EXISTING BRIDGES: RISK OF FAILURE IN THE CLIMATE CHANGE CONTEXT

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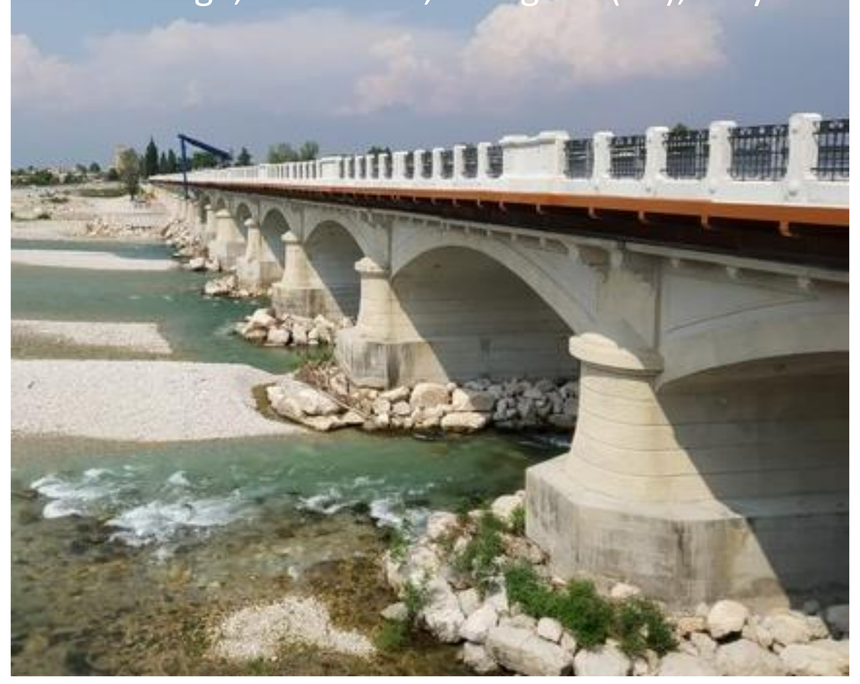
1. INTRODUCTION

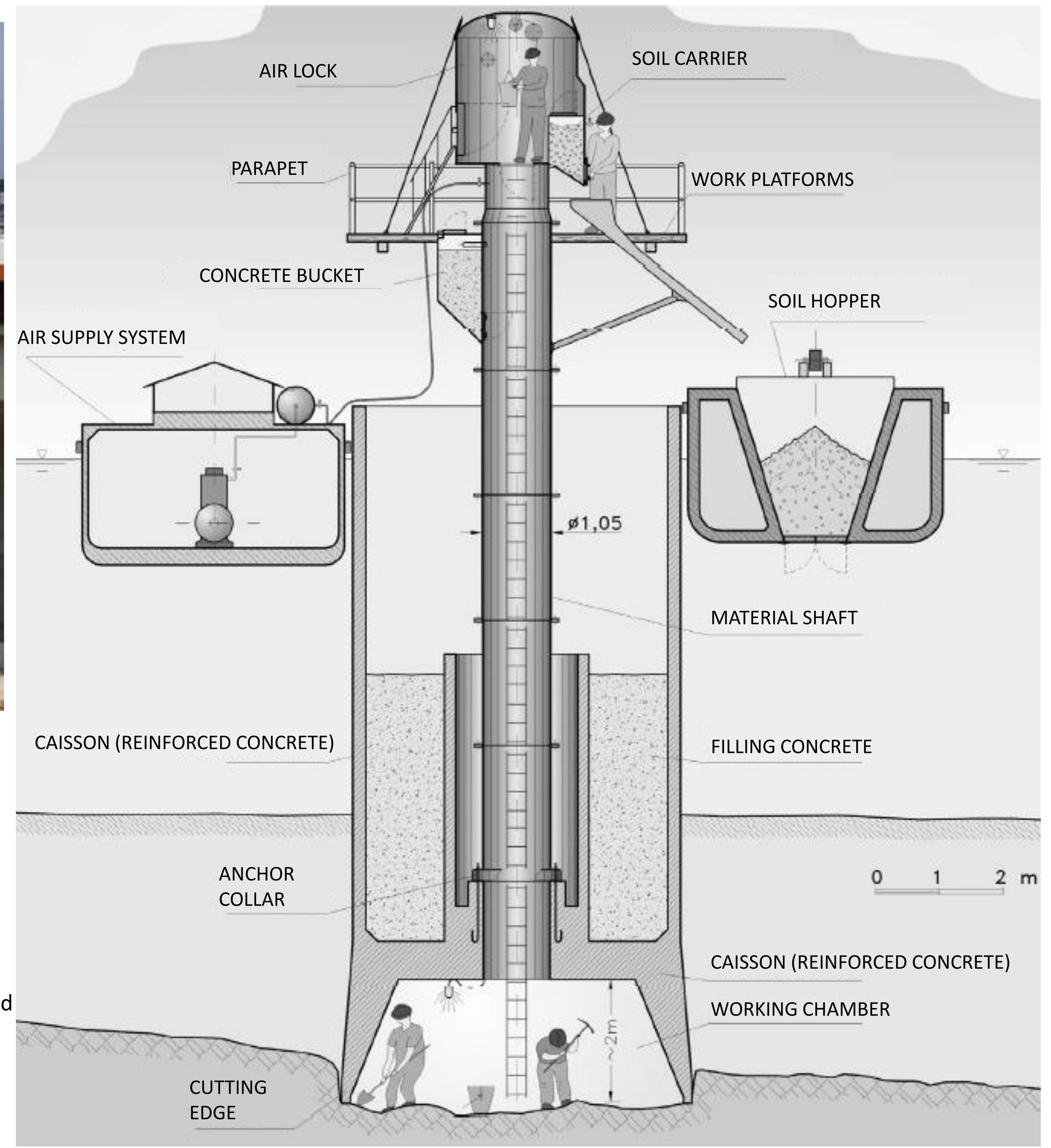
More than 50% of **bridge failure** are related to **hydraulic phenomena** (e.g. Montalvo et al., 2020; Wardhana & Hadipriono, 2003), like scour around pier and abutments, if a proper foundation deepening is not provided in the design. In the present climate change context, the risk of bridge collapse is growing following the frequency increase of extreme events (e.g. Seneviratne et al., 2021).

In Italy bridges rebuilded after 2nd world war has been characterized by **large pneumatic caisson**, and only after 1960 the use of pile foundations has been widely adopted.

Many bridges realized in the past are actually still working thanks to the ancient custom of **filling** the initial **scour** around bridge piers and abutments with **launchable stones** after each relevant flood event

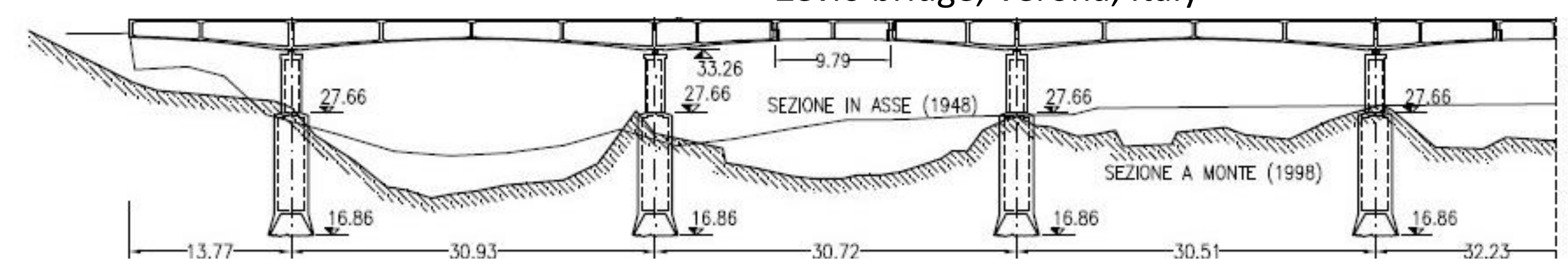
Priula bridge, Piave river, Susegana (TV), Italy

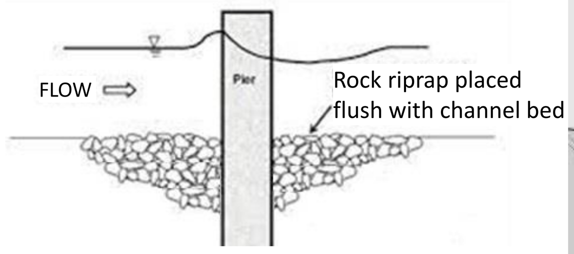




Along the time, the rip-rap deepens in sand/silt riverbed material, assuming an inverted **conical shape.**

Zevio bridge, Verona, Italy



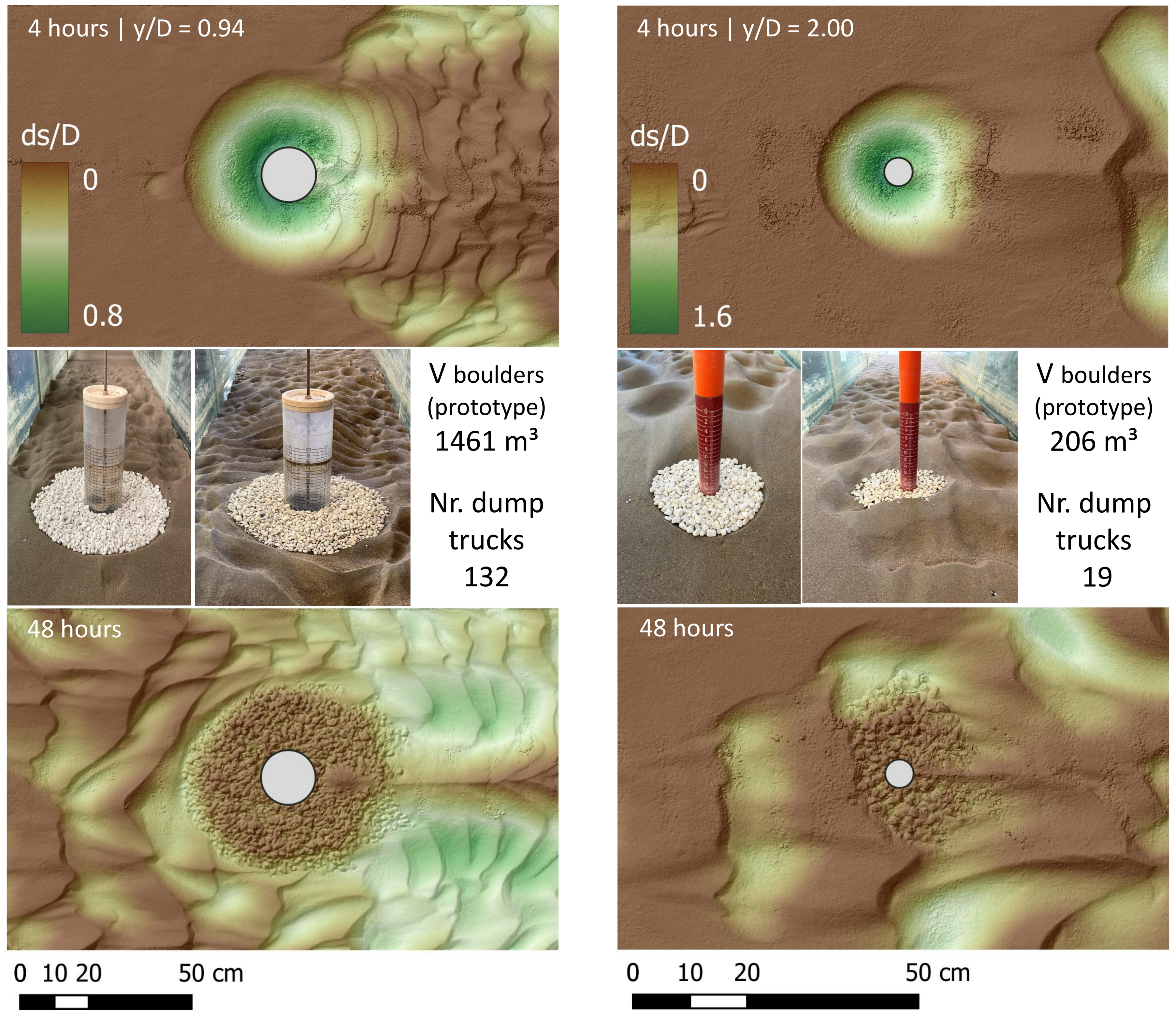


2. METHOD

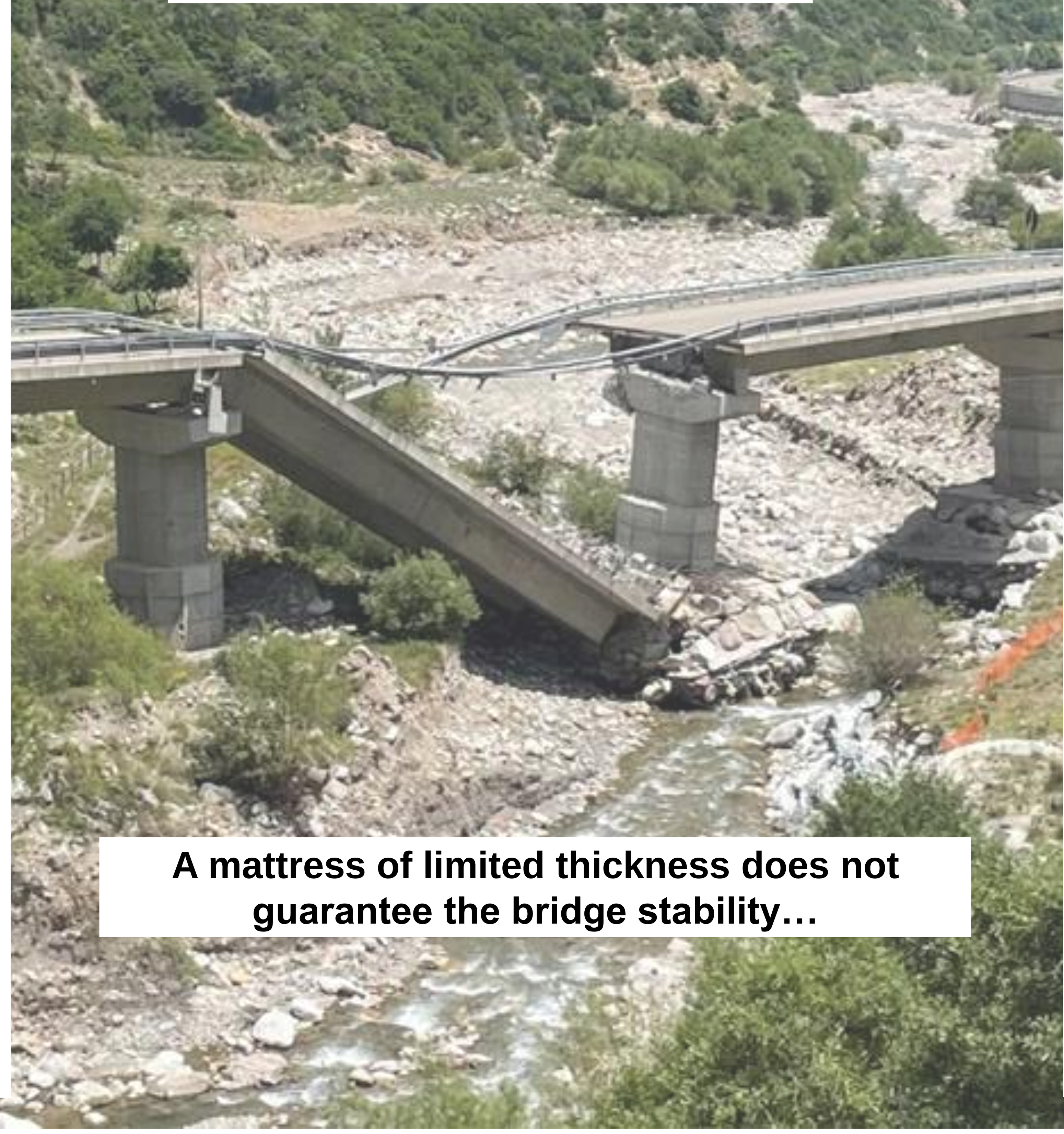
The effectiveness of launchable stones is investigated by **physical modelling** of the sediment-flow-structures interaction in a rectangular flume 1 m wide and 15 m long, using quite uniform sands (median grain size d_{50}=0.34mm) to simulate the riverbed.

According to the Froude and Shields similitudes, and assuming a **geometric scale of 1:50**, the scour (obtained in steady state conditions with U/Uc=0.9) after 4 hours simulates the effect of a flood event lasting about 28 hours in the prototype. The scour has been filled by gravel with d_{50}=9mm (**50 cm** in the prototype), that is the material commonly adopted as **launchable stone**. Then, the experiment has been run for the next 44 hours (model scale) to simulate a sequence of flood events.

3. RESULTS 1/2

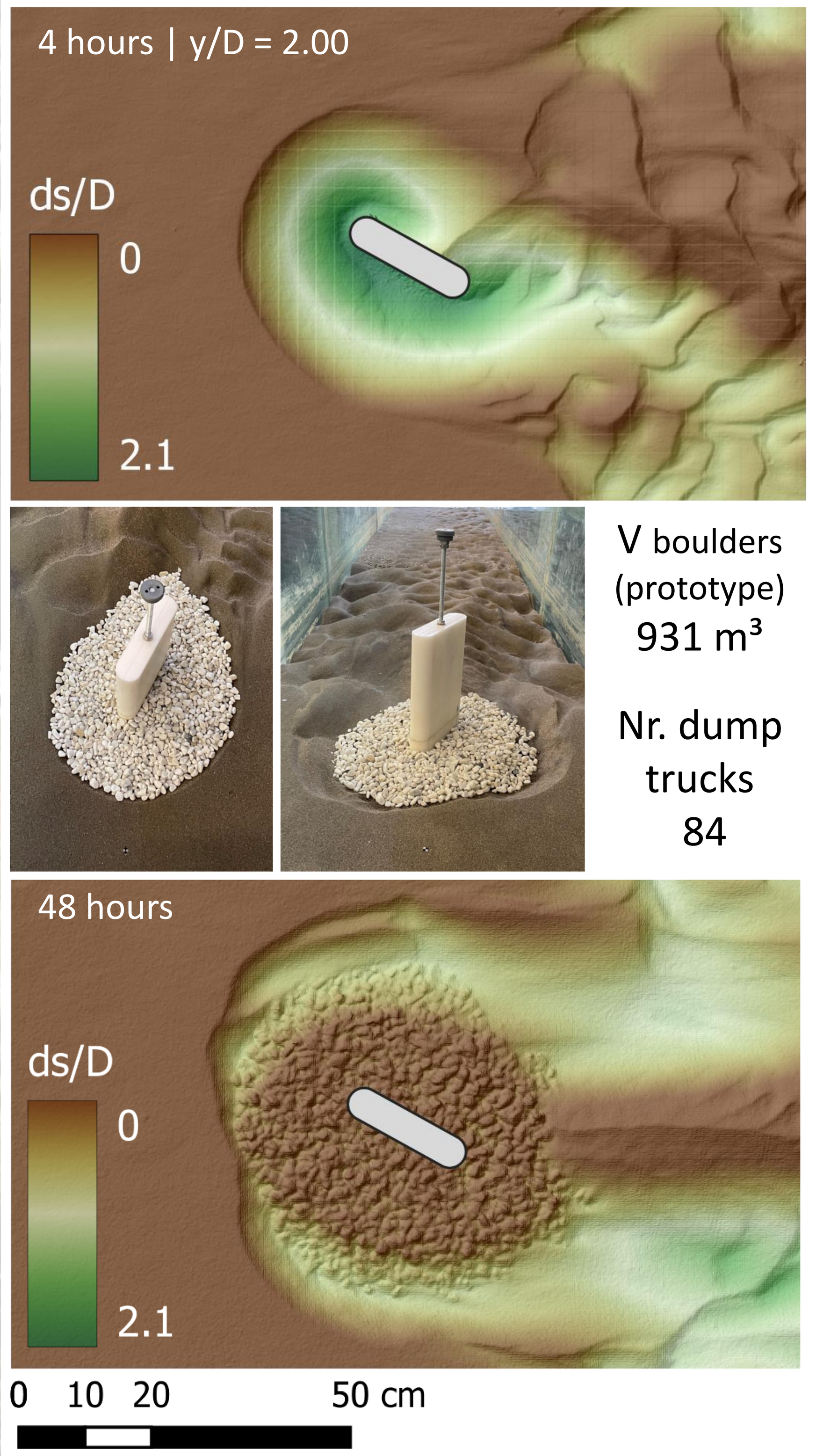


Trionto bridge, Longobucco (CS), Italy May 2023



A mattress of limited thickness does not guarantee the bridge stability…

3. RESULTS 2/2



Legend
y = flow depth
D = diameter

Circular pier
y/D = 0.94 | y = 15 cm | D = 16 cm
y/D = 2.00 | y = 10 cm | D = 5 cm

Elongated pier
y/D = 2.00 | y = 10 cm | 5 x 20 cm²
skew-angle = 30°

The experiments reproduce two wide piers (y/D<1), two narrow piers (y/D>1), and an elongated round-nose pier. The **stability** of the of **old bridges** protected with several subsequent filling of scoured volume with **launchable stones** has been verified in the range 0.9<U/Uc <1.1.

Large volumes of stones are requested to fill the scoured volume, even if in the real world this is accomplished in several years.

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