposure has to be based on a simplified assessment of the network's ability to absorb the consequences of exceptional events. In practical terms, the probability of human losses is linked to two primary parameters: the Average Daily Traffic (TGM), i.e., the average number of vehicles traveling on the entire width of the carriageway in one day, and the average span of the structure. The logic suggested by the standard provides that as the average span of a structure increases, the risk to which the user is exposed during transit increases. Secondary parameters are introduced, such as the presence of alternative roads and the identification of the type of entity crossed. The logical flow for determining the level of exposure of the structural and foundational class is shown in Figure 13.

In this phase, it is necessary to request information from the managing entity regarding the possibility of dangerous goods passing over the structure, which can cause significant damage to people and the environment. The transit of such materials results in an increase in the exposure of the structure. Formally, this aspect is not related to an increase in the exposure class obtained from the flow in Figure 13. The transit of dangerous goods is used as a secondary parameter to define a priority order among structures belonging to the same attention class.

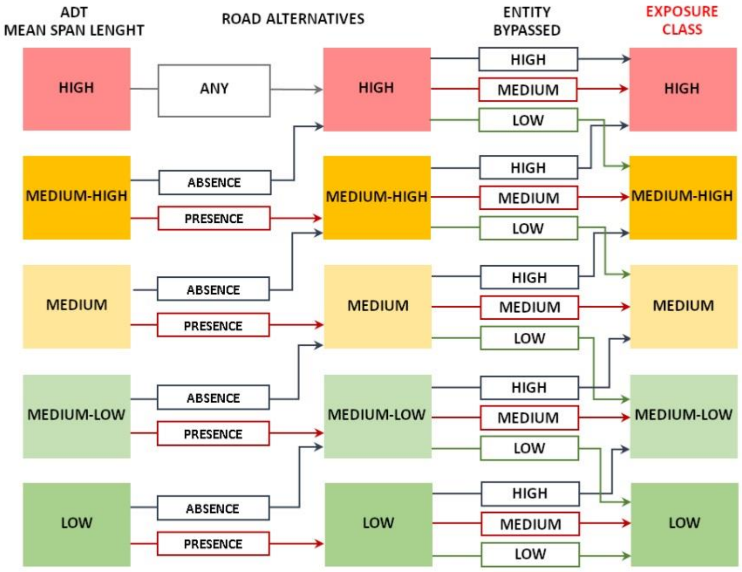

Figure 13: Logical flow for determining the class of structural and foundation exposure.

Some considerations regarding the data that have influenced the results of the exposure levels of the sample are reported. The average span of 32 structures is less than 20 meters, while the remaining 18 have an average span between 20 and 50 meters. In terms of Average Daily Traffic (ADT), for 33 bridges, the number of transits is low (≤ 10000 vehicles/day), while for 2, it is medium (10000 < vehicles/day < 25000). For the remaining part of the sample, it was not possible to retrieve the data related to ADT from the portal of the Emilia-Romagna region or from the owning entity, nor through specific transport studies. For these bridges, the data was estimated through comparative evaluations with the transits detected on similar nearby roads. For these structures, ADT was found to be low. Regarding the secondary parameters, the exposure level associated with the type of entity crossed is medium for 47 crossings. These are crossings on secondary roads or watercourses. Only 3 bridges cross primary roads and, therefore, fall into the high exposure level. For each of the analysed structures, suitable alternative routes were identified in terms of costs, times, and distances, on which traffic flows can be diverted in case of closures or traffic restrictions on the bridge. Therefore, this parameter did not influence the results presented below.

Interactions with the managing entity permit to establish that the transit of dangerous goods on the bridges of the sample is merely occasional and does not increase the exposure of the structures under examination. Figure 14 represents the exposure levels of the structures in the sample as a function of the parameters discussed above. Once again, a distinction is made into 5 classes (Low, Medium-Low, Medium, Medium-High, High). The data shows contained levels of exposure, in line with the context under study.

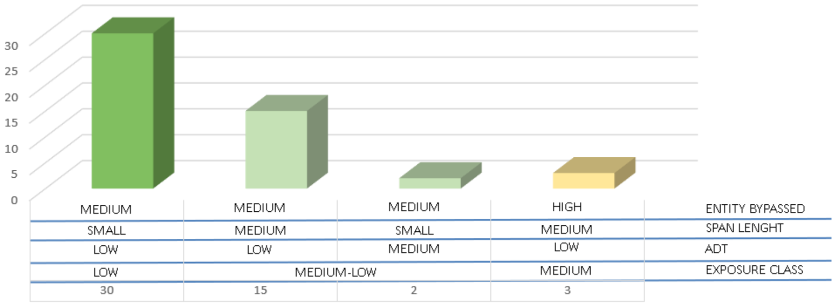

Figure 14: Sample distribution as a function of the class of structural and foundational exposure.

The determination of the structural and foundational attention class is carried out by combining, for each bridge, the results obtained in terms of hazard, vulnerability, and exposure. It is reiterated that bridges with a high level of defectiveness and consequent vulnerability class are associated with a high structural and foundational class, which ultimately results in a high overall attention class for the bridge. In conclusion of this part of the study, the distributions of the sample in terms of structural and foundational attention class are reported (Figure 15).

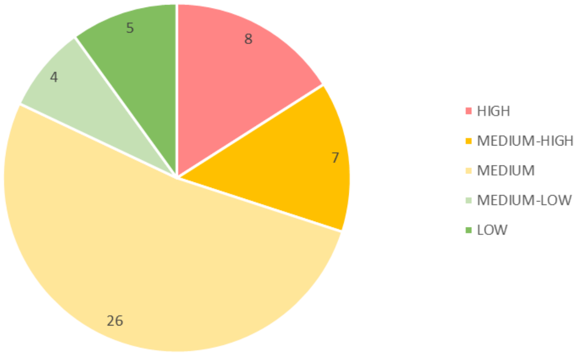

Figure 15: Sample distribution according to structural and foundational attention class.

5. Evaluation of recurrent forms of deterioration

For each structure in the sample, the level of defectiveness of each structural element of the bridge was estimated. Each form of deterioration found was mapped, critically analysed for its type, and its intensity and extent were estimated. Subsequently, a level of defectiveness was assigned to the entire structure based on the highest level of defectiveness found in each subgroup of the structure. At the end of the process, 6 structures presented a high level of defectiveness, 8 medium-high, 22 medium, 1 medium-low, and 13 low. The analyses permit to identify the most recurrent forms of deterioration within the sample, shown in Figure 16.

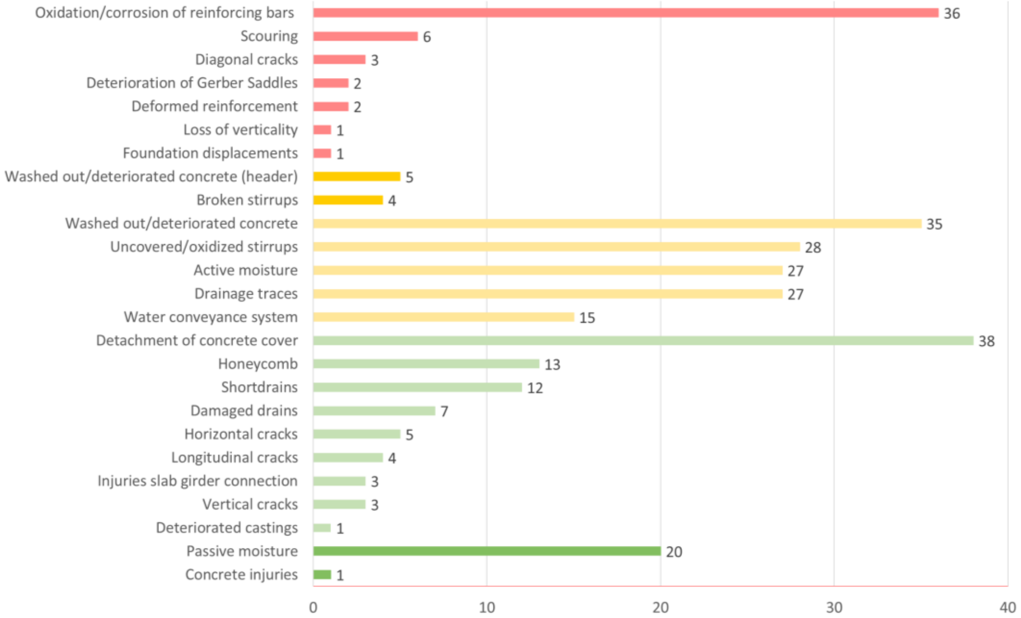

Figure 16: Pathologies found in the sample.

From the collected data, it can be seen that among the defects of medium and medium-low severity, problems related to the deterioration of concrete surfaces are recurrent: washout and presence of moisture stains. Most of these issues can be easily attributed to dysfunctions in the rainwater removal system. More than half of the bridges show design defects: 15 structures do not have a water conveyance system, and 12 have drains of insufficient length to optimally channel water from the roadway. Maintenance deficiencies, such as clogged manholes and damaged drains, have to be added to the design deficits. The washing action of water, the presence of humid and particularly aggressive environments are direct causes of the detachment of the concrete cover. As evidence of this claim, out of the 38 bridges where washout deterioration was observed, 32 showed signs of concrete cover detachment on various elements. Although the data show a strong correlation between the two defects, possible underestimation of the concrete cover thickness during the design and construction phases, as well as the limited bar spacing, should not be forgotten as causes of detachment. The lack of an adequate covering layer determines the exposure of the longitudinal and transverse reinforcement to the surrounding environment. If prolonged, the action of aggressive agents causes the oxidation and corrosion of the reinforcement bars (Petrangeli M.P. 1993). In the most extreme cases, there is a progressive decrease in the section of the bar, which results in a reduction in the load-bearing capacity of the element in which it is inserted. The data show that 36 bridges in the sample have corroded reinforcement bars, and 28 have exposed and corroded stirrups. Only four structures have broken transverse reinforcement bars. Two bridges in the sample have an isostatic scheme in which Gerber dapped-ends are inserted. As established in paragraph 3.3 of the Guidelines, these elements must be considered critical to the structure because the consequences of any deterioration can have repercussions on its behaviour (Mornati, S et al., 2021, Kun et al., 2015). Both structures showed forms of advanced deterioration attributable to the infiltration of platform water that has favoured rapid deterioration processes of the concrete and reinforcement, placing them in the highest attention class.

Another defect that can compromise the global static behaviour of a bridge is certainly the scouring of piles or abutments, which is the removal of solid material around the immersed supports of a structure due to the watercourse (Pefano R. 2021, Laursen, E. M. et al., 1956). Statistically, worldwide and also in Italy, the main causes of bridge collapses are of hydrogeological nature (C.Lee, G. et al., 2013). The analysed sample presents 6 multi-span artifacts with scouring problems.

Looking at the defect sheets, there are only two types of cracks that have a significant impact: diagonal cracks and transverse cracks. These two lesions should be sought in the structural elements of bridges because they can be warning signs. If diagonal cracks are present on piles and abutments, these may have formed as a result of foundation settlement or differential ground pressures, while on elements such as beams and piers, they are located at the position of maximum shear or bending of the reinforcement; in this case, they have a structural origin and are due to excessive stresses and/or insufficient reinforcement. Transverse cracks, on the other hand, develop on beams, crossbeams, slabs, and arches along the transverse axes and are caused by the use of poor-quality concretes, insufficient transverse reinforcement, or reinforcement with a high pitch (Cosenza et al., 2019). The Guidelines consider the presence of very extensive and intense crack patterns critical, as they facilitate the infiltration of water and aggressive agents such as salt used during winter maintenance (Shi, X. et al., 2010, Autelitano et al., 2019) through the material, favouring the presence of moisture stains, washing out, and weakening of the concrete.

The bridges in the sample are mostly affected by less extensive and intense lesions, with the exception of some cases where diagonal, vertical, and horizontal cracks were detected. For the evaluation of the condition of accessory elements such as pavements, curbs, sidewalks, light poles, utilities, drainage, and guardrails, any defects are recorded based on the weight assigned in the reference sheet, without specifications regarding the intensity and extension of the defect. In the analysed sample, the road pavement is cracked and deteriorated in more than 50 percent of cases, mainly at the joints, which are of the sub-pavement type, except for five cases in rubber/neoprene. The study allowed a focus on the state of conservation of the bridge parapets: in only one case, they were absent, and in 33 percent of cases, they were damaged or poorly anchored.

6. Conclusion

The Italian Guidelines for the classification and management of risk, safety assessment and monitoring of existing bridges fill a regulatory gap in the national legislative framework and represent a turning point in the management of existing infrastructure assets. The strength of the document lies in the attempt to standardize data collection and decision-making processes that lead to a reasoned judgment on the health status of the structure and the consequent drafting of an asset management plan.

The paper is intended as an example of the application of the method on a provincial road context. The input data and the dynamics between different types of information were described. The evolution of the data collected on the sample as a function of the decision-making processes implemented in the document was observed. After the experience it is possible to state that the determination of the global class of attention of a bridge is not affected by the uncertainties due to the level of knowledge reached on the structure only when it shows a marked level of degradation. In all other cases the absence of information about the year of construction, the design assumptions and the maintenance history performed on the bridge introduces a level of uncertainty to the data.

This problem can be significantly reduced through historical-critical analysis and comparative procedures with structures of similar characteristics. The uncertainties of these processes inevitably affect the accuracy of the results obtained and the scheduling of maintenance work.

The last part of the work is dedicated to the evaluation of the forms of degradation found in the sample. The data collected can be useful to managing authorities in defining intervention strategies and maintenance plans aimed at mitigating the development of aggressive forms of degradation.

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