G7 ITALIA 2024

MOST

POLITECNICO MILANO 1863

G7 Transport Academic Workshop

Policies and practices for mitigation and adaptation: the motorway concessionaire industry perspective

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Wednesday, 10th April 2024 - Aula Magna "Carassa e Dadda"
Politecnico di Milano, Bovisa Campus, Milan (Italy)

Agenda

A. The Italian motorway system: key features

B. Definition of infrastructures resilience

C. ASPI's planning process on resilience, adaptation and mitigation

Follow-up Morandi Bridge 2018

ASPI's planning analysis

Necessity of regenerative maintenance and upgrades

D. Conclusions: lessons learnt from concrete experience

Collapse of Morandi Bridge 2018

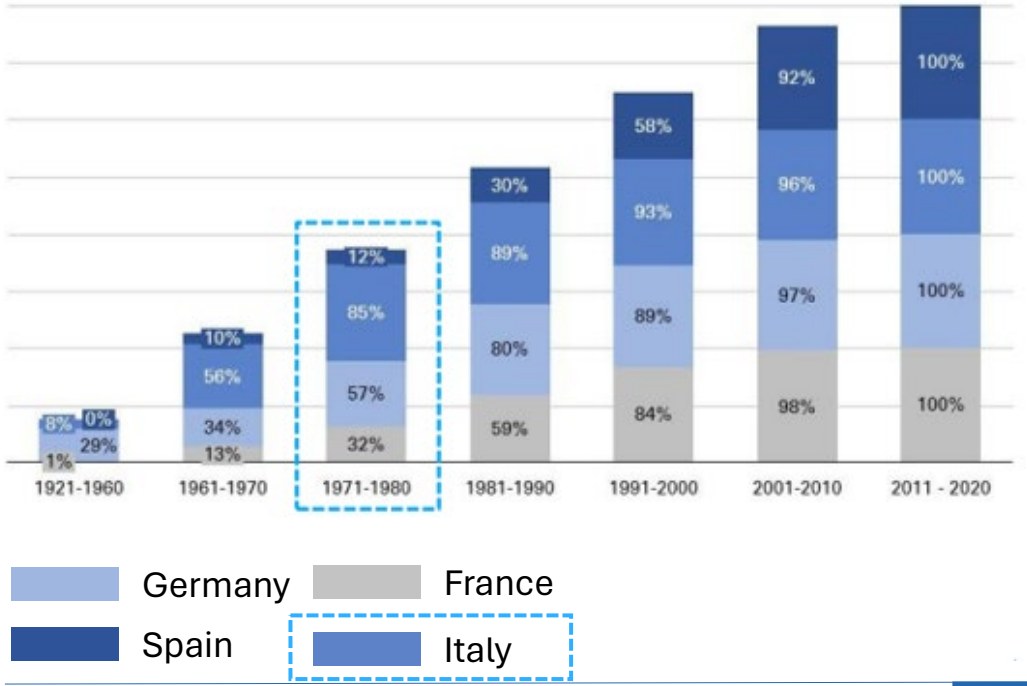
The floods in Toscana and Emilia Romagna 2023

The Italian motorway system: key features

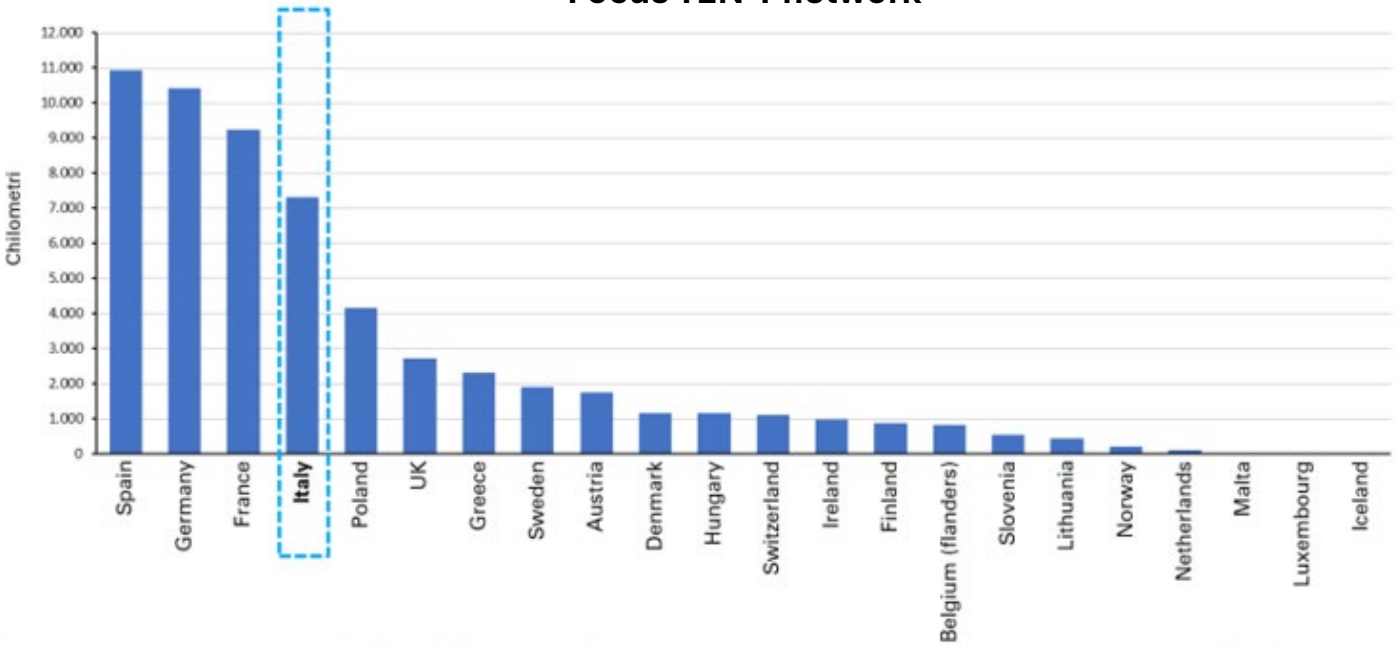
The Italian motorway system is one of the most developed in Europe: after Spain, France and Germany, Italy is the fourth European country in terms of the extension of its motorway network.

This network is also one of the oldest, most fragile and busiest in Europe: at the end of the 1970s, 85% of the current motorway network was in operation in Italy, compared to 57% in Germany, 32% in France and 12% in Spain.

Period of construction of European highways[1]



Total length of the motorway network at European level[2]
Focus TEN-T network



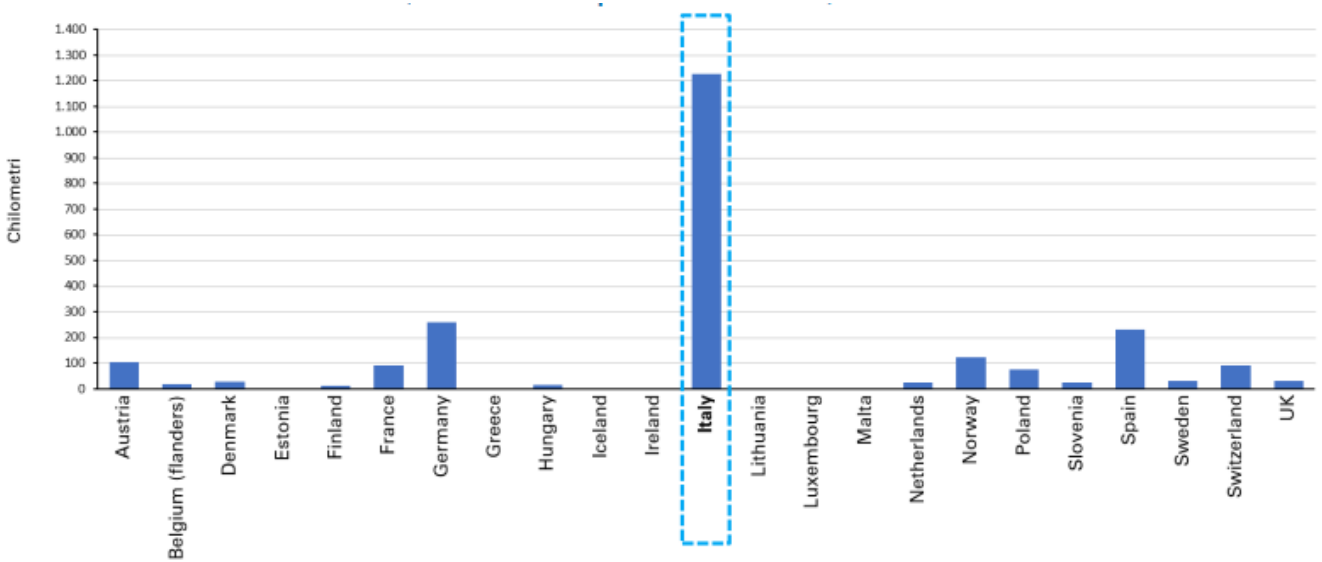
[1]For Italy the source is ''AISCAT in cifre'' July 2022; for Germany the source is Auìutobahn GmbH
[2] Source: ''2021 Pan European Road Network Performance Report'', CEDR Working Group Performance od Road Network

The Italian motorway system: key features

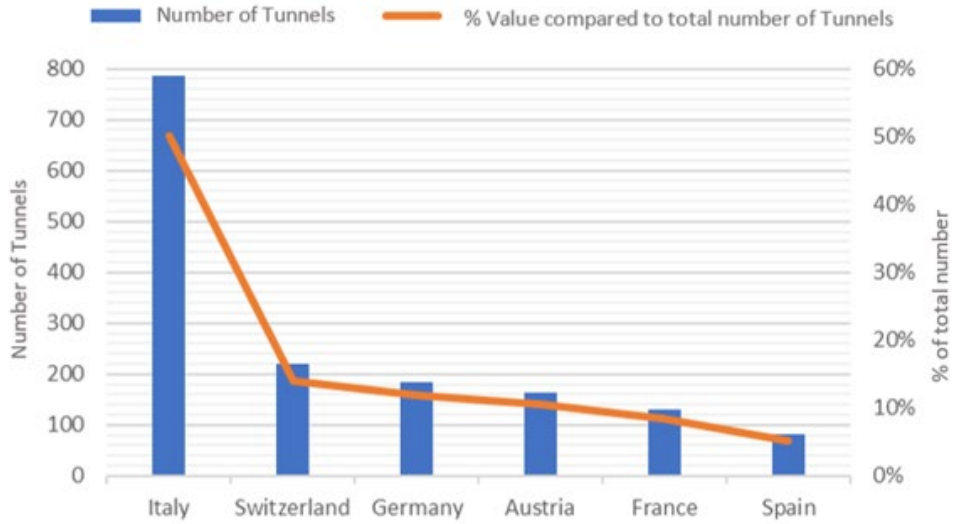
The Italian motorway network is the first in terms of orographic complexity: more than 2.000 km on 7.000km of the entire network are bridges and tunnels infrastructures.

If we consider the TEN-T network, Italy is the country with the highest number of km of bridges (1.200km) and the number of tunnels, with 50% of the tunnels compared to the total of the main European countries.

Total length of bridges at the European level
Focus TEN-T network



Number of tunnels in the main EU countries and the trend in the % value vs total number of tunnels



Data source for Germany: Die Autobahn GmbH des Bundes, data source for France: ASFA, data source for Spain: SEOPAN, data source for Italy: AISCAT in cifre 2018, data source for Austria: ASFINAG, data source for Switzerland: FEDRO

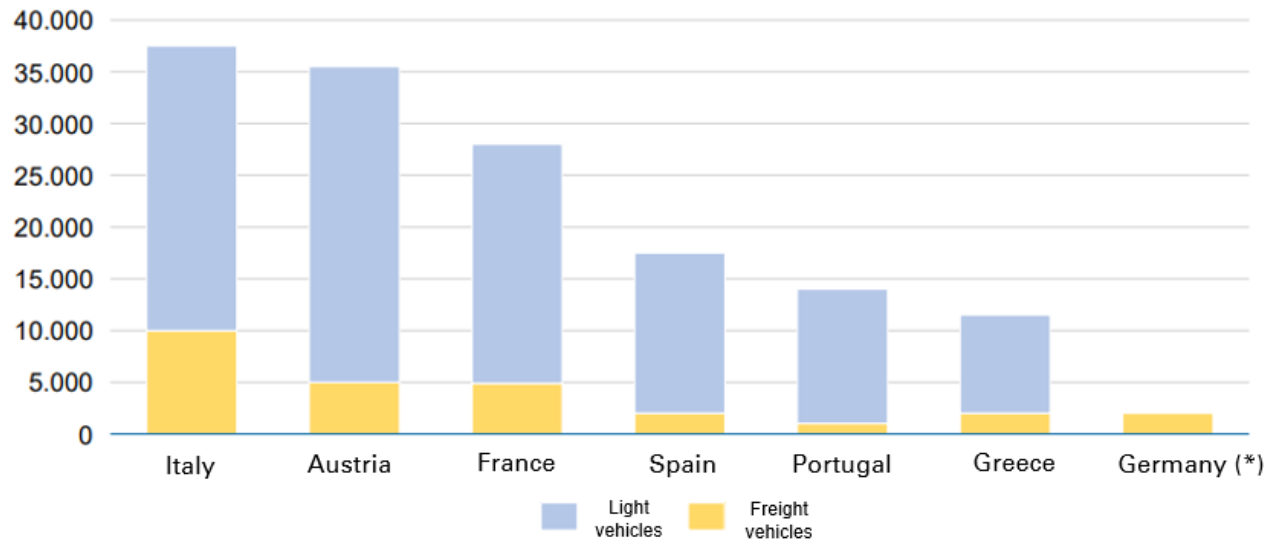
The Italian motorway system: key features

Comparing the traffic using highways in major European countries, the different degree of intensity of use and thus the different role of highways within the transportation and logistics systems of the relevant countries becomes clear.

Once again, the supremacy of the Italian highway network with the highest average degree of utilization of its infrastructure is highlighted.

- In Italy, motorway volumes are 65%** higher than the average value of other countries
- AADTV: in Italy 40.000 against 30.000 in France and 20.000 in Spain
- AADTV freight: in Italy 10.000 trucks against approx. 5.000 in France and 1.000 in Germany

Annual Average Daily Theoretical Vehicles - AADTV (ASECAP 2021)

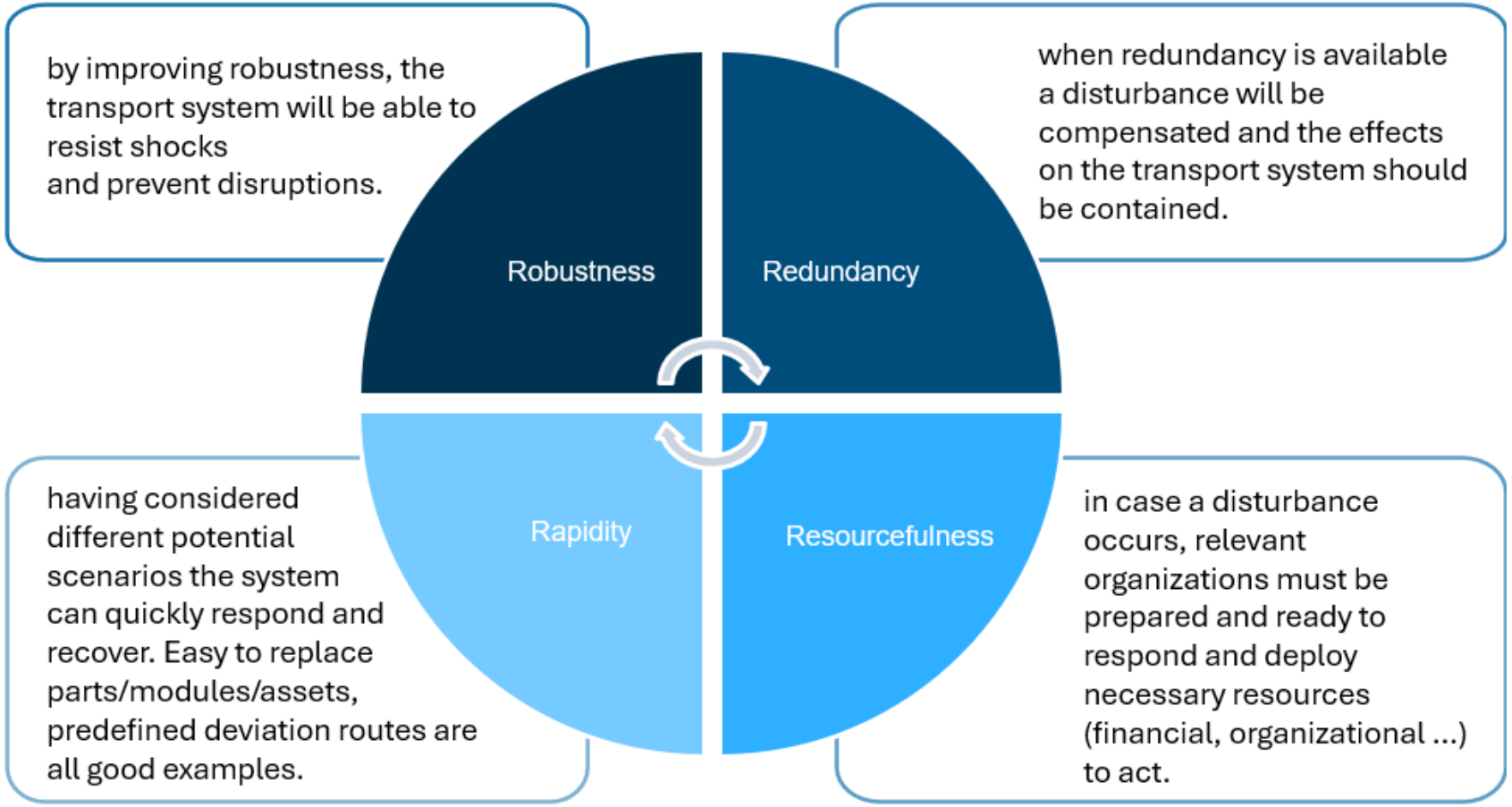


*In Germany only freight vehicles are detected
**The average was calculated by weighting the volumes in relation to the km of network in each country. Germany was excluded from the calculation because light vehicles are not included.

Definition of infrastructures resilience

Resilience is a property that characterizes both the individual element (e.g., a bridge, a tunnel) and the individual section (e.g., the A1 Milan-Bologna), as well as the entire network (highway, road, etc.), progressively increasing the complexity of the system.

The concept of resilience applied to a transportation network is closely related to vulnerability: Bruneau's approach, referred to the 4R, aims at measuring resilience to natural disasters.



M. Bruneau, S. Chang, R. Eguchi, G. Lee, T. O'Rourke, A. Reinhorn, M. Shinozuka,K. Tierney, W. Wallace, D. Winterfledt, "A Framework to Quantitatively Assess and Enhance the Seismic Resilience of Communities", Sage Journal, 2003, DOI: 10.1193/1.1623497

ASPI's planning process on resilience, adaptation and mitigation

Critical event

The **collapse of the Morandi bridge in Genova 2018** raised an alert on the vulnerability of the whole transport systems and **a profound revision of technical regulations** to define clear rules for the global safety assessment of existing assets and the related evaluation of operating conditions was implemented.

Extreme events

In Italy, in 2023, the extreme events increased by 22% from the previous year. Damage, for just the two events in Toscana and Emilia Romagna regions, is estimated in more than 10 billion euros. After these events, ASPI adopted **a new procedure at corporate level** to minimize downtime, restore the services and minimize the impacts on traffic.

ASPI's planning process on resilience, adaptation and mitigation

Follow-up Morandi Bridge 2018

BEFORE 2018

The technical regulations for main assets (tunnels, bridges, viaducts, barriers) established:

Not codified inspections; Not specific technical regulations for the assessment and planning of interventions on existing assets; **Prevalence of local interventions aiming at repairing single parts or damaged elements**

AFTER 2018

In 2022 the **New Guidelines** for risk classification and management, safety assessment and monitoring of existing bridges and tunnels were published by the Italian Superior Council of Public Works, **providing a management multi-level model of surveillance and assessment, to obtain a ranking list of the regenerative maintenance, to prolong the infrastructures life span.**

SCOPE	BRIDGES	TUNNELS
TECHNOLOGIES ADOPTED/ CONSTRUCTION PROCEDURES.	**Bridges regulation focused attention on post-tensioned tendons, which have shown their limitations (lack of injection) that can trigger degradation processes.**	**Galleries regulation focused attention on the absence of tunnels waterproofing (pre-1980s) which is responsible for preservation issues**
LEVEL OF KNOWLEDGE	• Substantial change in inspection methods • Reports on materials and construction details • Special reports in presence of post-tensioned tendons	• Substantial change in inspection methods • Reports on materials and construction details • Diagnostic insights to restore the external layer conditions
PLANNING APPROACH	• Necessity to perform global tests ex NTC2018 • Usage of heavier loads compared to previous technical regulations • Demand of major performance compared to previous technical regulations	• Demand of major performance compared to previous technical regulations • Adoption of focused interventions aimed at solving the degradation causes • Definition of wide lifetime interventions to limit repeated impact on traffic

Before 2018: Extraordinary maintenance – After 2018: Regenerative Maintenance

The planning process on resilience, adaptation and mitigation

ASPI's planning analysis

The Italian highway network is characterized by a "structural vulnerability" that is above the average of other countries and it presents a highly differentiated gradient of "transport strategic index," offering overall a varied picture of complex situations concentrated in specific areas of the territory.

Vulnerability Index

To measure the need for infrastructure modernization, the vulnerability of the Italian highway network was mapped according to:

- age of first opening of the highway section
- viaduct and tunnel incidence
- seismicity

Transport Strategic Index

It measures the importance of the individual highway section and the potential impact generated by the road works on it.

It depends on:

- average daily traffic
- Accessibility (number of toll plaza/km)
- anthropic area
- Redundancy (alternative paths)

Complexity Index

Vulnerability Index and Transport Strategic Index provides a measure of the potential impacts of regeneration roadworks.

Vulnerability Index

Transport Strategic Index

Complexity Index

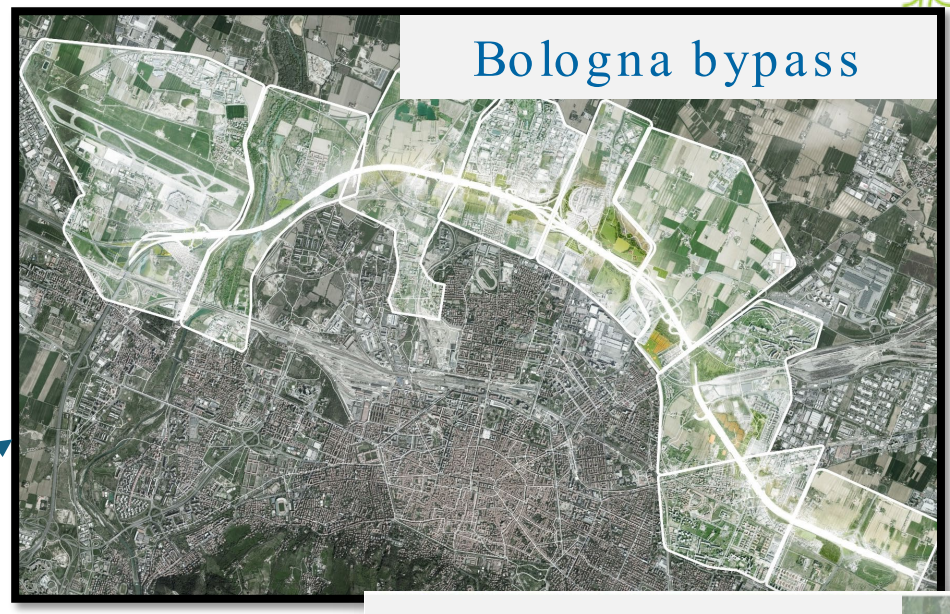
Necessity of regenerative maintenance

1.500 bridges in regenerative maintenance (180 km)
596 tunnel arches in regenerative maintenance (370 km)
4.800 km requalified safety barriers
350 km new acoustic barriers

Necessity of upgrades

165 km divided 100km expansions to third and fourth lanes and 65km of new tracks along the network
26 new tunnels (55 km),**17** new bridges and **50** new overpass
100 bridges affected by expansions
500 enhanced underpasses and hydraulic crossings
50 km new acoustic barriers

Bologna bypass



The project foresees the **enlargement of both Bologna motorways system and ring road**. It's the first motorways infrastructure in all Europe to receive the **Envision Certification** (Platinum Rating – the highest level reachable).

Genova bypass

The purpose is to **shift the long-haul traffic** from the existing highway crossing the urban area to an external new one (almost all in galleries)

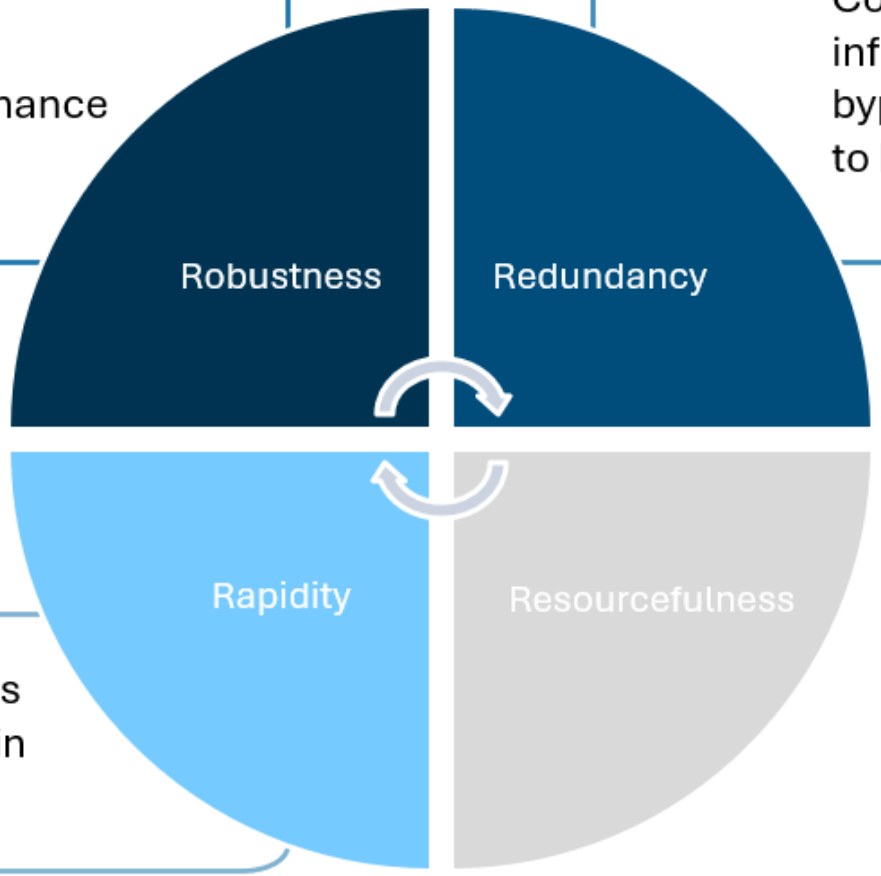
	The floods in Toscana 2/10/23 - A11 motorway involved	The floods in Emilia Romagna 1-4/05/23 and 16-18/05/23 – D14 and A14 motorway involved
damage 	• Loss of function of hydraulic crossings • Pavement (350.000 m^2) • Highway body disruption • Failure of safety barriers and fence net • Culvert obstructions and tree failure	• 3 km of traffic island barriers and more than10 km of side edge barrier • Pavement (50.000 m^2) • +10 km of highway embankment and hydraulic regulation works and +30 km of fence network
task force 	• **30 men** from the Firenze Trunk Directorate and **20 men** from AMPLIA and contractors • **30 work vehicles** between AMPLIA and contractors • **TECNE employees** involved for construction management and safety coordination.	• Autostrade per l'Italia has activated a task force of **100 men and more than 50 vehicles**, in addition to **500 men and 110 vehicles from AMPLIA and contractors**
milestone 	• **14h after closure**, full A11 reopens with one way through in Pisa direction at East Prato • in **less than 48 hours** reopening of two transit routes at East Prato in the direction of Pisa	• **Reopening D14** after only **8 hours** after closure • **Reopening A14 only 30 hours after the closure**, with the most affected section (Forlì-Cesena) to one lane in each direction in a roadway swap • **Restore all 6 lanes** of the most affected section of the A14 after only **5 days after the event**

Conclusions: lessons learnt from concrete experience

Collapse of Morandi Bridge

Improve the assets' robustness through regenerative maintenance and continuous monitoring activities

Construction of new infrastructures, i.e. Genova bypass and Bologna bypass to have route alternatives

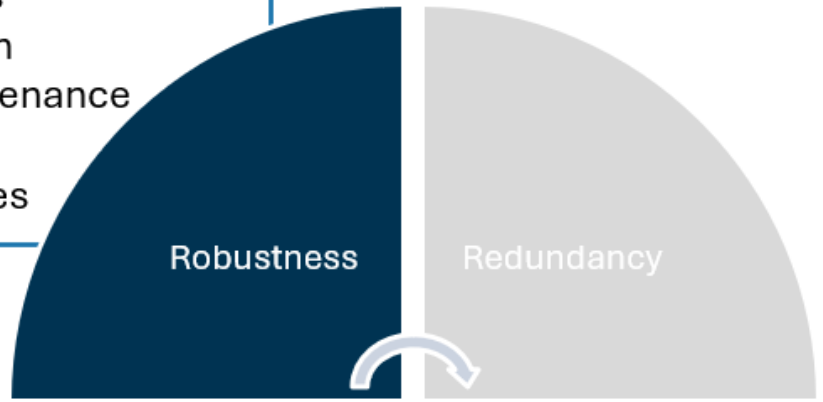


The new bridge was planned and built in less than 2 years

Conclusions: lessons learnt from concrete experience

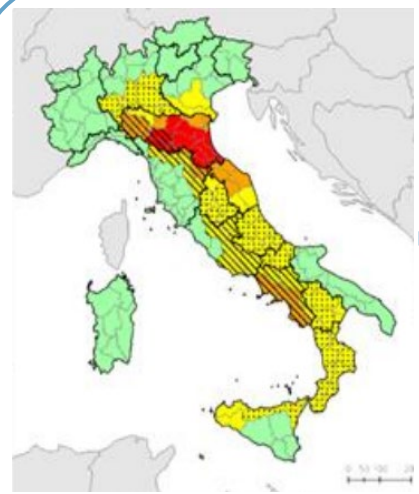
The floods in Toscana and Emilia Romagna

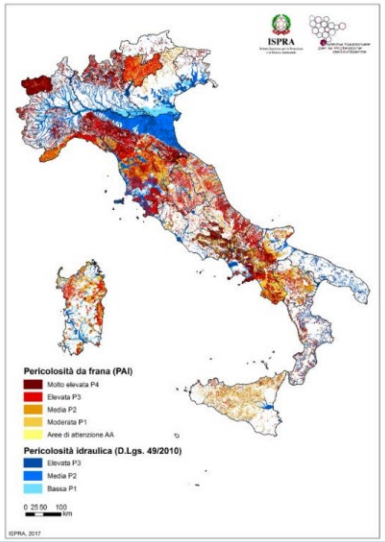
Improve the assets' robustness through regenerative maintenance and continuous monitoring activities



8h for Ravenna branch rehabilitation and 30 hours to restore one lane in each direction for the worst-affected section of the A14 highway and 5 days to restore all lanes

New procedures adopted at the corporate level to minimize downtime: a multi-level approach that brings together bulletin of civil protection, hydrogeological and landslide hazard maps and class of attention





Class of attention
(Guidelines 2022)

During the floods, the teamwork has shown a high reactivity that has allowed to restart the operation in a very short time. So as a lesson learnt the company has decided to publish a new internal procedure to standardize this good practices in similar situations.

THANK YOU

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