Advisory Mission on Infrastructure Resilience after Cyclone Ditwah

FINAL REPORT

10-21 December 2025

Summary

1. Introduction

Following the request for assistance submitted by the Government of Sri Lanka on 29 November 2025 through the Union Civil Protection Mechanism (UCPM), in response to the impacts of Cyclone Ditwah, the EU mobilised an EU Civil Protection Team (EUCPT) structural engineer expert and Italy deployed technical expertise through a seven-member engineering assessment team, which was later expanded to ten members.

The mission took place from 10 to 21 December 2025 and focused on damage and resilience assessment of critical infrastructure affected by floods and landslides, with particular attention to bridges, roads, railways, dams, and landslide-prone areas.

During the mission, strong coordination mechanisms were established with the Disaster Management Centre (DMC) and sectoral authorities, including the Road Development Authority, Sri Lanka Railways, and the Irrigation Department. A total of 40 infrastructure assessments and 17 drone surveys were completed within five days across multiple provinces, covering approximately 6,400 km. The assessments addressed both immediate damage and broader resilience considerations, in line with "Build Back Better" principles.

Key outputs included detailed assessment reports, a georeferenced database of assessed assets, drone survey products, and a comprehensive debriefing delivered to national authorities and international partners. The mission demonstrated the effectiveness of deploying UCPM experts in close coordination with national technical teams, highlighted the value of multidisciplinary approaches, and identified clear opportunities to link assessment results to future Post-Disaster Needs Assessments (PDNA).

Overall, the mission successfully met its objectives, provided actionable technical recommendations to the Government of Sri Lanka, and contributed to strengthening national capacities for resilient infrastructure.

This report contains main findings and recommendations and the results of the conducted assessments.

2. Overview of the situation

At the end of November 2025 Sri Lanka was impacted by Cyclone Ditwah, which brought heavy rains for several days. As of 12 December 2025, when the team arrived in the country, Disaster Management Centre, (DMC) reported 639 fatalities, 210 missing persons, nearly 84,700 evacuated people, and approximately 1.7 million affected individuals. DMC also indicated 5,588 fully damaged and 87,496 partially damaged houses nationwide.

According to the "Joint Rapid Needs Assessment – Phase 1 I Sri Lanka I 2 December 2025", 78 roads were damaged or rendered temporarily impassable and 15 bridges collapsed, particularly in the Western Province and several landslide-prone districts in the hill country and flood-prone areas. Road impacts range from flooded to collapsed sections and damaged bridge approaches, causing partial or complete loss of access in some areas. In parallel, railway infrastructure has also suffered significant disruption: several key lines experienced track flooding, embankment failures, and earth slips, leading to suspension or reduced daily turns from 200 to 74, and has been interrupted 4 main lines out of 9 throughout the country. The National Building Research Organisation (NBRO) estimated a number of 1,241 landslides

affecting infrastructure. The Mavil Aru dam breached caused flooding across Trincomalee District. Power outages affected about 30 percent of the country.
As of now, emergency clearance is ongoing, with some services and primary roads gradually reopening, but full restoration of safe, reliable connectivity for both road and rail will require extensive short-term repairs and longer-term reconstruction.

3. The team

The overall team was composed of 11 Italian experts: 10 as members of the Italian team and 1 deployed as TL of the UCPT. The experts were drawn from Italian institutions involved in resilient infrastructure, including the Italian Civil Protection Department (https://www.protezionecivile.gov.it/en/), Italferr (https://www.italferr.it/en.html), Network of Seismic and Structural Engineering Laboratories (https://www.reluis.it/en/), Red Cross (https://cri.it/), and the Directorate General for Dams and Water Infrastructure of the Ministry of Infrastructure and Transport (https://dgdighe.mit.gov.it/). Team members arrived at different times. The composition of the team and the mission duration for each member are shown in the following table.

			December											
			10	11	12	13	14	15	16	17	18	19	20	21
Agostino Goretti	UCPT TL, Structural engineer	DPC	■	■	■	■	■	■	■	■	■	■	■	■
Paolo Vaccari	IT-Team TL	DPC	■	■	■	■	■	■	■	■	■	■		
Francesco Giordano	IT-Team DTL, Bridge expert	DPC		■	■	■	■	■	■	■	■	■	■	
Paolo Putrino	Landslide expert	DPC		■	■	■	■	■	■	■	■	■		
Marco Cassani	Documentation	DPC		■	■	■	■	■	■	■	■	■	■	
Luigi Evangelista	Railway expert	Italferr		■	■	■	■	■	■	■	■	■		
Rossano Lerra	Railway expert	Italferr			■	■	■	■	■	■	■	■	■	
Luigi Di Sarno	Bridge expert	ReLuis					■	■	■	■	■	■	■	
Stefano Melosi	Drone Pilot	Red Cross		■	■	■	■	■	■	■	■	■	■	
Roberta Ventini	Dam expert	MIT						■	■	■	■	■	■	
Simona Guglielmi	Dam expert	MIT						■	■	■	■	■	■	

UCPT TL, Italian team composition and duration of the mission (including travel)

4. Conducted activities

Main activities included:

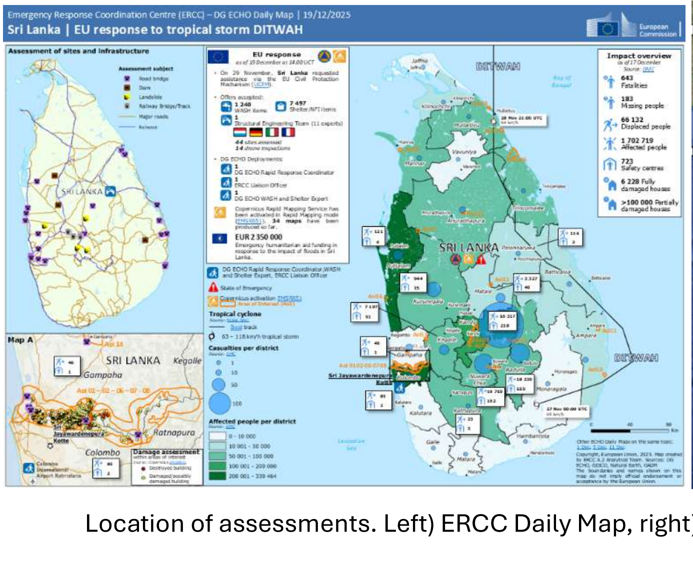
- liaison with the DMC at both the central and district levels. The DMC focal point was Ms Dushyanthi Wijesuriya, HADR Coordinator on behalf of the DMC.
- liaison with the EUCPT LO, ERCC, EU Delegation
- liaison with the HQ of the Italian Civil Protection Department, Italferr, ReLuis, Red Cross and General Directorate for Dams and Water Infrastructure.
- liaison with focal points of the Sri Lankan administrations responsible for infrastructure: the Road Development Authority (Ministry of Higher Education & Highways), the Sri Lanka Railway Department (Ministry of Transport), and the Irrigation Department (Ministry of Irrigation)

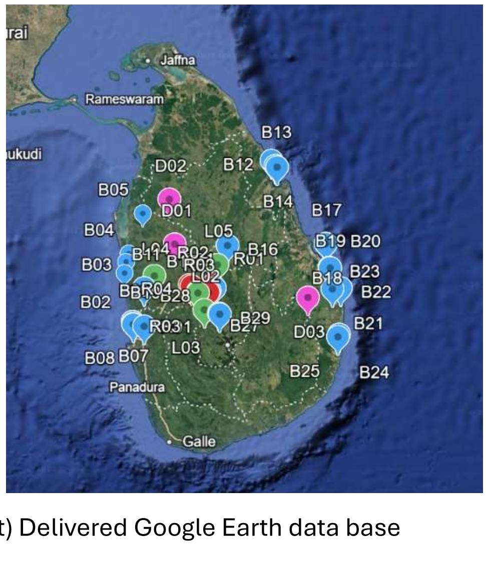
- participation to the initial meeting, organised by DMC on 12 December 2025, during which infrastructure sectors presented their assessment priorities. Later on, the same day, DMC summarised and validated these priorities
- Completion of 40 assessments and 17 drone surveys in 5 days, covering approximately 6,400 Km, with 1, 2 or 3 teams deployed on site per day. During each assessment, representatives from the relevant infrastructure sector, as well as central or district DMC representatives, were present on site.
- Participation to debriefing meeting with presentation of the mission results on 19/12/25.
- Delivery of geodatabase of assessments, assessment reports and supporting documentation (pictures, drone surveys and technical documentation).

The breakdown of assessments by day and sector, followed by their localisation is shown below.

	Railway bridges/tracks	Road bridges	Landslides	Dams	Drone surveys	
13-dic	1	1	3		3	
14-dic	3	5	2		2	
15-dic		5			5	
16-dic		5		2	2	
17-dic		12		1	4	
18-dic					1	
19-dic						
Total	4	28	5	3	17	57

Breakdown of assessments per day and sector





Location of assessments. Left) ERCC Daily Map, right) Delivered Google Earth data base

Initial meeting at DMC

The team in action

The team in action

5. Hand-over arrangements

As mentioned, a debriefing meeting was held on 19/12/25 at the DMC premises, with the participation of representatives from infrastructure sectors, the DMC Director General, EU Delegation, ERCC, the Italian Embassy in Colombo, the World Bank, and representatives from Italian institutions (connected online), including the Italian Civil Protection Department, Italferr, ReLUIS, the Italian Red Cross, and General Directorate for Dams and Water Infrastructure.

At the end of the debriefing, the following materials were delivered to the DMC:

- Debriefing presentations, including conclusions and general recommendations
- A folder containing individual assessments, pictures, drone surveys and additional technical material
- Link to a kmz project were all the assessments are georeferenced.

6. Main findings and recommendations

Based on the observations and assessments carried out during the mission, the key findings are:

1. DMC effectively coordinated the planning and implementation of the site visits by establishing a focal point for communication management, supporting the definition and validation of assessment priorities, making district-level representatives available to accompany the site visits, and organizing a debriefing meeting.

2. Sectoral preparedness is in place to ensure the restoration of functionality of disrupted infrastructure and effective coordination among actors for short-term interventions. This is reflected in the involvement of multiple stakeholders, including line agencies and the army, in implementing temporary measures such as Bailey bridges, debris removal, slope regrading, and soil reprofiling to reinstate road functionality.
3. Discussions with counterparts on the design and implementation of long-term infrastructure solutions indicate that there is a clear understanding of sectoral long-term infrastructure interventions, as well as the skills and knowledge development needed for their effective implementation.
4. Discussions with counterparts from the road, railway, dam, emergency management, and academic sectors confirmed the presence of technical expertise.
5. Systems and technology for landslide early warning (EWS) are in place, comprising pluviometric stations to monitor rainfall, predefined alert thresholds, and established communication channels to notify relevant authorities and communities.
6. The majority of the infrastructure is aged and was not designed to withstand extreme event.

Based on the observations and assessments carried out during the mission, the key recommendations are:

1. It is recommended to strengthen an integrated approach for both new and existing infrastructure by systematically considering flood, landslide, and seismic risks throughout planning, design, and rehabilitation. This should involve evaluating both the effects of hazards on infrastructure, to safeguard infrastructure and communities from damage, and the effects of infrastructure on hazard behaviour, to prevent the amplification of risks to the environment and local populations.
2. It is suggested to assess the interaction between bridges and watercourses, with a detailed evaluation of water levels (piers or embankments into riverbed reduce hydraulic section), hydraulic clearances (freeboards), and flow velocities at the crossing section. This assessment is fundamental for the analysis of scour processes, which informs the design of foundations for piers and abutments, as well as the design of protective works for both the foundations and the embankments.
3. It is suggested to strengthen flood hazard and risk assessment including the management of heavy rainfall and the potential impacts on both existing and new infrastructure, as well as on the areas adjacent to these structures. The availability of flood hazard and risk maps serves as a valuable tool for planning and for prioritizing hydraulic mitigation interventions.
4. It is suggested to strengthen dam discharge hazard assessment (considering downstream impacts but also upstream effects in case of bridges and embankments crossing reservoirs). Dam-related hazard assessments should include extreme flood scenarios, emergency releases, and potential malfunction of spillway or outlet works,

with particular attention to flood wave propagation and impacts on downstream communities and critical infrastructure potentially affected.

5. When repairing or rebuilding bridges, consider regrading the riverbanks to provide sufficient water flow and protecting the embankments, especially in river reaches influenced by regulated flows downstream of dams.

6. It is suggested to implement measures to protect bridge foundations and riverbanks from scouring, including riprap or gabion armouring, scour aprons, bank protection works, riverbed stabilization works upstream and downstream of the bridge, and regular monitoring of erosion processes.

7. It is suggested to implement continuous, real-time monitoring of critical infrastructure or risky situations (e.g., installing piezometers in dams, inclinometers or laser displacement sensors on landslides), with automated data acquisition and linkage to alert devices and procedures.

8. It is suggested to strengthen the systematic and preventive maintenance of existing assets, including regular inspections, condition assessments, timely repairs, and rehabilitation works addressing corrosion of steel elements, bearing and expansion joints in road and railway bridge, pavements, culvert, drainages, dam crest, spillways, outlet works, downstream face of dams, etc.

9. It is recommended to incorporate seismic design measures to increase the resilience of bridges, especially for structures with tall piers, such as overstrength bearings, enlarged deck beam seats and expansion joints on pier caps and abutments, and seismic restraints, to avoid deck failure under large seismic displacements.

10. It is suggested to implement a national programme for systematic bridge multi-hazard condition assessment, with emphasis on scour risk, supported by bathymetric surveys, hydraulic measurements, and characterization of foundations and foundation soils, alongside the creation of a national database and the definition of priorities for inspections and interventions.

11. It is recommended to develop and implement Standard Operating Procedures (SOPs) that enable the systematic rapid assessment of the condition of bridge structural and non-structural elements, together with their condition recording. This could form part of the Bridge Management System.

12. It is suggested to implement a Bridge Management System (BMS) that, starting from a catalog of potential defects for structural components and ancillary/complementary elements (as available in the literature), provides for scheduled inspections at predetermined intervals and the recording of findings on standardized forms (checklists), so that the condition of the infrastructure can be monitored over time, including the calculation of bridge reliability indices. By comparing the temporal evolution of inspection results and reliability indices, it is possible to assess the overall health of the asset and determine the need to plan more in-depth inspections and/or establish intervention priorities.

13. It is suggested to assess the adequacy of national standard in relation to natural and man-made hazards, considering the effects of climate changes.

14. Where landslides occurred, it is suggested, when possible, to implement low impact stabilization measures such as installation of surface and subsurface drainage systems, aimed at removing and reducing groundwater presence; selective removal or securing of unstable rock blocks and boulders, when appropriate; slope stabilization and re-profiling works to restore acceptable safety conditions, including slope reshaping, grassing, and erosion control systems, to improve long-term slope performance.

15. It is suggested to establish systematic maintenance programs for slopes, drainage systems, and protective works near settlements and strategic roads. It is also suggested to establish systematic monitoring (satellite imagery, LiDAR or inclinometers) and periodic review and validation of the EWS, incorporating lessons learned from future events and climate change projections to update and localize rainfall thresholds of the EWS.

16. It is suggested to introduce land-use regulations to restrict new development and roadside housing construction in areas of high landslide susceptibility, as such developments can steepen slopes and increase both landslide hazard and exposure.

17. Specific short-, medium-, and long-term recommendations for each assessed infrastructure asset are provided in the following reports

7. Assessments' reports

The present chapter contains all assessment reports for the evaluated infrastructure assets.

Each report provides the location, assessment date, participants, observed damages and causes, resilience recommendations for short-, medium-, and long-term measures, and supporting documentation such as photographs, drone imagery, or technical documentation.

Below the list of the assessed assets.

ID	Name	Sector	Assessment date
B01	Br n° 331 Colombo–Kandy road	Road bridge	13/12/2025
B02	Br. n° 27/1 B-640	Road bridge	14/12/2025
B03	Pelyagoda 78/1	Road bridge	14/12/2025
B04	Pelyagoda 88/1	Road bridge	14/12/2025
B05	Br. No. 16/2-A12 road	Road bridge	14/12/2025
B06	Bridge on B-503	Road bridge	14/12/2025
B07	Mattakuliya	Road bridge	15/12/2025
B08	Japanese Sri Lanka Friendfhip Bridge	Road bridge	15/12/2025
B09	Br. No. 7/1 – Kelani Old Bridge	Road bridge	15/12/2025
B10	Kaduwela	Road bridge	15/12/2025
B11	Bridge close to Hanwella	Road bridge	15/12/2025
B12	Kinnya Bridge N° 122/1 AA 015	Road bridge	16/12/2025
B13	Gangai Bridge n° 114/31 Road AA015	Road bridge	16/12/2025
B14	Ralkuli Bridge Br.No. 112 / 1 Road AA-015	Road bridge	16/12/2025
B15	Moragahakanda	Road bridge	16/12/2025
B16	Lewella	Road bridge	16/12/2025
B17	Old Kallady Bridge	Road bridge	17/12/2025
B18	New Kallady Bridge	Road bridge	17/12/2025
B19	Br. n° 11/1 Ampilanthurai-Veeramunai road	Road bridge	17/12/2025
B20	Br. n° 11/1 Sammanthurai-Deegawapiya road	Road bridge	17/12/2025
B21	Br. n°375/1 Oluvil road	Road bridge	17/12/2025
B22	Br. n°375/5 Oluvil road	Road bridge	17/12/2025
B23	2 Span Bailey Bridge	Road bridge	17/12/2025
B24	Br. n° 3/4 "American Bridge" on Arungambay	Road bridge	17/12/2025
B25	Br. n° 7/1 Potuvil – Panama B-374 road	Road bridge	17/12/2025
B26	Gannoruwa	Road bridge	17/12/2025
B27	Peradeniya	Road bridge	17/12/2025
B28	Ramboda_Bridge	Road bridge	17/12/2025
R01	Paradeniya	Railway bridge	13/12/2025
R02	Kadigamuwa	Rail_Station	14/12/2025
R03	Balana	Rail_Station	14/12/2025
R04	Rambukkana	Rail_Station	14/12/2025
D01	Deduru Oya	Dam	16/12/2025
D02	Rajanganaya	Dam	16/12/2025
D03	Senanayake Samudrayaa	Dam	17/12/2025
L01	Kadugannawa Colombo-Kandy Road (A001)	Landslide	13/12/2025
L02	Ulapane Kandy-Nawalapitiya Road (AB13)	Landslide	13/12/2025
L03	Ramboda	Landslide	13/12/2025
L04	Kalalpitiya–Ukuwala–Elkaduwa (B180) Km 12 to 13	Landslide	14/12/2025
L05	Matale	Landslide	14/12/2025
DR	Summary of drone surveys		13-18/12/2025

Assessment of bridge n° 331 Colombo–Kandy road

Location (N, E): *7.091944° N, 80.036944° E*

Date of assessment: 13/12/2025

Participants:

- *Ramachandran Thambirajah, Road Development Authority;*
- *Francesco Giordano, Italian Team, Italian Civil Protection Department;*
- *Luigi Evangelista, Rossano Lerra, Italian Team, Italferr.*

1. Description of the asset

The bridge consists of a single span and is the result of the successive addition of three structural typologies constructed in different periods to adapt the roadway. The original structure is an arch bridge with an overlying deck, later flanked by two reinforced concrete structures with simply supported decks resting on abutments. Despite these extensions, the hydraulic section remains governed by the original arch structure, which may represent a limiting factor for flow capacity under flood conditions.

Photo 1 - View from the soffit of the deck

2. Observed damages and causes

No damage to the main structural elements of the bridge was observed. On the embankment approaching the left abutment, a localized pavement collapse caused by embankment washout occurred; this had already been repaired (embankment refill) at the time of the site inspection.

3. Recommendations

1. Short Term
   - Monitoring, warning, alert, and bridge closure in case flood level thresholds are exceeded.

2. Medium Term
   - A detailed hydraulic study of the bridge to assess the hydraulic capacity of the cross-section.
   - If indicated by the study, consider implementing a solution to increase the water conveyance capacity.

3. Long Term
   - Visual inspection of the bridge stability (deck and piers) after each major flood event(s).
   - It is recommended to consider adopting a Bridge Management System (BMS) to compare inspection results over time, monitor the bridge's condition, assess bridge reliability indices and plan interventions, or further investigations, accordingly.

Assessment of Br. No. 27/1 B-640 road

Location (N, E): *7.4925° N, 79.798056° E*

Date of assessment: 14/12/2025

Participants:

- *Ramachandran Thambirajah, Road Development Authority;*
- *Agostino Goretti, UCPT Team, Italian Civil Protection Department;*
- *Francesco Giordano, Italian Team, Italian Civil Protection Department;*

1. Description of the asset

The bridge over the Lunu Oya, located along the Iranawila–Thoduwawa Road near the river mouth, is a multi-span (7-span) reinforced concrete bridge with intermediate piers and abutments provided with wing walls. The total bridge length is approximately 90–100 m, with spans ranging from 10 to 17 m. The deck carries a two-lane carriageway with an approximate width of 6.0 m.

The intermediate piers are reinforced concrete solid piers with rectangular shape, aligned with the flow direction. The dimensions are approximately 5,5 m in width and 1.0 m in thickness.

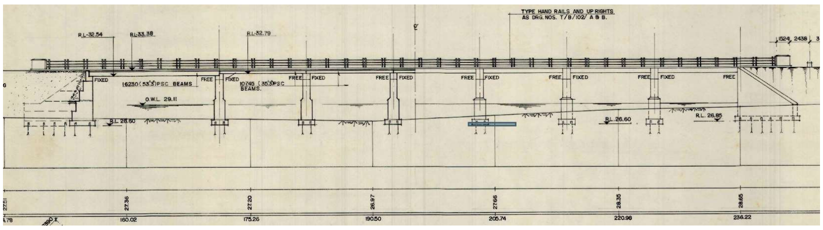


Photo 1 - Longitudinal profile from construction drawings (left)- View of the Bridge from the deck (right)

2. Observed damages and causes

During the flood event, the bridge suffered severe structural damage with the collapse of the sixth and seventh spans. The failure was caused by the collapse of an intermediate pier, while the adjacent pier that remained in place shows residual rotation and settlement due to intense foundation scour. Based on the measurements carried out and presented, the local scour depth appears to exceed 7 m.

The main cause of the damage is attributable to foundations that are effectively shallow and founded on alluvial material, in contrast with the design documents that indicated foundations anchored into rock. The absence of scour protection measures facilitated the progressive erosion of the riverbed, leading to loss of support, pier rotation, and overall structural instability.

Photo 2 – View of the bridge section affected by the collapse

3. Recommendations

1. Short Term
   - Safe removal of the damaged part of the bridge and debris.
   - A rapid assessment of the bearing capacity and scour stability of the existing foundations should be carried out, based on updated bathymetric data to evaluate the safe reuse of the remaining structure with a temporary solution for the collapsed section
   - Install a temporary Bailey bridge at spans 6-7 of the bridge, considering the reuse of the existing undamaged spans, subject to a preliminary structural condition assessment.

2. Medium Term
   - The construction of a new bridge, including the demolition of the existing structure, is envisaged. The potential modification of the alignment, deck elevation, and overall bridge length should be assessed in order to preserve the hydraulic regime of the river at the crossing section. The design shall be integrated with a detailed hydraulic and morphological study of the entire river reach upstream and downstream of the bridge; in any case, the new design shall include appropriate scour protection and defensive works for the new piers.

3. Long Term
   - Visual inspection of the bridge stability (deck and piers) after each major flood event(s).
   - It is recommended to consider adopting a Bridge Management System (BMS) to compare inspection results over time, monitor the bridge's condition, assess bridge reliability indices and plan interventions, or further investigations, accordingly.

4. Additional documentation

Pictures.

Assessment Br.No. 78/1 on Peliyagoda - Puttalam A-03 road

Location (N, E): *7.598611° N, 79.809444° E*

Date of assessment: 14/12/2025

Participants:

- *Ramachandran Thambirajah, Road Development Authority;*
- *Agostino Goretti, UCPT Team, Italian Civil Protection Department;*
- *Francesco Giordano, Italian Team, Italian Civil Protection Department;*

1. Description of the asset

The asset consists of a short-span road bridge. The deck is formed by 7 m long precast prestressed concrete (PSC) flat beams, placed side by side and supported by masonry abutments. The nominal riverbed width at road level is approximately 20 m, although the effective flow section is likely reduced toward the base of the riverbed. The surrounding environment is characterized by riverbanks with significant vegetation growth and debris accumulation, which directly influence the hydraulic performance of the crossing.

Photo 1 - View of the Bridge from the deck

2. Observed damages and causes

The inspection identified critical issues linked to both the torrential hydraulic behaviour of the watercourse and the structural configuration of the bridge. The accumulation of vegetation and debris within the channel significantly obstructs flow during the flood. Flood levels were estimated to reach approximately 1.2 m above the level of the deck. From a structural perspective, the absence of a cast-in-place reinforced concrete slab over the PSC beams prevents the beams from working together effectively as a single structural deck. The abutments and the wing walls of the downstream bridge are cracked.

Photo 2 – View of the bridge deck soffit and riverbed with obstructive debris accumulation and damage to left abutment (left), and visible cracks between abutments and wing walls (central, right).

3. Recommendations

1. Short Term
    - Removal of the accumulated debris and vegetation from the riverbed and around the bridge to restore the hydraulic section and reduce flow obstruction.
    - Repair of the masonry abutments and wing walls. Interventions should be compatible with masonry structures (e.g. repointing, masonry stitching, localized reconstruction), avoiding concrete crack sealing or concrete restoration techniques.
    - Monitoring, warning, alert, and bridge closure in case flood level thresholds are exceeded.

2. Medium Term
    - A comprehensive assessment of the structural and bearing capacity of the existing masonry abutments, including both foundation performance and abutment stability, with specific consideration of scour effects. The assessment should be based on the reconstruction of bathymetry, a detailed geotechnical profile (geometry and characteristics of soil layers down to bedrock), and the geometric and material properties of the existing abutments and their foundations. if necessary, implement scour protection measures at foundations and along the riverbed.
    - If necessary, reprofile and stabilize the riverbanks to improve flow conveyance and limit erosion during torrential events.
    - Improve transverse connections between PSC beams and cast a reinforced concrete slab on top of the deck to ensure composite action and enhance stiffness

3. Long Term
    - Consider long-term adaptation solutions, including partial reconstruction or replacement, if repeated flood events continue to compromise safety and serviceability.
    - Visual inspection of the bridge stability (deck and piers) after each major flood event(s).
    - It is recommended to consider adopting a Bridge Management System (BMS) to compare inspection results over time, monitor the bridge's condition, assess bridge reliability indices and plan interventions, or further investigations, accordingly.

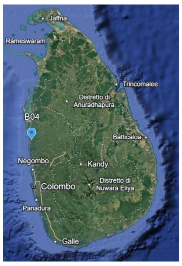
4. Additional documentation

Pictures.

Assessment Br.No. 88/1 on Peliyagoda - Puttalam A-03 road

Location (N, E): *7.677778 N, 79.833333 E*

Date of assessment: 14/12/2025



Participants:

- *Ramachandran Thambirajah, Road Development Authority;*
- *Agostino Goretti, UCPT Team, Italian Civil Protection Department;*
- *Francesco Giordano, Italian Team, Italian Civil Protection Department;*

1. Description of the asset

The structure is a 3-span reinforced concrete bridge. The deck consists of a solid slab supported by hexagonal piers, arranged in pairs at each support. The abutments are of reinforced concrete, and the bridge is founded on caissons.

Photo 1 - View from the deck

2. Observed damages and causes

No damage to the main structural elements of the bridge was observed. However, the morphology of the river cross-section upstream and downstream has been altered. On the embankment approaching the left abutment of the bridge, a localized pavement collapse caused by washout of soil occurred; this had already been repaired (embankment refill) at the time of the site inspection. Some nearby structures (pipe crossings) have collapsed and partially obstruct the river section. The riverbed contains sediments, vegetation debris, and wooden remains.

Picture 2 - View of the bridge from the left abutment, showing the repaired sinkhole (left), and the general condition of the riverbed after the flood (right).

3. Recommendations

1. Short Term
   - Removal of the accumulated debris and vegetation from the riverbed and around the bridge to restore the hydraulic section and reduce flow obstruction.
   - Monitoring, warning, alert, and bridge closure in case flood level thresholds are exceeded.

2. Medium Term
   - A comprehensive assessment of the bearing capacity of the foundation system, including considerations for scour stability, should be conducted based on the reconstruction of the bathymetry and detailed geotechnical profile (indicating the geometry and characteristics of the soil layers until the bedrock) and the geometric and material properties of the existing foundations.
   - If necessary, reprofile and stabilize the riverbanks to improve flow conveyance and limit erosion during torrential events.

3. Long Term
   - Consider long-term adaptation solutions, including partial reconstruction or replacement, if repeated flood events continue to compromise safety and serviceability.
   - Visual inspection of the bridge stability (deck and piers) after each major flood event(s).
   - It is recommended to consider adopting a Bridge Management System (BMS) to compare inspection results over time, monitor the bridge's condition, assess bridge reliability indices and plan interventions, or further investigations, accordingly.

4. Additional documentation

Pictures.

Assessment of Bridge Br. No. 16/2-A12 road

Location (N, E): *8.05944°N - 79.96667°E*

Date of assessment: 14/12/2025

Participants:

- *Ramachandran Thambirajah, Road Development Authority;*
- *Agostino Goretti, UCPT Team, Italian Civil Protection Department;*
- *Francesco Giordano, Italian Team, Italian Civil Protection Department;*

1. Description of the asset

The structure is a 2-span bridge located along a road upstream of the Tabbowa artificial lake. The roadway mainly consists of an embankment and includes three bridges designed to allow the passage of the watercourses supplying the reservoir. The assessed bridge, which has now collapsed, originally consisted of two simply supported reinforced-concrete decks resting on a central pier and abutments. At the time of the inspection, the installation of a temporary Bailey bridge had already been completed to restore traffic continuity.

Photo 1 - View of the the bridge alignment and the temporary Bailey bridge.

2. Observed damages and causes

The causes of the bridge collapse can be attributed to the effect of scour at the central pier. The hydraulic cross-section of the bridge seems to not adequate for the for the discharge of the downstream dam on case of major floods. Additionally, the section is partially obstructed by a significant presence of aquatic vegetation upstream of the bridge, resulting in a reduction of the effective hydraulic section. This condition may have further contributed to a local increase in water velocity and hydrodynamic forces. During the flood event, overtopping of the deck is reported to have occurred.

Photo 2 – View of the Bailey bridge (left), view of the bridge collapsed at the central pier (right).

3. Recommendations

1. Short Term
   - Safe removal of the damaged parts of the bridge and debris to ensure the proper functioning of the temporary solution during potential future flood events.
   - Removal of the vegetation from the riverbed and around the bridge to restore the hydraulic section and reduce flow obstruction.
   - Monitoring, warning, alert, and bridge closure in case flood level thresholds are exceeded.

2. Medium Term
   - The construction of a new bridge is necessary. The potential modification of the deck elevation and overall bridge length should be assessed to preserve the hydraulic regime of the river at the crossing section, considering also the dam discharge. The new design shall include appropriate scour protection and defensive works for the new piers.

3. Long Term
   - Visual inspection of the bridge stability (deck and piers) after each major flood event(s).
   - It is recommended to consider adopting a Bridge Management System (BMS) to compare inspection results over time, monitor the bridge's condition, assess bridge reliability indices and plan interventions, or further investigations, accordingly.

4. Additional documentation

Pictures.

Assessment of Bridge on B-503 road

Location (N, E): *7.3014°N 79.9836°E*

Date of assessment: 14/12/2025

Participants:

- *Ramachandran Thambirajah, Road Development Authority;*
- *Agostino Goretti, UCPT Team, Italian Civil Protection Department;*
- *Francesco Giordano, Italian Team, Italian Civil Protection Department;*

1. Description of the asset

The bridge, mad of multiple isostatic spans, has an overall length of approximately 100 m and width of about 10 m. The decks are composed of precast reinforced concrete beams, except for one span constructed with a solid reinforced concrete slab. The piers are made of reinforced concrete and consist of pier caps supported by two hexagonal-section columns, aligned with the direction of the water flow. The piers are founded on caissons.

Photo 1 - View of the the bridge from the downstream left river bank

2. Observed damages and causes

The structure does not show significant structural damage following the flood event. Horizontal cracks, with an estimated width on the order of about 1 cm, were observed on some elements at the top of the foundations. Additionally, vertical cracks, estimated to be sub-centimetric, were detected on the caisson foundations. The hydraulic section upstream of the bridge is partially obstructed by vegetative debris transported by the current. As evidenced by the exposure of the caisson foundations, the river morphology is altered due to erosion in the section close to the bridge.

Photo 2 – View of the vegetative debris (left), details of cracks on foundation elements (central, right).

3. Recommendations

1. Short Term
   - Removal of the accumulated debris and vegetation from the riverbed and around the bridge to restore the hydraulic section and reduce flow obstruction.
   - Carry out a detailed on-site inspection of the bridge piers to more accurately determine the nature and extent of the cracks near the foundations.
   - Monitoring, warning, alert, and bridge closure in case flood level thresholds are exceeded.

2. Medium Term
   - A detailed hydraulic study of the river reach upstream and downstream of the bridge should be prepared to assess riverbed modifications caused by general erosion at the bridge section.
   - Reprofile and stabilize the riverbanks to improve flow conveyance and limit erosion during torrential events.

3. Long Term
   - Visual inspection of the bridge stability (deck and piers) after each major flood event(s).
   - It is recommended to consider adopting a Bridge Management System (BMS) to compare inspection results over time, monitor the bridge's condition, assess bridge reliability indices and plan interventions, or further investigations, accordingly.

4. Additional documentation

Pictures.

Assessment of Br. No. 1/1 - Mattakkuliya Bridge

Location (N, E): 6.98058 N, 79.87527 E

Date of assessment: 15/12/2025

Participants:

- *Ramachandran Thambirajah, Road Development Authority*
- *Paolo Vaccari and Marco Cassani, Italian Team; Italian Civil Protection Department*
- *Luigi Evangelista, Italian Team, Italferr*
- *Luigi Di Sarno, Italian Team, ReLuiss*
- *Stefano Melosi, Italian Team, Italian Red Cross*

1. Description of the asset

The bridge is a seven span simply supporte beam; the deck is composed by 6 precast prestressed concrete beams. The piers are composed of 2 circular columns linked by the pier cap.

Photo 1 - Overall view of the bridge.

2. Observed damages and causes

From a structural point of view, no problems or damage due to the flood were detected. The main beams do not have transverse beams at the supports. The joints between adjacent spans are very small, and traces of moisture and efflorescence can be seen on the surfaces of the beams. There are only general considerations regarding the bridge management and design approach for future design.

Photo 2 – Detail of underside of the deck and abutment (left) and pier (right).

3. Recommendations

1. Short Term
   - Visual inspection of the deck joints and support devices, with recording of the results (particularly if any defect is found), in order to monitor their evolution over time;
   - Visual inspection and, if necessary, cleaning/repairing of the drainage ducts along the deck.

2. Medium Term
   - A comprehensive assessment of the bearing capacity of the foundation system, including considerations for scour stability, should be conducted based on the reconstruction of a detailed geotechnical profile (indicating the geometry and characteristics of the soil layers - including a bathymetry of riverbed - until the bedrock) and the geometric and material properties of the existing foundations.
   - Evaluate the concrete cover of the exposed concrete elements to determine carbonation depth and steel protection, particularly due to its seaside location.
   - Assess the current condition of the bridge deck pavement and undertake repair or resurfacing works as necessary.

3. Long Term
   - Visual inspection of the bridge stability (deck and piers) after each major flood event(s).
   - It is recommended to consider adopting a Bridge Management System (BMS) to compare inspection results over time, monitor the bridge's condition, assess bridge reliability indices and plan interventions, or further investigations, accordingly.

4. Additional documentation

Pictures, drone images

Assessment of Br. No. 1/2 - Japan Sri Lanka Friendship Bridge

Location (N, E): 6.96041 N, 79.87844 E

Date of assessment: 15/12/2025

Participants:

- *Ramachandran Thambirajah, Road Development Authority*
- *Paolo Vaccari and Marco Cassani, Italian Team; Italian Civil Protection Department*
- *Luigi Evangelista, Italian Team, Italferr*
- *Luigi Di Sarno, Italian Team, ReLuiss*
- *Stefano Melosi, Italian Team, Italian Red Cross*

1. Description of the asset

Two bridges with separate carriageways for each direction of travel. For each of them, the structure is a seven span continuous box girder bridge made of prestressed reinforced concrete with solid section reinforced concrete piers, designed and built by a Japanese company.

Photo 1 - Overall view of the bridge.

2. Observed damages and causes

From a structural point of view, no problems or damage due to the flood were detected. On the third pier from the abutment in the middle of the river, subvertical cracks were reported (by a fisherman). A drone inspection revealed a crack on both sides, the total length of the various sections being a few meters, but the width could be estimate as 0.3÷1 mm. It should be noted that the concrete cover used for the piers is 75 mm, so there may be shrinkage issues. The end of the deck face isn't inspectable, and the joints between beams and abutments is rather small; some trace of humidity and efflorescence are visible on the external surfaces of the beams.

Photo 2 – Detail of the bearing system

Photo 3 – Detail of external surface of deck.

3. Recommendations

1. Short Term:
    - Detailed inspection of the concrete surface of the piers and box girder, mapping of cracks, and measurement of their width and depth.
    - Visual inspection of the support devices and deck joints, with recording of the results (particularly if any defect is found), to monitor their evolution over time;
    - Visual inspection and, if necessary, cleaning/repairing of the drainage ducts along the deck.

2. Medium Term
    - A comprehensive assessment of the bearing capacity of the foundation system, including considerations for scour stability, should be conducted based on the reconstruction of a detailed geotechnical profile (indicating the geometry and characteristics of the soil layers - including a bathymetry of riverbed - until the bedrock) and the geometric and material properties of the existing foundations.
    - Evaluate the concrete cover of the exposed concrete elements to determine carbonation depth and steel protection, particularly due to its seaside location.
    - Assess the current condition of the bridge deck pavement and undertake repair or resurfacing works as necessary.

3. Long Term
    - Visual inspection of the bridge stability (deck and piers) after each major flood event(s).
    - It is recommended to consider adopting a Bridge Management System (BMS) to compare inspection results over time, monitor the bridge's condition, assess bridge reliability indices and plan interventions, or further investigations, accordingly.

4. Additional documentation

Pictures and drone images

Assessment of Br. No. 7/1 – Kelani Old Bridge

Location (N, E): 6.95494 N, 79.88238 E

Date of assessment: 15/12/2025

Participants:

- *Ramachandran Thambirajah, Road Development Authority*
- *Paolo Vaccari and Marco Cassani, Italian Team; Italian Civil Protection Department*
- *Luigi Evangelista, Italian Team, Italferr*
- *Luigi Di Sarno, Italian Team, ReLuiss*
- *Stefano Melosi, Italian Team, Italian Red Cross*

1. Description of the asset

Multi-span viaduct in reinforced concrete with a deck composed of six main girders and transverse prestressed concrete beams, designed with a continuous beam static scheme interrupted by isostatic spans with intermediate hinges (Gerber type).

Photo 1 - Overall view of the bridge.

2. Observed damages and causes

From a structural point of view, no problems or damage due to the flood were detected. The Gerber saddles are located on the span adjacent to the incised riverbed. Although direct inspection of these saddles is not possible, there are no visible indications of structural damage at this location. Some lack in the concrete cover has been identified, resulting in areas where reinforcing bars are exposed. This condition can potentially compromise the durability and integrity of the structure over time.


Photo 2 – Detail of the main girders (left) and pier cap (right).

3. Recommendations

1. Short Term:
   - Detailed inspection of the concrete surface of the main deck beams and piers, mapping of cracks, and measurement of their width and depth.
   - Visual inspection of the support devices and deck joints, with recording of the results (particularly if any defect is found), to monitor their evolution over time;
   - Visual inspection and, if necessary, cleaning/repairing of the drainage ducts along the deck.

2. Medium Term
   - A comprehensive assessment of the bearing capacity of the foundation system, including considerations for scour stability, should be conducted based on the reconstruction of a detailed geotechnical profile (indicating the geometry and characteristics of the soil layers - including a bathymetry of riverbed - until the bedrock) and the geometric and material properties of the existing foundations.
   - Evaluate the concrete cover of the exposed concrete elements to determine carbonation depth and steel protection, particularly due to its seaside location.
   - Assess the current condition of the bridge deck pavement and undertake repair or resurfacing works as necessary.

3. Long Term
   - Visual inspection of the bridge stability (deck and piers) after each major flood event(s).
   - It is recommended to consider adopting a Bridge Management System (BMS) to compare inspection results over time, monitor the bridge's condition, assess bridge reliability indices and plan interventions, or further investigations, accordingly.

4. Additional documentation

Pictures and drone images

Assessment of Br. No. 7/1 – Kaduwela Bridge

Location (N, E): 6.95494 N, 79.88238 E

Date of assessment: 15/12/2025

Participants:

- *Ramachandran Thambirajah, Road Development Authority*
- *Paolo Vaccari and Marco Cassani, Italian Team; Italian Civil Protection Department*
- *Luigi Evangelista, Italian Team, Italferr*
- *Luigi Di Sarno, Italian Team, ReLuiss*
- *Stefano Melosi, Italian Team, Italian Red Cross*

1. Description of the asset

The bridge was built in two phases at different times. The upstream bridge has pier foundations on submerged box elements filled with aggregate/concrete. The foundation of the abutment should be on piles (but with the piles cap higher than the piers) and, maybe for this reason, subject to scour erosion. The new bridge has deep pile foundations, and the abutment piles cap is set at a lower level than the previous one and is not subject to scour erosion.

Photo 1 - Overall view of the bridge.

2. Observed damages and causes

Following the flood, only a very slight rotation of the central pier of the old bridge is reported, likely due to a possible undermining of the foundation due to scour. The joints between adjacent spans are very small, and traces of moisture and efflorescence can be seen on the surfaces of the beams and the lowerside of the deckslab (specially the oldest one) and on the piers cap.

Photo 2 – Detail of the two abutments.

3. Recommendations

1. Short Term

- Removal of debris around the piers and abutments
- Bathymetric survey of the river cross-section in the proximity of the bridge piers and abutment to assess erosion processes around the abutment. The area subject to scour needs to be filled and subsequently, the riverbed and the banks must be protected with a riverbed defense system (riprap- see the Additional documentation).
- Detailed measurement of geometry of piers and abutments and evaluation of the tilt on the pier/abutments caps;
- Visual inspection of the support devices and deck joints, with recording of the results (particularly if any defect is found), to monitor their evolution over time;
- Visual inspection and, if necessary, cleaning/repairing of the drainage ducts along the deck

2. Medium Term

- A comprehensive assessment of the bearing capacity of the foundation system, including considerations for scour stability, should be conducted based on the reconstruction of a detailed geotechnical profile (indicating the geometry and characteristics of the soil layers - including a bathymetry of riverbed - until the bedrock) and the geometric and material properties of the existing foundations.
- Evaluate the concrete cover of the exposed concrete elements to determine carbonation depth and steel protection.
- Assess the current condition of the bridge deck pavement and undertake repair or resurfacing works as necessary.

3. Long Term

- Visual inspection of the bridge stability (deck and piers) after each major flood event(s).
- Definition a strategy for scour protection of the bridge foundations and riverbank and design and realization of scour protection (see technical document *Examples_of_Rirap_Protection*).
- It is recommended to consider adopting a Bridge Management System (BMS) to compare inspection results over time, monitor the bridge's condition, assess bridge reliability indices and plan interventions, or further investigations, accordingly.

4. Additional documentation

Pictures, drone and technical documentation (document on *Examples_of_Rirap_Protection)*

Assessment of Br. No. 3/3 – Road Bridge (Close to Hanwella Town)

Location (N, E): 6.90950 N, 80,08334 E

Date of assessment: 15/12/2025

Participants:

- *Ramachandran Thambirajah, Road Development Authority*
- *Paolo Vaccari and Marco Cassani, Italian Team; Italian Civil Protection Department*
- *Luigi Evangelista, Italian Team, Italferr*
- *Luigi Di Sarno, Italian Team, ReLuiss*
- *Stefano Melosi, Italian Team, Italian Red Cross*

1. Description of the asset

The Bridge is a four simple supported span, each of them made of seven precast prestressed concrete beams and a cast-in-place slab, with special reinforced concrete supports. The three piers are founded on 2-3-meter-diameter shafts made with submerged box elements and connected at the top by a foundation

Photo 1 - Overall view of the bridge.

2. Observed damages and causes

The planimetric course of the river, which has a curve at the road bridge crossing, can favour the scour caused by flood wave. In fact, the bed and banks of the river have been subject to erosion: the "plinths" of the pylons are completely exposed to air and water, and the banks have been subject to landslides. It has been reported that even before the last major flood in November, the central pillar had lowered slightly (probably due to scour) and, at the same time, some bearings (made in reinforced concrete) on the top of the central pier had broken.

Even before the last flood, repair/replacement work was underway on the support devices. In fact, on the central pier the beams are supported on temporary bearing (a series of metal plates) and around the pier when the last flood arrived there were scaffolding; scaffolding that is full of debris carried by the flood. It should be noted that the last flood does not seem to have increased the settlement of the pier.

The joints between adjacent spans are very small, and traces of moisture and efflorescence can be seen on the surfaces of the beams and the lowerside of the deckslab (specially the oldest one) and on the piers cap and in r.c. berings.

Photo 2 – Detail of the bearings on the piers/abutments cap

Photo 3 In the background the work (temporary bearings) on the central pier cap and on the right side the scaffolding with debris

3. Recommendations

1. Short Term
   - Removal of debris around the piers and abutments
   - Bathymetric survey of the river cross-section in the proximity of the bridge piers and abutment to assess erosion processes around the abutment. The area subject to scour needs to be filled and subsequently, the riverbed and the banks must be protected with a riverbed defense system (riprap, see the Additional documentation).
   - Detailed measurement of geometry of piers and abutments and evaluation of the tilt on the pier caps;
   - Visual inspection of the support devices and deck joints, with recording of the results (particularly if any defect is found), to monitor their evolution over time;
   - Visual inspection and, if necessary, cleaning/repairing of the drainage ducts along the deck

2. Medium Term
   - A comprehensive assessment of the bearing capacity of the foundation system, including considerations for scour stability, should be conducted based on the reconstruction of a detailed geotechnical profile (indicating the geometry and characteristics of the soil layers - including a bathymetry of riverbed - until the bedrock) and the geometric and material properties of the existing foundations.
   - Evaluate the concrete cover of the exposed concrete elements to determine carbonation depth and steel protection.
   - Assess the current condition of the bridge deck pavement and undertake repair or resurfacing works as necessary.

3. Long Term
   - Visual inspection of the bridge stability (deck and piers) after each major flood event(s).

- Definition a strategy for scour protection of the bridge foundations and riverbank and design and realization of scour protection (see technical document *Examples_of_Riprap_Protection*).
- It is recommended to consider adopting a Bridge Management System (BMS) to compare inspection results over time, monitor the bridge's condition, assess bridge reliability indices and plan interventions, or further investigations, accordingly.

4. Additional documentation

Pictures, drone images and technical documentation (document *Examples_of_Riprap_Protection)*

Assessment of Kinniya Bridge n° 122/1 Roadway AA015

Location (N, E): *8.507222° N, 81.191389° E*

Date of assessment: 16/12/2025

Participants:

- *Ramachandran Thambirajah, Road Development Authority;*
- *Francesco Giordano, Paolo Putrino, Italian Team, Italian Civil Protection Department;*
- *Luigi Di Sarno, Italian Team, ReLuiss*
- *Stefano Melosi, Italian Team, Italian Red Cross*

1. Description of the asset

A 9-span bridge with a total length of about 400 m. The structural system is a multi-beam composite steel and concrete structure. The steel girders are symmetric I-section, with a depth of about 1.50 m. There are transverse trussed stiffeners (back-to-back double angles) along the girder bays. The piers consist of large T-shaped reinforced concrete (RC) columns supported by square RC foundation mats. Lateral restraints (to prevent lateral movement of the bridge deck) consist of RC walls sitting laterally on the bridge piers. The steel beams are supported by steel supports (bearings).


Photo 1 - Overall view of the Bridge with drone (left), detail of the bridge pier (right).

2. Observed damages and causes

No global structural damage attributable to the flooding event was observed. The piers and the bridge deck do not show any visible signs of damage. However, degradation of structural materials was noted, particularly affecting the concrete and the embedded reinforcement bars, which are subject to corrosion. The steel bearings are not directly accessible for inspection however, signs of oxidation were observed on the protective casings. Water stagnation was identified at the abutment walls, in the proximity of the bridge supports. In addition, some drainage systems on the bridge deck were found to be partially non-functional.



Photo 2 – Details of the corroded elements (left, central), detail of the joint (right).

3. Recommendations

1. Short Term
   - Cleaning and repair of the drainage system, and execution of asphalt repair or resurfacing works
   - Cleaning bridge joints along the deck.
   - Detailed inspection for concrete and steel reinforcement, especially for the abutment walls (at the location of the bearings).

2. Medium Term
   - Assessment of the current condition of the bridge girders, considering corrosion affecting the load-bearing elements.
   - Prevent the progression of corrosion in the bridge load-bearing elements.
   - A comprehensive assessment of the bearing capacity of the foundation system, including considerations for scour stability, should be conducted based on the reconstruction of the bathymetry and detailed geotechnical profile (indicating the geometry and characteristics of the soil layers until the bedrock) and the geometric and material properties of the existing foundations
   - Evaluate the concrete cover of the exposed elements to determine carbonation depth and steel protection, particularly due to its marine location.
   - Replacement of bridge joints, if necessary.

3. Long Term
   - Visual inspection of the bridge stability (deck and piers) after each major flood event(s).
   - It is recommended to adopt a Bridge Management System (BMS) to compare inspection results over time, monitor the condition of the structure, assess bridge reliability indices and plan interventions, or further investigations, accordingly.

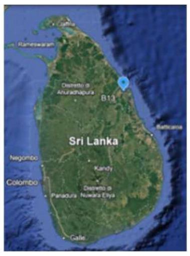
4. Additional documentation

Pictures and results of drone survey.

Assessment of Gangai Bridge n° 114/31 Road AA015

Location (N, E): *8.4600° N, 81.2294° E*

Date of assessment: 16/12/2025



Participants:

- *Ramachandran Thambirajah, Road Development Authority;*
- *K. Sugunathas, Disaster Management Center, District Secratariat, Trincomalee*
- *Francesco Giordano, Paolo Putrino, Italian Team, Italian Civil Protection Department;*
- *Luigi Di Sarno, Italian Team, ReLuis*
- *Stefano Melosi, Italian Team, Italian Red Cross*

1. Description of the asset

The asset is a 7-span prestressed reinforced concrete (RC) road bridge. The superstructure includes longitudinal prestressed concrete (PC) beams supporting the RC deck slab. The bridge is supported by RC piers and abutments with pier caps transferring loads to the substructure. The Neoprene bearings with a thickness of approximately 16 cm, are installed between the prestressed RC beams and the RC pier caps/abutments. Expansion joints with an approximate width of 10 cm are located at the bridge ends, near the abutments.

Photo 1 - Overall view of the Bridge with drone (left) - view of the bridge from the deck level (right).

Photo 2 - Details of the structure

2. Observed damages and causes

The visual inspection did not reveal any visible structural damage due to the recent flood event; however, the presence of debris obstructing the expansion joints was observed. There are only general considerations regarding bridge management.

Photo 3 - Detail of the joint

3. Recommendations

1. Short Term
   - Cleaning bridge joints.
   - Visual inspection and, if necessary, cleaning/repairing of the drainage ducts along the deck.

2. Medium Term
   - A comprehensive assessment of the bearing capacity of the foundation system, including considerations for scour stability, should be conducted based on the reconstruction of the bathymetry and detailed geotechnical profile (indicating the geometry and characteristics of the soil layers until the bedrock) and the geometric and material properties of the existing foundations.
   - Assess the concrete cover of exposed elements to determine carbonation depth and steel protection, particularly due to its marine location.

3. Long Term
   - Visual inspection of the bridge stability (deck and piers) after each major flood event(s).
   - It is recommended to consider adopting a Bridge Management System (BMS) to compare inspection results over time, monitor the condition of the bridge, assess bridge reliability indices and plan interventions, or further investigations, accordingly.

4. Additional documentation

Pictures, drone images, drone 3D geometric model

Assessment of Ralkuli Bridge Br.No. 112 / 1 Road AA-015

Location (N, E): *8.446944° N , 81.244444° E*

Date of assessment: 16/12/2025

Participants:

- *Ramachandran Thambirajah, Road Development Authority;*
- *K. Sugunathas, Disaster Management Center, District Secratariat, Trincomalee*
- *Francesco Giordano, Paolo Putrino, Italian Team, Italian Civil Protection Department;*
- *Luigi Di Sarno, Italian Team, ReLuis*
- *Stefano Melosi, Italian Team, Italian Red Cross*

1. Description of the asset

The asset is a 5-span prestressed reinforced concrete (RC) road bridge. The superstructure consists of longitudinal prestressed concrete (PC) beams supporting RC deck slab. The structure is not accessible for pier inspection.

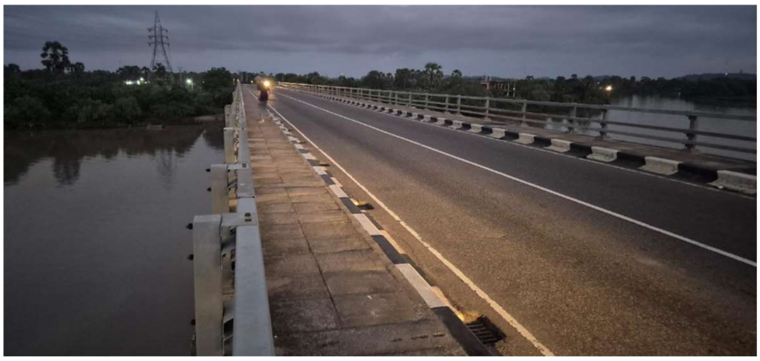


Photo 1 – Overall view of the structure

2. Observed damages and causes

Visual inspection indicates visible localized non-structural damage on the deck carriage, due to settlement of the road pavement. A filling intervention with asphalt has already been carried out.

Photo n.2 – View of damage to the asphalt pavement.

3. Recommendations

1. Short Term
   - Detailed visual inspection of piers, beams, deck, and abutment walls.
   - Visual inspection to assess the overall current condition of the bridge deck, with reference to the pavement, deck drainage ducts, and expansion joints.
   - Where necessary, cleaning and repair of the drainage system, and execution of asphalt repair or resurfacing works should be considered.

2. Medium Term
   - A comprehensive assessment of the bearing capacity of the foundation system, including considerations for scour stability, should be conducted based on the reconstruction of a detailed bathymetry and geotechnical profile (indicating the geometry and characteristics of the soil layers until the bedrock) and the geometric and material properties of the existing foundations.
   - Assess concrete cover of exposed elements to determine carbonation depth and steel protection, particularly due to its marine location.

3. Long Term
   - Visual inspection of the bridge stability (deck and piers) after each major flood event(s).
   - It is recommended to consider adopting a Bridge Management System (BMS) to compare inspection results over time, monitor the condition of the structure, assess bridge reliability indices and plan interventions, or further investigations, accordingly.

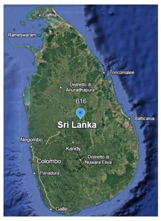
4. Additional documentation

Pictures.

Assessment of Br. No. 1/1 - Moragahakanda Bridge

Location (N, E): 7,70494° N, 80,77410° E

Date of assessment: 16/12/2025



Participants:

- *Eng. Athula Liyanage, Shasthri Senavirathna, Road Development Authority*
- *Paolo Vaccari, Italian Team, Italian Civil Protection Department*
- *Luigi Evangelista, Rossano Lerra, Italian Team, Italferr.*

1. Description of the asset

The Moragahakanda Bridge is a four- span simply supported precast prestressed concrete bridge on reinforced concrete piers; foundations are on piles. It is located immediately downstream (a few hundred meters) of the Moragahakanda Wellawala Dam, which was built at the same time as the bridge approximately 15 years ago.

Photo 1 - Overall views of the bridge.

2. Observed damages and causes

From structural point of view, the bridge is in good condition, but one of the abutments has its upper part of the foundation completely exposed due to the scour (at least for 2 meters). The flood arrived from the dam, has been concentrated on the body of the embankment behind the abutment, therefore the entire embankment was swept away by the current for several dozen meters, destroying the entire roadway above. The cause of this failure can be found both in the flow rate released by the dam during the event, and in the direction of the water flow released by the dam, which does not appear to be aligned with the bridge, unlike the original riverbed Traces of moisture and efflorescence can be seen on the surfaces of the beams and the lowerside of the deckslab and on the piers cap.


Photo 2 – Damage to embankment and right abutment completely exposed.

3. Recommendations

1. Short Term

- Removal of debris around the piers and abutment
- Bathymetric survey of the river cross-section in the proximity of the bridge piers and abutment to assess erosion processes. The area subject to scour needs to be filled and subsequently, the riverbed and the banks must be protected with a riverbed defense system (riprap- see the Additional documentation).
- Visual inspection of the support devices and deck joints, with recording of the results (particularly if any defect is found), to monitor their evolution over time;
- Visual inspection and, if necessary, cleaning/repairing of the drainage ducts along the deck Recognition of actual condition of the foundations of the piers (entity of scour).

2. Medium

- For the reconstruction of the road, hydraulic checks must be performed, considering the maximum flow rate released by the dam and its direction. Based on this, it is necessary to determine whether it is possible to rebuild an embankment with adequate hydraulic transparency (boxes to be built in succession within the body of the embankment) or whether it is necessary to build another three or four spans of the same type as the existing ones, modifying the geometry of the abutment.
- A comprehensive assessment of the bearing capacity of the foundation system, including considerations for scour stability, should be conducted based on the reconstruction of a detailed geotechnical profile (indicating the geometry and characteristics of the soil layers - including a bathymetry of riverbed - until the bedrock) and the geometric and material properties of the existing foundations.
- It is warmly suggested an inspection of the bridge bearings. It seems that some bearings of the "fixed" alignments are unloaded (missing contact between beams and bearings).
- Evaluate the concrete cover of the exposed concrete elements to determine carbonation depth and steel protection.
- Assess the current condition of the bridge deck pavement and undertake repair or resurfacing works as necessary.

3. Long Term
   - Visual inspection of the bridge stability (deck and piers) after each major flood event(s).
   - It is recommended to consider adopting a Bridge Management System (BMS) to compare inspection results over time, monitor the bridge's condition, assess bridge reliability indices and plan interventions, or further investigations, accordingly.

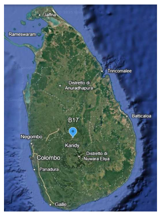
4. Additional documentation

Pictures, technical documentation (document *Examples_od_Rirap_Protection*)

Assessment of Br. No. 2/3 - Lewella Bridge

Location (N, E): 7,30125° N, 80,65391° E

Date of assessment: 17/12/2025



Participants:

- *Eng. Athula Liyanage, Shasthri Senavirathna, Road Development Authority*
- *Paolo Vaccari, Italian Team, Italian Civil Protection Department;*
- *Luigi Evangelista, Rossano Lerra, Italian Team, Italferr;*

1. Description of the asset

The bridge is a three simply supported beams composed with deck in precast prestressed concrete beams and rectangular piers (no information about foundation). The bridge is located between two dams on the river, and this justifies that the waterflow speed at this specific point is very low. Laterally there was a suspended pedestrian steel bridge, structurally independent of the road bridge, at a distance less than 5 meters.

Photo 1 - Overall view of the bridge.

2. Observed damages and causes

There are no structural issues detected in the road bridge due to the flood, while the pedestrian bridge has collapsed. The joints between adjacent spans are very small, and traces of moisture and efflorescence can be seen on the surfaces of the beams.

It is urgent to remove the rubble of the pedestrian bridge collapsed in the river, as it constitutes a barrier to the passage of water.

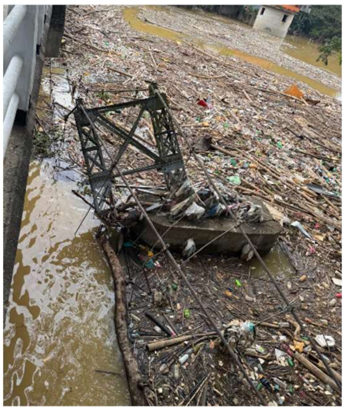


Photo 2 – Collapsed pedestrian bridge.

3. Recommendations

1. Short Term

- Removal of debris around the piers and abutments, and the debris of the collapsed pedestrian bridge; paying attention to recover the less damaged components.
- Bathymetric survey of the river cross-section in the proximity of the bridge piers and abutment to assess erosion processes. The area subject to scour needs to be filled and subsequently, the riverbed and the banks must be protected with a riverbed defense system (riprap- see the Additional documentation).
- Visual inspection of the support devices and deck joints, with recording of the results (particularly if any defect is found), to monitor their evolution over time;
- Assess the current condition of the bridge deck pavement and undertake repair or resurfacing works as necessary.

2. Medium Term

- A comprehensive assessment of the bearing capacity of the foundation system, including considerations for scour stability, should be conducted based on the reconstruction of a detailed geotechnical profile (indicating the geometry and characteristics of the soil layers - including a bathymetry of riverbed - until the bedrock) and the geometric and material properties of the existing foundations.
- Evaluate the concrete cover of the exposed concrete elements to determine carbonation depth and steel protection.
- Assess the current condition of the bridge deck pavement and undertake repair or resurfacing works as necessary.

3. Long Term

- Visual inspection of the bridge stability (deck and piers) after each major flood event(s).
- It is recommended to consider adopting a Bridge Management System (BMS) to compare inspection results over time, monitor the bridge’s condition, assess bridge reliability indices and plan interventions, or further investigations, accordingly.

4. Additional documentation

Pictures, technical documentation (document *Examples_od_Rirap_Protection*)

Assessment of The Old Kallady Bridge

Location (N, E): *7.719444° N, 81.706944° E*

Date of assessment: 17/12/2025

Participants:

- *Ramachandran Thambirajah, Road Development Authority;*
- *DMC representative;*
- *Francesco Giordano, Paolo Putrino, Italian Team, Italian Civil Protection Department;*
- *Luigi Di Sarno, Italian Team, ReLuis*
- *Stefano Melosi, Italian Team, Italian Red Cross*

1. Description of the asset

Historical steel truss bridge constructed in 1924. The bridge has a total length of approximately 300 m and consists of six spans. It is currently open only to bicycles and motorcycles. The foundations are composed of two large circular steel caissons filled with unreinforced concrete.

Photo 1 - Overall view of the Bridge with drone (left) - view of the bridge from the deck level (right).


Photo 2 - Details of the structure.

2. Observed damages and causes

The visual inspection did not reveal any visible structural damage due to the flood event, although severe damage is observed in the diagonal bracing members, consisting of back-to-back L-shaped steel sections. The damage includes both buckling of members and fracture of individual elements.

The buckling of the diagonal bracings is mainly attributed to the transit of heavy trucks carrying large containers in the past. The expansion joints are also damaged, primarily due to inadequate maintenance and prolonged exposure to heavy vehicular traffic.

Photo 2 – View of damage to the diagonal bracing members and general conditions of the abutment

3. Recommendations

1. Short Term
    - Repairing of the damaged steel members (buckled and fractured) and painting of all the members for corrosion resistance.
    - Cleaning and repair of the drainage system, and execution of asphalt repair or resurfacing works.
    - Cleaning bridge joints.
    - Cleaning of the riverbed near the bridge abutments

2. Medium Term
    - A comprehensive assessment of the bearing capacity of the foundation system, including evaluation of scour stability, should be conducted based on the reconstruction of a detailed bathymetry and geotechnical profile (indicating the geometry and characteristics of the soil layers until the bedrock) and the geometric and material properties of the existing foundations.
    - Replacements of bridge joints (if necessary).

3. Long Term
    - Visual inspection of the bridge stability (deck and piers) after each major flood event(s).
    - It is recommended to adopt a Bridge Management System (BMS) to compare inspection results over time, monitor the bridge's condition, assess bridge reliability indices and plan interventions, or further investigations, accordingly.

4. Additional documentation

Pictures, drone images

Assessment of The New Kallady Bridge

Location (N, E): 7.7189° N, 81.7072° E

Date of assessment: 17/12/2025

Participants:

- *Ramachandran Thambirajah, Road Development Authority.*
- *DMC representative;*
- *Francesco Giordano, Paolo Putrino, Italian Team, Italian Civil Protection Department;*
- *Luigi Di Sarno, Italian Team, ReLuis*
- *Stefano Melosi, Italian Team, Italian Red Cross*

1. Description of the asset

Multi-span precast RC concrete bridge on piled foundations. Width of the deck is about 14.00m (two lanes). There are no lateral restrainers on each pier to stop lateral displacements. The deck beams are supported by rubber pads. The bridge deck has an overall width of approximately 14.00 m and accommodates two traffic lanes.

The superstructure consists of precast RC deck beams supported on elastomeric rubber bearings. The bearings have nominal dimensions of 1000 mm × 500 mm × 70 mm.

Photo 1 - Overall view of the Bridge with drone (left) - view of the bridge from the abutment (right).

2. Observed damages and causes

The visual inspection did not reveal any visible structural damage due to recent flood event; however, the presence of debris obstructing the expansion joints was observed. There are only general considerations regarding bridge management.


Photo 2 – Detail of the joints

3. Recommendations

1. Short Term
   - Cleaning and repair of the drainage system, and execution of asphalt repair or resurfacing works.
   - Cleaning bridge joints.

2. Medium Term
   - A comprehensive assessment of the bearing capacity of the foundation system, including evaluation of scour stability, should be conducted based on the reconstruction of the bathymetry and detailed geotechnical profile (indicating the geometry and characteristics of the soil layers until the bedrock) and the geometric and material properties of the existing foundations.
   - Evaluate the concrete cover of the exposed elements to determine carbonation depth and steel protection, particularly due to its seaside location.
   - Replacements of bridge joints (if necessary).

3. Long Term
   - Visual inspection of the bridge stability (deck and piers) after each major flood event(s).
   - It is recommended to consider adopting a Bridge Management System (BMS) to compare inspection results over time, monitor the bridge’s condition, assess bridge reliability indices and plan interventions, or further investigations, accordingly.

4. Additional documentation

Pictures, drone images, drone 3D geometric model.

Assessment of Br. No. 11/1 Ampilanthurai – Veeramunai Road

Location (N, E): *7.4925° N, 81.740277° E*

Date of assessment: 17/12/2025

Participants:

- *Ramachandran Thambirajah, Road Development Authority;*
- *DMC representative;*
- *Francesco Giordano, Paolo Putrino, Italian Team, Italian Civil Protection Department;*
- *Luigi Di Sarno, Italian Team, ReLuis*
- *Stefano Melosi, Italian Team, Italian Red Cross*

1. Description of the asset

The structure is a two-span reinforced concrete (RC) bridge. Each span has a length of 13.5 m, for a total bridge length of 27 m. The bridge has an overall width of 13.4 m. The bridge consists of an RC deck supported by an intermediate pier located in the riverbed and by RC abutments. Pier is resting on deep foundations.

Photo.1 – Overall view of the structure

2. Observed damages and causes

The wing wall of the downstream abutment on the left bank has pronounced cracking (Photo 2, left), indicating progressive erosion and instability created by scouring (Photo 2, right). The interface between the embankment and the abutment shows evidence of differential movement, with visible longitudinal and vertical cracking (Photo 2, left).

Photo 2 –Damage to the wing wall

At the foundation level, concrete degradation and scouring were observed near the waterline, suggesting the presence of erosion. The intermediate pier seems tilted, likely associated with rigid ground movement and foundation instability. On the embankment approaching the left bank abutment of the bridge, a localized pavement settlement is caused by washout of soil occurred. A drone survey for 3D-modelling was carried out during the assessment.

Photo 3 –Damage in proximity of the abutment (left) - 3D-modelling throw drone survey and assessment of the damaged area (right)

3. Recommendations

1. Short Term
   - Detailed inspection of damaged peer with measurement of the potential tilt;
   - Monitoring, warning with alert leading to bridge closure in case flood level thresholds are exceeded.
   - Assess erosion processes around the abutment including a bathymetric survey of the river cross-section in the proximity of the bridge piers and abutment.
   - Repair the abutment wing wall by restoring the plain concrete connection-wing wall at the top.
   - Cleaning of bridge joints.

2. Medium Term
   - A detailed hydraulic study of the river reach upstream and downstream of the bridge should be prepared to assess riverbed modifications caused by general erosion and local scour at the bridge section. The study should evaluate the effects on the crossing and shall define and design

any required permanent mitigation measures to prevent damage and ensure long-term structural safety.

- Provide a protective structure to mitigate erosion and prevent further loss of bearing capacity at the right riverbank abutment.
- A comprehensive assessment of the bearing capacity of the foundation system, including evaluation of scour stability, should be conducted based on the reconstruction of a detailed bathymetry and geotechnical profile (indicating the geometry and characteristics of the soil layers until the bedrock) and the geometric and material properties of the existing foundations.
- Replacements of bridge joints (if necessary).

3. Long Term
   - Visual inspection of the bridge stability (deck and piers) after each major flood event(s).
   - It is recommended to adopting a Bridge Management System (BMS) to compare inspection results over time, monitor the bridge's condition, assess bridge reliability indices and plan interventions, or further investigations, accordingly.

4. Additional documentation

Pictures, drone images, drone 3D geometric model

Assessment of Br. No. 11/1 Sammanthurai – Deegawapiya Road

Location (N, E): *7.489444° N, 81.746944° E*

Date of assessment: 17/12/2025

Participants:

- *Ramachandran Thambirajah, Road Development Authority;*
- *Francesco Giordano, Paolo Putrino, Italian Team, Italian Civil Protection Department;*
- *Luigi Di Sarno, Italian Team, ReLuis*

1. Description of the asset

The structure is a single-span Bailey bridge with an approximate span length of 35 m and a deck width of 5 m. It was installed following the collapse of a previous bridge in 2010.

Photo.1 – Overall view of the structure

2. Observed damages and causes

The flood caused severe structural damage to the abutments supporting the Bailey bridge constructed in 2010. Consequently, as a temporary solution, the bridge span was increased by relocating the abutments toward the embankment. The hydraulic cross-section in the vicinity of the bridge remains partially obstructed by the remaining of the abutments and embankments of the original bridge.

Photo 2 –Damage to the abutments

3. Recommendations

1. Short Term
    - Removal of the previous abutments and embankments.

2. Medium Term
    - If the Bailey bridge is intended to be used as a long-term solution, a detailed hydraulic study of the bridge to assess the hydraulic capacity of the cross-section is suggested.
    - If indicated by the study, consider implementing a solution to increase the water conveyance capacity.
    - In the case of a new bridge design, the total span length shall be sufficient to avoid interference with the river hydraulic cross-section.

3. Long Term
    - Visual inspection of the bridge stability (deck and piers) after each major flood event(s).
    - It is recommended to adopt a Bridge Management System (BMS) to compare inspection results over time, monitor the bridge's condition, assess bridge reliability indices and plan interventions, or further investigations, accordingly.

4. Additional documentation

Pictures

Assessment of Br. n°375/1 Oluvil road

Location (N, E): *7.297222° N, 81.848333° E*

Date of assessment: 17/12/2025

Participants:

- *Ramachandran Thambirajah, Road Development Authority.*
- *Francesco Giordano, Paolo Putrino, Italian Team, Italian Civil Protection Department;*
- *Luigi Di Sarno, Italian Team, ReLuis*

1. Description of the asset

The bridge is a 6-span reinforced concrete (RC) deck bridge, with total length of approximately 35 m, and with 7.2 m. The superstructure consists of a RC deck slab, supported by RC pier caps connected directly to cylindrical RC piers located within the riverbed. The piers are founded on caisson foundations, extending below the riverbed to provide adequate bearing capacity and overall stability. End supports are provided by reinforced concrete abutments at both banks.

Photo n.1 – Overall view of the structure

2. Observed damages and causes

The visual inspection did not reveal any visible structural damage caused by recent flood event; however, debris was found obstructing the drainage system and joints. The river morphology upstream and downstream of the bridge section has been altered by the passage of the flood.

Photo n.2 –view of the deck (left) and downstream of the bridge (right)

3. Recommendations

Recommendations

1. Short Term
   - Cleaning bridge joints.
   - Cleaning drainage ducts along the deck.

2. Medium Term
   - A comprehensive assessment of the bearing capacity of the foundation system, including evaluation of scour stability, should be conducted based on the reconstruction of the bathymetry and detailed geotechnical profile (indicating the geometry and characteristics of the soil layers until the bedrock) and the geometric and material properties of the existing foundations.
   - Evaluate the concrete cover of the exposed elements to determine carbonation depth and steel protection, particularly due to its marine location.

3. Long Term
   - Visual inspection of the bridge stability (deck and piers) after each major flood event(s).
   - It is recommended to adopt a Bridge Management System (BMS) to compare inspection results over time, monitor the bridge’s condition, assess bridge reliability indices and plan interventions, or further investigations, accordingly.

4. Additional documentation

Pictures

Assessment of Bridge n°375/5 Oluvil road

Location (N, E): *7.3028° N, 81.8478° E*

Date of assessment: 17/12/2025

Participants:

- *Ramachandran Thambirajah, Road Development Authority;*
- *Francesco Giordano, Italian Team, Italian Civil Protection Department;*
- *Stefano Melosi, Italian Team, Italian Red Cross;*

1. Description of the asset

The structure is a single-span Bailey bridge with an approximate span length of 35 m and a deck width of 5 m. It was installed following the collapse of the previous bridge after recent floods (occurred in 2024 - early 2025).

Photo.1 – Overall view of the structure taken through the drone

2. Observed damages and causes

No structural damage was observed due the flood. From the areal assessments based on interviews, drone's survey and aero-photogrammetric historical data, it appears that the flood events of the nearby Galo Oya River tend to overflow in an upstream area of this crossing, which acts as a preferential flow path toward the downstream section of the river, close to the coastal area.

3. Recommendations

1. Short Term
   - None

2. Medium Term
   - If the Bailey bridge is intended to be used as a permanent structure, a detailed hydraulic study of the bridge to assess the hydraulic capacity of the cross-section is suggested.
   - If indicated by the study, consider implementing a solution to increase the water conveyance capacity.
   - In the case of a new bridge design, the total span length shall be sufficient to avoid interference with the river hydraulic cross-section.

3. Long Term
   - Visual inspection of the bridge stability (deck and piers) after each major flood event(s).
   - It is recommended to adopt a Bridge Management System (BMS) to compare inspection results over time, monitor the bridge's condition, assess bridge reliability indices and plan interventions, or further investigations, accordingly.

4. Additional documentation

Results of drone survey.

Assessment of 2-Span Bailey Bridge on B18 road

Location (N, E): *7.494722° N, 81.738056° E*

Date of assessment: 17/12/2025

Participants:

- *Ramachandran Thambirajah, Road Development Authority;*
- *Francesco Giordano, Paolo Putrino, Italian Team, Italian Civil Protection Department;*
- *Luigi Di Sarno, Italian Team, ReLuis*

1. Description of the asset

The structure is a two-span Bailey (steel) bridge, constructed as a temporary bypass to restore road connectivity following the collapse of the road embankment. The Bailey bridge appears to be used as a medium-term solution. The abutments and the central pier consist of rigid reinforced concrete (RC) blocks, supported on rock caissons.

Photo.1 – Overall view of the structure

2. Observed damages and causes

No structural damage was observed due the flood, however, a deformation of the rock caisson supporting the concrete cap was noted, most likely occurring in the initial phase, during the construction of the RC block. In any case, the bridge configuration permits potential differential settlements between the abutments and the central pier. The adopted clear span and the foundation system seem to be appropriate for the smooth flow of the river water.

Photo 2 – Views of the rock caissons and abutments foundations

3. Recommendations

1. Short Term

   none

2. Medium Term

   - If the Bailey bridge is intended to be used as a permanent structure rather than a temporary solution, a comprehensive assessment of the bearing capacity of the foundation system is required. The assessment should include considerations of scour stability, based on the reconstruction of the bathymetry and a detailed geotechnical profile (indicating the geometry and characteristics of the soil layers down to the bedrock),

3. Long Term

   - Visual inspection of the bridge stability (deck and piers) after each major flood event(s).
   - It is recommended to adopt a Bridge Management System (BMS) to compare inspection results over time, monitor the condition of the structure, assess bridge reliability indices and plan interventions, or further investigations, accordingly.
   - In the case of a new bridge is designed, the total span length should be sufficient to avoid any interference with the river hydraulic cross-section

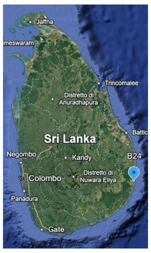
4. Additional documentation

Pictures.

Assessment of Br. n° 3/4 "American Bridge" on Arungambay

Location (N, E): 6.854444° N, 81.831111° E

Date of assessment: 17/12/2025



Participants:

- *Ramachandran Thambirajah, Road Development Authority.*
- *Francesco Giordano, Paolo Putrino, Italian Team, Italian Civil Protection Department;*
- *Luigi Di Sarno, Italian Team, ReLuis*

1. Description of the asset

The bridge is a multi-span composite steel–concrete bridge constructed in 2008 through a donation from the United States following the 2004 Sumatra tsunami. The superstructure consists of longitudinal symmetric steel I-girders supporting a reinforced concrete (RC) deck, with elastomeric bearings provided at the supports. Full-depth transverse web stiffeners are installed between adjacent longitudinal girders along the deck to ensure adequate transverse stiffness and load distribution. The piers are founded on three transversely arranged piles connected by a rigid transverse RC pile cap, providing overall stability and effective load transfer to the foundations.


Photo 1 - View of the bridge (left) – detail of the deck (right).

2. Observed damages and causes

The visual inspection did not reveal any visible structural damage due to the flood event; however, non-structural damage was observed. The cracks observed in the asphalt, in proximity to the abutment bays, are induced by beam vibrations caused by the heavy dynamic traffic loading. The joints observed in the asphalt, located in proximity to the abutment bays, are intentionally provided to accommodate beam vibrations and excessive span deformability in these specific areas, thereby preventing generalized cracking of the pavement under dynamic traffic loading. Severe corrosion is affecting the bridge, particularly along the downstream lateral pedestrian parapet walkway.



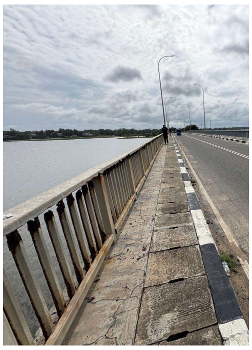


Photo 2 – Asphalt joints accommodating surface vibrations (left); corrosion of the deck steel frames (centre); corrosion of the pedestrian parapet (right).

3. Recommendations

1. Short Term
   - Cleaning and repair of the drainage system, and execution of asphalt repair or resurfacing works
   - Cleaning bridge joints along the deck.

2. Medium Term
   - Detailed assessment of the current condition of the bridge girders, considering corrosion affecting the load-bearing elements.
   - Prevent the progression of corrosion in the bridge load-bearing elements.
   - Replace non-structural elements (such as the parapets on the downstream/seaside) following an evaluation of their functional effectiveness as affected by corrosion.
   - A comprehensive assessment of the bearing capacity of the foundation system, including considerations for scour stability, should be conducted based on the reconstruction of the bathymetry and detailed geotechnical profile (indicating the geometry and characteristics of the soil layers until the bedrock) and the geometric and material properties of the existing foundations
   - Evaluate the concrete cover of the exposed elements to determine carbonation depth and steel protection, particularly due to its marina location.
   - Replacement of bridge joints (if necessary).

3. Long Term
   - Visual inspection of the bridge stability (deck and piers) after each major flood event(s).
   - It is recommended to adopt a Bridge Management System (BMS) to compare inspection results over time, monitor the condition of the structure, assess bridge reliability indices and plan interventions, or further investigations, accordingly.

4. Additional documentation

Pictures

Assessment of Bridge n° 7/1 Potuvil – Panama B-374 road

Location (N, E): *7.3028° N, 81.8478° E*

Date of assessment: 17/12/2025

Participants:

- *Ramachandran Thambirajah, Road Development Authority;*
- *Francesco Giordano, Paolo Putrino, Italian Team, Italian Civil Protection Department;*
- *Luigi Di Sarno, Italian Team, ReLuis*
- *Stefano Melosi, Italian Team, Italian Red Cross*

1. Description of the asset

The bridge, made of 2 isostatic spans, has an overall length of approximately 50 m and width of about 10 m. The deck is supported by an intermediate pier made of reinforced concrete, including a pier cap supported by two circular-section columns, aligned with the direction of the water flow. The pier is founded on rectangular blocks.

Photo.1 – Overall view of the structure by drone (left) and from riverbank (right)

2. Observed damages and causes

Localized deterioration is observed at the left abutment of the crossing structure; moreover, immediately upstream of the abutment, the river overtopped the embankment, resulting in a localized breach of the levee. Erosion along the affected bank and the presence of deposited material near the opposite abutment suggest the development of morpho dynamic processes related to the planform evolution of the river reach.

These observations are consistent with the results of a historical review of aerial view of the areas upstream and downstream of the crossing, which indicates that over the past two decades the fluvial morphology has undergone several modifications. Overall, these elements suggest that the river reach under consideration does not currently exhibit a fully stabilized morphological equilibrium.

Photo 2 –View of damaged abutment to wing wall

3. Recommendations

1. Short Term
   - Monitoring, warning with alert leading to bridge closure in case flood level thresholds are exceeded.
   - Assess erosion processes around the abutment including a bathymetric survey of the river cross-section in the proximity of the abutment.

2. Medium Term
   - A detailed hydraulic study of the river reach upstream and downstream of the bridge should be prepared to assess riverbed modifications caused by general erosion and local scour at the bridge section. The study should evaluate the effects on the crossing and shall define and design any required permanent mitigation measures to prevent damage and ensure long-term structural safety.

3. Long Term
   - Visual inspection of the bridge stability (deck and piers) after each major flood event(s).
   - It is recommended to adopting a Bridge Management System (BMS) to compare inspection results over time, monitor the bridge's condition, assess bridge reliability indices and plan interventions, or further investigations, accordingly.

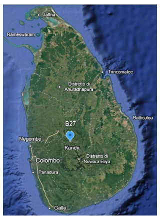
4. Additional documentation

Pictures, drone images, drone 3D geometric model

Assessment of Br. No. 1/1 - Gannoruwa Bridge

Location (N, E): 7,27193° N, 80,60500° E

Date of assessment: 17/12/2025



Participants:

- *Eng. Athula Liyanage Shasthri Senavirathna, Road Development Authority*
- *Paolo Vaccari, Italian Team, Italian Civil Protection Department;*
- *Luigi Evangelista, Rossano Lerra, Italian Team, Italferr;*

1. Description of the asset

Gannoruwa Bridge was built 25 years ago by a public company. The deck is composed of 10 simply supported precast prestressed concrete beams and concrete circular piers on shallow foundations

Photo 1 - Overall view of bridge (left) and underside of the deck (right).

2. Observed damages and causes

The bridge does not present structural issues, although the water level has risen above the deck. However, the condition of the bearings will need to be checked. The piers show clear signs of scour and debris accumulation (also close to bearings). Traces of moisture and efflorescence can be seen on the surfaces of the beams and the lowerside of the deckslab (specially the oldest one) and on the piers cap.

Photo 2 – debris on the foundation (left) and flow debris close to the bearings (right).

3. Recommendations

1. Short Term

- Removal of debris around the piers, abutment and their caps close the bearings
- Bathymetric survey of the river cross-section in the proximity of the bridge piers and abutment to assess erosion processes. The area subject to scour needs to be filled and subsequently, the riverbed and the banks must be protected with a riverbed defense system (riprap- see the Additional documentation).
- Visual inspection of the support devices and deck joints, with recording of the results (particularly if any defect is found), to monitor their evolution over time;
- Visual inspection and, if necessary, cleaning/repairing of the drainage ducts along the deck Recognition of real condition of the foundations of the piers (entity of scour).

2. Medium Term

- A comprehensive assessment of the bearing capacity of the foundation system, including considerations for scour stability, should be conducted based on the reconstruction of a detailed geotechnical profile (indicating the geometry and characteristics of the soil layers - including a bathymetry of riverbed - until the bedrock) and the geometric and material properties of the existing foundations.
- Evaluate the concrete cover of the exposed elements to determine carbonation depth and steel protection.
- Assess the current condition of the bridge deck pavement and undertake repair or resurfacing works as necessary.

3. Long Term

- Visual inspection of the bridge stability (deck and piers) after each major flood event(s).
- It is recommended to consider adopting a Bridge Management System (BMS) to compare inspection results over time, monitor the bridge's condition, assess bridge reliability indices and plan interventions, or further investigations, accordingly.

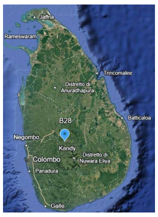
4. Additional documentation

Pictures, technical documentation (document *Examples_of_Riprap_Protection*)

Assessment of Br. No. 110/1 - Peradeniya Bridge

Location (N, E): 7,26397° N, 80,59327° E

Date of assessment: 17/12/2025



Participants:

- *Eng. Athula Liyanage, Shasthri Senavirathna, Road Development Authority*
- *Paolo Vaccari, Italian Team, Italian Civil Protection Department;*
- *Luigi Evangelista, Rossano Lerra Italian Team, Italferr;*
- *;*

1. Description of the asset

Historical bridge (likely constructed around 1870) near (lower stream) at the railway bridge with the same name. The bridge is composed of 3 arch-spans; each span is supported by 4 steel arches and a concrete slab. The piers and abutments are in masonry with a rectangular section.

As reported form RDA's technicians, a new road bridge is being planned, the older will be preserved with intention being to make it an iconic symbol of the city of Kandy.

Photo 1 - Overall view of the bridge (left) and detail of abutment (right).

2. Observed damages and causes

The bridge does not present structural issues. Signs of erosion and scour can be seen at one of the two abutments (the one on the right of the riverbed).

Photo 2 – Lateral view of the bridge (left) and detail of one of the four steel arch (right).

3. Recommendations

1. Short Term

- Removal of debris around the piers and abutments,
- Bathymetric survey of the river cross-section in the proximity of the bridge piers and abutment to assess erosion processes. The area subject to scour (especially close to the right abutment) needs to be filled and subsequently, the riverbed and the banks must be protected with a riverbed defense system (riprap- see the Additional documentation).
- Visual inspection of the support devices and deck joints, with recording of the results (particularly if any defect is found), to monitor their evolution over time
- Visual inspection and, if necessary, cleaning/repairing of the drainage ducts along the deck

2. Medium Term

- A comprehensive assessment of the bearing capacity of the foundation system, including considerations for scour stability, should be conducted based on the reconstruction of a detailed geotechnical profile (indicating the geometry and characteristics of the soil layers - including a bathymetry of riverbed - until the bedrock) and the geometric and material properties of the existing foundations.
- Evaluate the concrete cover of the exposed elements to determine carbonation depth and steel protection.
- Assess the current condition of the bridge deck pavement and undertake repair or resurfacing works as necessary.

3. Long Term

- Visual inspection of the bridge stability (deck and piers) after each major flood event(s).
- It is recommended to consider adopting a Bridge Management System (BMS) to compare inspection results over time, monitor the bridge’s condition, assess bridge reliability indices and plan interventions, or further investigations, accordingly.

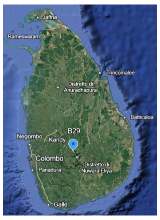
4. Additional documentation

Pictures, technical documentation (document *Examples_of_Riprap_Protection*)

Assessment of Br. No. 45/3 - Ramboda Bridge

Location (N, E): 7,05453° N, 80,70058° E

Date of assessment: 17/12/2025



Participants:

- *Eng. Athula Liyanage, Shasthri Senavirathna, Road Development Authority*
- *Paolo Vaccari, Italian Team, Italian Civil Protection Department;*
- *Luigi Evangelista, Rossano Lerra, Italian Team, Italferr;*

1. Description of the asset

Bridge crossing a mountain stream near a small waterfall. The deck is made up of two different types of structures built at different times: the downstream deck consists of two spans with metal beams, span length approximately 7.5 m. The upstream deck (built later) is a single-span composed by precast concrete beams (abutment-to-abutment), span length approximately 15 m. The old pier is masonry with a rectangular section. The foundations are directly connected to the bedrock. As reported from the RDA's technicians, the older two-span structure is planned to be replaced, removing the central old pier, and making the entire bridge as a single span composed of precast prestressed concrete beams. The design has already been developed and is currently in the tender phase for construction.

Photo 1 - Overall view of the bridge. Downstream (left) and upstream (right).

2. Observed damages and causes

The area around the bridge is affected by a very significative landslide event, however the bridge itself does not present particular structural issues due to the landslide or scour, but it's evident that the reduced dimension of the minimum span length, equal to 7,5 m, and the consequent presence of the central pier, represent an obstacle to the waterflow, especially during no-ordinary events, due to particular condition of the site, as described above

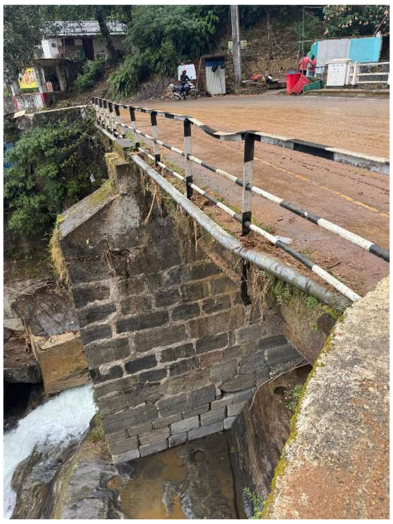



Photo 2 – Detail of the old central pier. Left side (left) and Right side (right).

3. Recommendations

1. Short Term

    - Removal of debris around the abutments

2. Medium Term:

    - As previously mentioned, an intervention is already scheduled for this bridge. The primary objective of this intervention is to replace the existing old deck by a new structure similar the existing one upper stream removing the existing central pier. This solution is specifically intended to enhance the bridge's hydraulic performance, ensuring improved waterflow management under both ordinary and extreme conditions.
    - Assess the current condition of the bridge deck pavement and undertake repair or resurfacing works as necessary.

3. Long Term

    - Visual inspection of the bridge stability (deck and piers) after each major flood event(s).
    - It is recommended to consider adopting a Bridge Management System (BMS) to compare inspection results over time, monitor the bridge's condition, assess bridge reliability indices and plan interventions, or further investigations, accordingly.

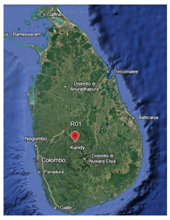
4. Additional documentation

Pictures

Assessment of Paradeniya Railway Bridge

Location (N, E): 7.25872° N; 80.59377° E

Date of assessment: 13/12/2025



Participants:

- *Ramachandran Thambirajah, Road Development Authority;*
- *Sandun Lokuarachchi and Danuschka, Sri Lanka Railways;*
- *Agostino Goretti, UCPT Team, Italian Civil Protection Department;*
- *Paolo Vaccari, Francesco Giordano and Marco Cassani, Italian Team, Italian Civil Protection Department;*
- *Luigi Evangelista, Rossano Lerra, Italian Team, Italferr.*

1. Description of the asset

Railway bridge consists of four simply supported steel truss girders in a through configuration, with piers and abutments constructed by rectangular stone masonry bonded with mortar, founded on direct (shallow) foundations.

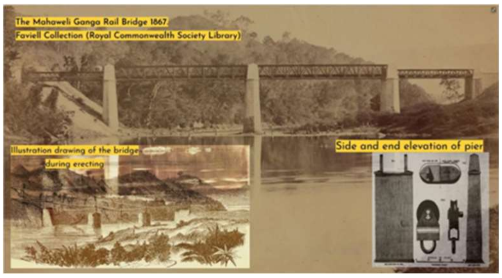


Photo 1 - Overall view of the original (left) and actual structure (right).

2. Observed damages and causes

During the flood event, the bridge experienced significant central pier tilting and settlement due to scour at the foundation. The damaging mechanism can be attributed to localized foundation scour combined with high flow velocities, debris impact, uplift effects, and interaction with the river flood. The water, accelerating around the pier, generates bottom vortices that can remove bed material (gravel, sand, silt).

Due to the extraordinary flood of the river, an excavation (scour) has been formed at the base of the central pier, lowering the upstream foundation level and causing it to rotate rigidly of about 7°, resulting in a horizontal displacement of approximately 1.8 m and a vertical settlement of 1.0 m of the top of the central pier. Consequently, the two girders supported on the pier altered their geometry by rotating and lowering at the extremity. This led to the out of service for the line.

Effectively, further erosion/undermining phenomena could compromise the structural stability of the pier and therefore, of the bridge.

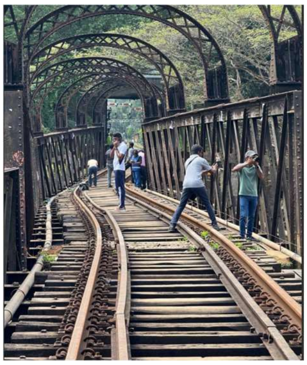
  

Photo 2 – Rotation of the pier (left), deviation of the rail (central and right).

3. Recommendations

1. Short Term
    - Removal of debris around the piers and abutments;
    - Survey the current geometry of the riverbed at the location of the existing foundations and for at least 10 m upstream and downstream;
    - Reconstruct the geotechnical profile of the foundation soils at the river crossing;
    - Verify the current condition of the pier foundation and assess the extent of erosion around its entire perimeter;
    - Evaluate the residual capacity of the piers, starting with the central pier, using standardized procedures.

2. Medium Term
    - Geometric and structural restoration of the foundations (possibly using micropiles), of the central pier and, subsequently, proceed with a rotation of about 7° with respect to the horizontal axis (up to the original position) to restore the verticality of the pier. This delicate operation must be carried out ensuring that the entire original foundation moves as a single unit, without damage and/or disconnections (a perimeter bracing of the foundation and the original shaft with steel or concrete elements may be helpful). During the movement of the shaft, the steel beams must be fixed to the pier cap with bidirectional connections. After the rotation, firmly connect the shaft to the reinforced foundation, consolidate the shaft, and then complete the intervention by restoring and/or reconstructing the pier cap.
    - Geometric and functional restoration of the bearing devices, prioritizing the two central spans and subsequently the two lateral ones

3. Long Term
    - Considering the frequency with which the bridge has been affected by floods that have reached and exceeded the deck level, evaluate the current hydraulic conditions and verify the need for raising the T.O.R. (Top of Rail) in accordance with the surrounding geometric constraints.
    - Definition a strategy for scour protection and realization of a protection itself (see technical document *Example_of_Riprap_Protection*).
    - Reshaping and protection of riverbed around the bridge
    - Considering the age of the steel trusses (more than 70 years), it is suggested to check and restore all the steel elements, also evaluating the possibility of replacing them.

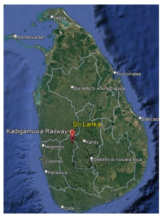
4. Additional documentation

Pictures and technical documentation (*Example_of_Riprap_Protection)*

Assessment of Kadigamuwa Rail Station Area

Location (N, E): 7.31795° N; 80.43341° E

Date of assessment: 14/12/2025



Participants:

- *Danushka Adec, Sri Lanka Railways*
- *Paolo Vaccari, Italian Team, Italian Civil Protection Department;*
- *Luigi Evangelista, Rossano Lerra, Italian Team, Italferr.*

1. Description of the area

Landslide affecting the railway track near the Station. Three different points were observed. The first one closes to the station, the others around 500 mt. from the main building The cross section of the railway in these areas is in trench. The conditions of the sites are stable (only debris over the track).

Photo 1 - Overall views of the site.

2. Observed damages and causes

A landslide event caused by heavy rainfall resulted in the detachment of soil and rock material from a steep slope adjacent to the railway line. The saturated ground lost stability due to prolonged precipitation, triggering a mass movement of debris downslope. The displaced material, consisting of mud, stones, and vegetation, accumulated on the railway line (over track bed), partially obstructing the track and forbidding train operations.

Photo 2 – Detailed views of the site.

3. Recommendations

1. Short Term
   - Removal of debris from the railway track and adjacent areas, with particular attention to unstable soil sections and/or trees.
   - Check and eventual replacement of Railway Track Equipment crushed or damaged.

2. Medium Term
   - Check of stability conditions in transversal and longitudinal direction of slope and, if necessary, re-profiling the geometry of the slope.

3. Long Term
   - Implement suitable protection measures for slopes located uphill or downhill from the railway infrastructure to mitigate the landslide risks and enhance resilience against external factors, based on:
     - Control of surface and subsurface water drainage,
     - Support/retain structures,
     - Improvement of the properties of the existing natural materials.

     This integrated approach will reduce the risk of landslides and rockfalls, ensuring the safety and continuity of railway operations.

4. Additional documentation

Pictures and technical documentation (*Examples of protection measures for infrastructures in landslide area* and *Atlas of Slope Stabilization Works* (in Italian))

Assessment of Balana Rail Station Area

Location (N, E): 1) 7.26369° N ; 80.49456° E

2) 7.26572° N ; 80.49322° E

Date of assessment: 14/12/2025

Participants:

- *Danushka Adec, Sri Lanka Railways*
- *Paolo Vaccari, Italian Team; Italian Civil Protection Department*
- *Luigi Evangelista and Rossano Serra, Italian Team, Italferr*
- *Stefano Melosi, Italian Team, Italian Red Cross (on 18/12/25 to conduct drone survey)*

1. Description of the area

There are three major landslides: two closes together, with the entire embankment collapsing downstream. The cross section of the railway in these areas is half-slope.

Photo 1 - Overall view of the area (drone image with possibility of extracting measurements).

2. Observed damages and causes

Three landslides triggered by intense and prolonged rainfall have caused a deep subsidence that affected the entire railway embankment for several dozen meters. As the embankment shifted, entire sections of the ballast slid downhill, leaving rails and sleepers suspended in the air in three distinct sections, each 15 to 30 meters long. In one of these sections, a rail joint failed, disjointing the track, and breaking several sleepers. These conditions make rail traffic impossible. Furthermore, a fourth landslide occurred near the entrance to Tunnel No. 9, partially obstructing the railway track and causing water to pool from the tunnel, which slopes steadily toward the entrance to the landslide.




Photo 2 – Detail of first (upper left), second (upper right), third (lower left) landslide and tunnel 09 impacted by debris (lower right).

3. Recommendations

1. Short Term

- Removal of debris from the railway track and adjacent areas, with particular attention to unstable soil sections and/or trees.
- Check and eventual replacement of Railway Track Equipment crushed or damaged
- Check of stability conditions in transversal and longitudinal direction of slope and, if necessary, re-profiling the geometry of the slope.

2. Medium and Long Term

- Rehabilitation of the railway line in areas where the embankment and the track have slid downhill can be accomplished by:
  a) rebuilding the embankment with prior consolidation of the foundation soil,
  b) if option a) is not technically possible or economically convenient, crossing the landslide with a new railway bridge.

  Intervention type a) can be considered for cases where the track elements are not damaged. It involves removing the landslide soil and the misaligned track, stabilizing the support surface, and rebuilding the new embankment in layers, followed by installation of the railway superstructure.

  Intervention type b) may be necessary in landslides where the track has broken. To build a bridge, the landslide embankment and the misaligned track must be removed, abutments must be built on stable ground, and the deck constructed, ensuring adequate clearance above the affected area.

- Implement suitable protection measures for slopes located uphill or downhill from the railway infrastructure to mitigate the landslide risks and enhance resilience against external factors, based on:
  - Control of surface and subsurface water drainage,
  - Support/retain structures;
  - improvement of the properties of the existing natural materials.

  This integrated approach reduces the risk of landslides and rockfalls, ensuring the safety and continuity of railway operations.

4. Additional documentation

Pictures, drone images and technical documentation (*Examples of protection measures for infrastructures in landslide area* and *Atlas of Slope Stabilization Works* (in Italian))

Assessment of the area near Rambukkana Rail Station

Location (N, E): 7.33068° N; 80.41708° E

Date of assessment: 14/12/2025

Participants:

- *Danushka Adec, Sri Lanka Railways*
- *Paolo Vaccari, Italian Team, Italian Civil Protection Department;*
- *Luigi Evangelista, Rossano Lerra, Italian Team, Italferr.*

1. Description of the area

The site visited is near Rambukkana station (direction to Polgahawela). In these areas the railway cross-section is half-slope. Two landslides covered the railway line with this debris from upslope.

2. Observed damages and causes

A landslide event caused by heavy rainfall resulted in the detachment of soil and rock material from a steep slope adjacent to the railway line. The saturated ground lost stability due to prolonged precipitation, triggering a mass movement of debris downslope. The displaced material, consisting of mud, stones, and vegetation, accumulated on the railway line (over track bed), partially obstructing the track and forbidding train operations.

In the first site observed (the first coming from Rambukkana), the landslide has occurred only upslope of the railway and not downslope, because a consolidation work with gabions and water management had recently been completed. A tangible sign of the effectiveness of this intervention. Another landslide also occurred on the mountain side.

In the proximity of the area is located Tunnel No. 2, but it was not affected by the landslide.

Photo 2 – Detail of landslide affecting railway tracks (left and center) and existing stabilization intervention (right)

3. Recommendations

1. Short Term
    - Removal of debris from the railway track and adjacent areas, with particular attention to unstable soil sections and/or trees.
    - Check and eventual replacement of Railway Track Equipment crushed or damaged.

2. Medium Term
    - Check of stability conditions in transversal and longitudinal direction of slope and, if necessary, re-profiling the geometry of the slope.

3. Long Term
    - Implement suitable protection measures for slopes located uphill or downhill from the railway infrastructure to mitigate the landslide risks and enhance resilience against external factors, based on:
        - Control of surface and subsurface water drainage,
        - Support/retain structures,
        - improvement of the properties of the existing natural materials.

      This integrated approach reduces the risk of landslides and rockfalls, ensuring the safety and continuity of railway operations.

4. Additional documentation

Pictures and technical documentation (*Examples of protection measures for infrastructures in landslide area* and *Atlas of Slope Stabilization Works* (in Italian))

Assessment of Deduru Oya Dam

Location (N, E): *7°43'04''N; 80°16'26''E*

Date of assessment: *16/12/2025*

Participants:

- *Gayan Weerasooriya and Dilruk Hettiarachchi, Irrigation Department;*
- *Viraj Dissanayake, Disaster Management Center - Kurunegala;*
- *Agostino Goretti, EUCPT, Italian Civil Protection Department;*
- *Marco Cassani, Italian Team, Italian Civil Protection Department;*
- *Simona Guglielmi and Roberta Ventini, Italian Team, MIT-General Directorate for Dams and Water Infrastructure.*

1. Description of the asset

Deduru Oya dam, built in 2014, is an earth zoned dam with a central concrete buttressed portion, where the surface outlet gates are located. The reservoir, in the Kurunegala District, is primarily used for irrigation, but it also powers a 1,5 MW hydroelectric power station.

The earth dam has an average height of 17 m and a length of 2400 m. The concrete portion is 68 m long and houses 8 mechanically operated radial gates. Two lateral sluices (left and right sluice) are also present in the right part of the concrete structure, next to the intake tunnel serving the power station downstream.

The high flood level is 71,32 m a.s.l.. The reservoir storage capacity at full supply level (70,79 m a.s.l.) is around 75 Mm^3.

Technical drawings are available, showing the general system layout as well as cross sections of both the spill and the embankment (prototype sections and along the longitudinal development). The dam is not equipped with monitoring instrumentation and there is no inspection tunnel.


Photo 1 - Overall view of the structure: left) earth dam portion, right) concrete dam portion

2. Observed damages and causes

No damages to the dam body have been recorded due to the flood by the local technicians, nor have they been visually observed during inspection. Embankment-spill interfaces do not show any issue upon visual inspection.

During the flood, the high flood level has been overcome, and all the surface gates have been fully opened, reaching a flow rate of 3200 m^3/s. This water release has caused damage downstream both to the riverbed and its banks (especially on the right bank) and to irrigation canals up to 1 km distance from the dam. Evacuation was ordered only for people within 1 km distance downstream.

Photo 2 – View of the riverbed with indication of the damaged right bank

3. Recommendations

1. Short Term

   It is suggested to restore the full operational functionality of the spillway gates that are currently not working, including a thorough inspection and repair of the associated operating and control systems. In parallel, an acoustic warning system related to the opening and closing of the spillway gates should be guaranteed. Vegetation removal and cleaning of the downstream face of the earth dam should also be carried out regularly to improve surface drainage conditions and allow effective visual inspections of the dam body. It is recommended that gate operations be carried out on a regular basis and, whenever feasible, that full-range gate operations be performed. It is suggested to establish an on-purpose "Register of gate operations" to keep a detailed record of all gate operations, timing, water level change during operations, opening degree, and water flow rate through the gate.

2. Medium Term:

   Over the medium term, extraordinary maintenance works should be undertaken on the dam crest on both earth and concrete sections. These activities should include the restoration of degraded surfaces, evaluation of core integrity, and re-establishment of horizontality of the crest to ensure long-term durability and hinder surface erosion especially in case of extreme loads like overtopping. It is suggested to establish a flood management plan to ensure hydraulic safety of the downstream region. In case of flood, to provide gradual increase of the spillway outflow rate, its amount must not exceed, in the flood increasing phase, the water inflow to the reservoir, allowing sufficient time for the population to be evacuated.

3. Long Term

   It is strongly suggested to implement a dam monitoring instrumentation system. This should include the installation of instruments for the measurement of pore water pressures and horizontal and vertical displacements, with the objective of improving the overall safety management of the dam and strengthening its resilience to future extreme hydraulic events.
   Measurements should be carried out at a predefined frequency depending on the parameter being monitored, recorded, and correlated with reservoir levels, to allow the detection of potential irregularities in the dam behavior during exceptional events.

4. Additional documentation

Pictures

Assessment of Rajanganaya Dam

Location (N, E): *8°08'26"N, 80°13'33" E*

Date of assessment: *16/12/2025*

Participants:

- *K.A. Sampath Samarajeewa and A.M. Amjath, Irrigation Department - Rajangana Division;*
- *V. Thawakkumar and D.G.K. Kamil, Irrigation Department – Anuradhapura Region;*
- *Nayan Samarakoon, Disaster Management Center – Anuradhapura District;*
- *Agostino Goretti, EUCPT, Italian Civil Protection Department;*
- *Marco Cassani, Italian Team, Italian Civil Protection Department;*
- *Simona Guglielmi and Roberta Ventini, Italian Team, MIT-General Directorate for Dams and Water Infrastructure.*

1. Description of the asset

The Rajanganaya Dam, located in north-western Sri Lanka, was constructed in 1962 across the Kala Oya river basin and serves primarily for irrigation purposes. The dam has a maximum height of 22.87 m and a crest length of about 4 km. The reservoir storage capacity at full supply level (68.28 m a.s.l.) is about 100 million cubic meters. The high flood level is 69.07 m a.s.l. It is an earth dam, partly zoned and partly homogeneous, with a concrete structure housing the surface spillway, which is equipped with 30 gated openings. Two upstream wet wells are also present, one on the left bank and one on the right bank, housing rectangular buried conduits equipped with slide gates (three on the left bank and one on the right bank). The earth dam is equipped with instruments for monitoring pore water pressures along three cross sections (two sections on the left bank and one on the right bank). A target used to measure crest displacements was also observed on the portion of the earth dam located on the right bank.

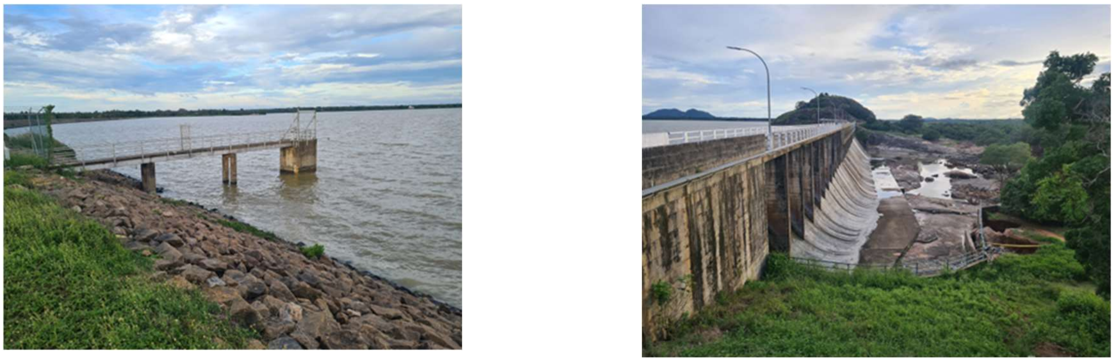


Photo 1 - Overall view of the structure.

2. Observed damages and causes

During Cyclone Ditwah, the peak flood inflow (1,000-year) was exceeded, resulting in the opening of 28 of the 30 spillway gates. Two gates were not opened due to a malfunction of the operating system. As observed during the site visit and reported by the on-site technicians, no damage to the dam structure was detected, either in the earth or concrete parts. However, the natural side saddle was overtopped and suffered significant damage due to material erosion and removal.

Photo 2 – View of the natural saddle surface erosion

In addition, damage was observed in the downstream riverbed, including houses being washed away and damage to local access roads. During the technical site inspection, several critical issues not directly related to the flood event were also identified. These include widespread deterioration of the pavement covering the crest of the concrete section of the dam, as well as the malfunction of the acoustic warning system intended to be activated in the event of spillway gates opening.

Photo 1 - Damage in the downstream riverbed.

3. Recommendations

1. Short Term

   It is suggested to restore the full operational functionality of the spillway gates that are currently not working, including a thorough inspection and repair of the associated operating and control systems. In parallel, an acoustic warning system related to the opening and closing of the spillway gates should be guaranteed. Vegetation removal and cleaning of the downstream face of the earth dam should also be carried out regularly to improve surface drainage conditions and allow effective visual inspections of the dam body. It is recommended that gate operations be carried out on a regular basis and, whenever feasible, that full-range gate operations be performed. It is suggested to establish an on-purpose "Register of gate operations" to keep a detailed record of all gate operations, timing, water level change during operations, opening degree, and water flow rate through the gate.

2. Medium Term

   Over the medium term, extraordinary maintenance works should be undertaken on the dam crest on both earth and concrete sections. These activities should include the restoration of degraded surfaces, evaluation of core integrity, and re-establishment of horizontality of the crest to ensure long-term durability and hinder surface erosion especially in case of extreme loads like overtopping. It is suggested to establish a flood management plan to ensure hydraulic safety of the downstream region. In case of flood, to provide gradual increase of the spillway outflow rate, its amount must not exceed, in the flood increasing phase, the water inflow to the reservoir, allowing sufficient time for the population to be evacuated.

3. Long Term

   It is strongly suggested to implement and enhance dam monitoring instrumentation system. This should include the installation of additional instruments for the measurement of pore water pressures and horizontal and vertical displacements, with the objective of improving the overall safety management of the dam and strengthening its resilience to future extreme hydraulic events. Measurements should be carried out at a predefined frequency depending on the parameter being monitored, recorded, and correlated with reservoir levels, to allow the detection of potential irregularities in the dam behaviour during exceptional events.

4. Additional documentation

Pictures

Assessment of Senanayake Samudraya Dam

Location (N, E): *7°11'40''N; 81°29'51''E*

Date of assessment: *17/12/2025*

Participants:

- *H.B.P. Bandara, S.A.D.W. Kumara, N. Nilanga Subasinghe, and Pavithra Weerasinghe, Irrigation Department;*
- *Malith Senadeera, Ceylon Electricity Board;*
- *Agostino Goretti, EUCPT, Italian Civil Protection Department;*
- *Marco Cassani, Italian Team, Italian Civil Protection Department;*
- *Simona Guglielmi and Roberta Ventini, Italian Team, MIT-General Directorate for Dams and Water Infrastructure.*

1. Description of the asset

Senanayake Samudraya dam, built in 1953, is an earth-fill dam forming the reservoir on the Gal Oya River, in the Ampara District. The reservoir is primarily used for irrigation as part of the Gal Oya Development Scheme, and it also supplies water to the Inginiyagala hydropower station located immediately downstream of the dam. The dam is an earth embankment dam with a maximum height of 37.18 m and a crest length of approximately 1,100 m. A separate concrete spillway structure, located away from the main embankment, is about 310 m long (spill length of 235 m) and is equipped with 6 gates (1.75m x 1.75m). The full supply level of the reservoir is 79.25 m a.s.l. while the high flood level is 81.45 m a.s.l. The total storage capacity of Senanayake Samudraya at full supply level is about 950 Mm^3, making it the largest reservoir in Sri Lanka.

The dam is not equipped with monitoring instrumentation, and there is an inspection tunnel only at the base of the concrete spillway structure. The water used for distribution is conveyed through a concrete sluice tower via a pipeline passing through the earth dam.

Photo 1 - Overall views of the dam.

2. Observed damages and causes

During the flood, 5 of the 6 bottom outlet gates were opened. One gate was not opened due to a malfunction of the operating system. As observed during the site visit and reported by the on-site technicians, no damage to the dam structure was detected, either in the earth or concrete parts.

During the technical site inspection, several critical issues not directly related to the flood event were identified. These include widespread deterioration of the pavement covering the crest of the earth dam and several cracks in concrete structure, both in the sluice tower and the spill structure.

The sluice tower has extensive cracking in the portion that is permanently submerged, which therefore could not be directly observed. A relative displacement between the tower and the access walkway was also detected, which has been attributed to a slight rotation of the tower itself. Over the years (since 1990s), investigations and crack-filling interventions have been carried out; however, the evolution of the cracking pattern is still ongoing. Crack patterns and investigations were, however, presented to the team by the Irrigation Department during a meeting before the site visit. The reported causes of cracking, such as concrete ageing or reinforcement corrosion, appear unlikely in this case, particularly given that the cracks are located in permanently submerged areas where oxygen availability is limited, and corrosion processes are inhibited. Investigations instead indicated the presence of alkali–sulphate reaction products along the cracks. This reaction is known to promote the formation of ettringite, leading to volumetric expansion of the concrete and associated cracking. The presence of water, as in the current conditions, is known to accelerate this reaction. The extent and asymmetric distribution of cracking on one side of the tower may also have contributed to the observed rotation of the sluice tower.

Regarding the spillway structure, cracks were observed both on the concrete surfaces (from a distance) and within the gallery at the base of the structure. In the latter, water seepage was also detected. The technical staff reported that cracks in the concrete are also present at the outlets of the bottom outlet. The technical staff are currently awaiting a design proposal for remedial works addressing both the sluice tower and the spillway structure. In addition, stockpiles of rock blocks were observed on the crest, intended for use in ongoing rehabilitation works aimed at restoring the riprap protection on the upstream face.




Photo 2 – Observed critical issues

3. Recommendations

1. Short Term

It is suggested to restore the full operational functionality of the bottom outlet gate that is currently not working. In parallel, an acoustic warning system related to the opening and closing of the gates should be guaranteed. Vegetation removal and cleaning of the downstream face of the earth dam should also be carried out regularly to improve surface drainage conditions and allow effective visual inspections of the dam body. It is recommended that gate operations be carried out on a regular basis and, whenever feasible, that full-range gate operations be performed. It is suggested to establish an on-purpose “Register of gate operations” to keep a detailed record of all gate operations, timing, water level change during operations, opening degree, and water flow rate through the gate. It is also noted that it would be useful to carry out periodic inspections of the dam body and of all critical sections. It would also be important to regularly measure and record the water leakage observed in the concrete dam gallery, in order to identify any correlations with the reservoir water level, which could be useful in determining the most effective type of intervention.

2. Medium Term

   Over the medium term, extraordinary maintenance works should be undertaken on the dam crest on the earth dam. These activities should include the restoration of degraded surfaces, evaluation of core integrity, and re-establishment of horizontality of the crest to ensure long-term durability and hinder surface erosion especially in case of extreme loads like overtopping. It is suggested to establish a flood management plan to ensure hydraulic safety of the downstream region. In case of flood, it is suggested to ensure that the flood is always laminated downstream, and that the presence of the dam is always beneficial, especially in the rising phase of the flood.

3. Long Term

   It is strongly suggested to implement and enhance dam monitoring instrumentation system. This should include the installation of instruments for the measurement of pore water pressures and horizontal and vertical displacements, with the objective of improving the overall safety management of the dam and strengthening its resilience to future extreme hydraulic events. Measurements should be carried out at a predefined frequency depending on the parameter being monitored, recorded, and correlated with reservoir levels, to allow the detection of potential irregularities in the dam behavior during exceptional events.

   It is further suggested to assess the mechanical properties of the foundation soils and the spillway concrete, and to perform stability analyses of the concrete dam. It will be beneficial to seal the cracks and to increase the weight of the spillway structure, which appears to be relatively slender, through a possible strengthening intervention on the downstream face.

   With regard to the condition of the sluice tower, the usefulness of constructing a new intake structure for the diversion works and installing a pipeline that does not pass through the earth embankment is acknowledged. Furthermore, to prevent damage to the pipeline currently crossing the earth dam in the event of a potential tower collapse, it is considered advisable to relocate the intake inlet further upstream, ensuring an effective connection to the existing pipeline. In this case, downstream flow regulation shall be provided where not already present. However, it will be necessary to infill the existing tower with suitable material to protect the new pipeline configuration in the event of tower collapse or controlled demolition. If strengthening of the sluice tower is pursued, the causes of the cracks and tower rotation must be clearly understood to enable an effective structural strengthening intervention.

   It is recommended to consider including the design and supply of the dam monitoring system in the scope of the integrated contract for the design and construction of the new sluice tower and conduit.

4. Additional documentation

Pictures

Assessment of Landslide in Kadugannawa Colombo-Kandy Road (A001)

Location (N, E): *7°25'45"N - 80°49'44"E*

Date of assessment: *13/12/2025*

Participants:

- *Prasad Dharmasena and Chinthaka Rathnasiri, National Building Research Organisation*
- *Paolo Putrino, Italian Team, Italian Civil Protection Department;*
- *Stefano Melosi, Italian Team, Italian Red Cross*

1. Description of the landslide

The area affected by the landslide is located halfway between Kegalle and Kandy on the A001 Road that connects the city of Colombo to Kandy and is characterized by heavy traffic and the presence of a slope surmounted by a bank of very fractured rock. Downslope the road there are some buildings.

Photo 1 - Overall views of the landslides.

2. Observed damages and causes

The slope along the A1 Road was affected by several landslides along a stretch of almost 100 metres, which damaged buildings and businesses and caused the death of six people. These localised landslides were caused by the collapse of large boulders from a rocky substrate above a layer of gravelly matrix material of varying thickness. They were triggered not only by heavy rains that eroded the base, but also by the fracturing of the rock layer due to the action of the roots of dense shrub vegetation. A drone flight conducted by Mr. Stefano Melosi confirmed the widespread landslides in the area. Clearing works were underway on a section of the road.

Photo 2 – Rockfall.

3. Recommendations

1. Short Term:

   Not only in landslide affected areas but also in nearby slopes it is recommended a post-event risk assessment to understand the possible evolution of the observed phenomena. To safeguard the surrounding buildings and the resident population, it is recommended to perform a detailed field visual assessment of the area's stability conditions, including the use of drone-based surveys. Conduct field assessment for the verification of the fracturing status of the rocky bank. Continuous on-site presence during severe weather events and operational watch of affected areas with and early warning system in the event of heavy rains with temporary closure of the road and evacuation of residents at risk. The installation of monitoring systems, including rapid or provisional ones, for the slope, connected to an Early Warning System (EWS) for the protection of the resident population is also recommended.

2. Medium Term:

   Where rockfall occurred or may occur, it is suggested to implement low impact stabilization measures such as selective removal or securing of unstable rock blocks and boulders; installation of surface and subsurface drainage systems, aimed at removing and reducing groundwater presence; slope stabilization and re-profiling works to restore acceptable safety conditions, including slope reshaping, grassing, and erosion control systems, to improve long-term slope performance. It is suggested to implement a systematic maintenance of the slopes and rock cliff, drainage system, and protective works near settlements. It is also suggested to establish an in-situ monitoring system (satellite imagery, LiDAR or inclinometers) with periodic review and validation of the EWS, incorporating lessons learned from future events and climate change projections to localize rainfall thresholds of the EWS.

3. Long Term:

   It is recommended that the monitoring systems installed in the medium term be maintained in place also in the long term, to verify the long-term effectiveness of the implemented measures. It is suggested to introduce land- use regulations to limit new development and roadside housing construction in high-landslide susceptibility areas as this increases landslide hazard and exposure.

4. Additional documentation

Pictures and drone images

Assessment of Landslide in Ulapane Kandy-Nawalapitiya Road (AB13)

Location (N, E): *7°09'52"N - 80°55'56"E*

Date of assessment: *13/12/2025*

Participants:

- *Prasad Dharmasena and Chinthaka Rathnasiri, National Building Research Organisation*
- *Agostino Goretti, EUCPT, Italian Civil Protection Department;*
- *Paolo Vaccari, Paolo Putrino, Marco Cassani, Italian Team, Italian Civil Protection Department;*
- *Stefano Melosi, Italian Team, Italian Red Cross*

1. Description of the landslide

The area affected by the landslide is located along the AB13 Nawalapitiya–Kandy road and adjacent railway, near commercial activities. Upslope of these infrastructures, the slope is very steep and composed of sandy-silty material.

Photo 1 – Overall view of the landslide

2. Observed damages and causes

The landslide consists of a debris flow that covered and destroyed approximately 180 m of the AB13 roadway and irreversibly damaged about 140 m of the railway line, causing disruptions to local transportation. In addition to the road and railway line, the landslide destroyed commercial properties, including a carpentry shop, a farm, and a factory, as well as causing damage to residential buildings. A drone flight conducted by Mr. Stefano Melosi confirmed the extension of the landslide. Work is currently underway to restore the roadway while the railway line remains interrupted.

Photo 2 – Detailed views of the landslide

3. Recommendations

1. Short Term:

   Not only in landslide affected areas but also in nearby slopes it is recommended a post-event risk assessment to understand the possible evolution of the observed phenomena. The installation of a slope monitoring systems, including rapid or provisional ones, connected to the existing Early Warning System (EWS) for the protection of the infrastructure and commercial activities is also recommended.

2. Medium Term:

   It is suggested to implement low impact stabilization measures such as installation of surface and subsurface drainage systems, aimed at removing and reducing groundwater presence; slope stabilization and re-profiling works to restore acceptable safety conditions, including slope reshaping, grassing, and erosion control systems, to improve long-term slope performance. It is suggested to implement a systematic maintenance of the slope, drainage system, and protective works. It is also suggested to establish an in-situ monitoring system (satellite imagery, LiDAR or inclinometers) with periodic review and validation of the EWS, incorporating lessons learned from future events and climate change projections to localize rainfall thresholds of the EWS.

3. Long Term:

   It is recommended that the monitoring systems installed in the medium term be maintained in place also in the long term, to verify the long-term effectiveness of the implemented measures.

4. Additional documentation

Pictures and drone images

Assessment of Ramboda landslide

Location (N, E): *7°04'05"N ; 80°41'23"E*

Date of assessment: *13/12/2025*

Participants:

- *Prasad Dharmasena and Chinthaka Rathnasiri, National Building Research Organisation*
- *Paolo Putrino, Marco Cassani, Italian Team, Italian Civil Protection Department;*
- *Stefano Melosi, Italian Team, Italian Red Cross*

1. Description of the landslide

The area, near 3M6V+R42, Ramboda, lies along the road to Ramboda and includes several catering activities as well as several homes. The slopes adjacent to this busy road are almost vertical with some sections reinforced with protective nets to prevent rockfalls.

Photo 1 - Overall view of the landslide.

2. Observed damages and causes

The landslide consists of a debris flow (estimate volume of about one million mc) which covered the roadway, destroyed about 10 buildings and caused 20 fatalities (10 bodies found). Additionally, the landslide affected 43 buildings and the following roads: i) Kandy-Nuwara Eliya Road (AA005) for 0.045 km, ii) Ramboda-Sangilipalama Road (B612) for 0.11 km, and, ii) Tawalantenna-Talawakele Road (B412) for 0.1 km.

Urgent measures were taken to clear the road surface to allow vehicles passage, although the entire route remains affected by widespread damage, making travel difficult. A drone flight conducted by Mr. Stefano Melosi confirmed the the considerable extent of the landslide.


Photo 2 – Detailed views of the landslide.

3. Recommendations

1. Short Term:

   Given the extent and severity of the observed landslide and considering that the entire surrounding area is characterized by the same lithological and geotechnical conditions, it is recommended to carry out detailed geological and geomorphological surveys also in the adjacent areas. These areas host numerous residential buildings located at the toe of very steep slopes, as well as a heavily trafficked connecting roadway. The investigations should also be supported by drone-based surveys, in order to assess the hydrogeological stability of the slopes and to evaluate the post-event risk associated with the potential evolution of the observed landslide. Furthermore, in view of the rapid kinematics typically associated with this type of landslide, it is strongly recommended to activate an Early Warning System (EWS), coupled with an emergency plan that includes the temporary evacuation of the resident population and road closure during severe meteorological events.

2. Medium Term:

   The presence of significant surface water and groundwater within the landslide-affected area may contribute to further slope instability in both the affected and surrounding areas, potentially resulting in additional damage and loss of life. Considering the large volume of the landslide body, priority should be given to the implementation of surface and subsurface drainage measures to reduce groundwater pressures within the landslide mass and adjacent slopes. These measures should be complemented by progressive slope regrading and reshaping interventions aimed at reducing overall slope angles and mitigating the risk of future landslide reactivation. It is suggested to implement a systematic maintenance of the slope, drainage system, and protective works. It is also suggested to establish an in-situ monitoring system (satellite imagery, LiDAR or inclinometers) with periodic review and validation of the EWS, incorporating lessons learned from future events and climate change projections to localize rainfall thresholds of the EWS.

3. Long Term:

   It is recommended that the monitoring systems installed in the medium term be maintained in place also in the long term, to verify the long-term effectiveness of the implemented measures.

4. Additional documentation

Pictures and drone images

Assessment of landslide in Kalalpitiya–Ukuwala–Elkaduwa (B180) from Km 12 to Km 13

Location (N, E): *7°41'62.9"N - 80°08'19.0''E*

Date of assessment: *14/12/2025*

Participants:

- *Prasad Dharmasena and Chinthaka Rathnasiri, National Building Research Organisation*
- *Joseph Logeswaran, Road Development Authority*
- *Paolo Putrino, Marco Cassani, Italian Team, Italian Civil Protection Department;*
- *Stefano Melosi, Italian Team, Italian Red Cross*

1. Description of the landslide

The landslide occurred across the road, in an area characterized by a steep downslope. Part of the B180 road was completely destroyed by landslide debris and displaced downslope into the valley. The soil mass has lowered by approximately 4–5 m in the crest area, and the ground surface at the road level has decreased by approximately 1–1.5 m.

The main issue is that further failures can occur during the rain due to water infiltration into the landslide body and uncontrolled surface runoff along the slope. The landslide may be reactivated during heavy rainfall, since the failed mass remains in a very unstable condition. The road section is currently inaccessible to traffic

Photo 1 - Overall views of the landslide.

2. Observed damages and causes

A rotational landslide caused the collapse of the road between km 13 and km 14, rendering the carriageway impassable. Upslope of the landslide, tension cracks were observed within and around the landslide body. Stream flow from the upper valley is running along the boundary of the landslide. A drone flight conducted by Mr. Stefano Melosi confirmed the actual extension of the landslide.

Photo 2 – Road damages.

3. Recommendations

1. Short Term:

   The landslide has occurred across the road with a steep downslope. Tension cracks were observed within the landslide's body. Stream flow from the upper valley is running along the boundary of the landslide. Not only in landslide affected areas but also in nearby slopes it is recommended a post-event risk assessment to understand the possible evolution of the observed phenomena. The installation of a slope monitoring systems, including rapid or provisional ones, connected to an Early Warning System (EWS) for the protection of the resident population, is also recommended.

2. Medium Term:

   Additional failures may occur during rainfall events due to water infiltration into the landslide mass and uncontrolled surface runoff along the slope. The landslide may be reactivated during periods of intense or prolonged rainfall, as the displaced material is currently in a highly unstable condition. In order to safeguard the surrounding buildings and the resident population, it is recommended to perform a detailed visual and numerical assessment of the area's stability conditions, including the use of drone-based surveys and in situ investigations; to implement both surface and deep drainage measures not only within the landslide body but also in adjacent areas; to stabilize the slope, reprofiling and reshaping the slope and implementing natural engineering works. Considering the widespread hydrogeological instability of the area examined, it is recommended that an alternative route be identified for the connecting road further upslope, in a geologically more stable area. It is suggested to implement a systematic maintenance of the slope, drainage system, and protective works. It is also suggested to establish an in-situ monitoring system (satellite imagery, LiDAR or inclinometers) with periodic review and validation of the EWS, incorporating lessons learned from future events and climate change projections to localize rainfall thresholds of the EWS.

3. Long Term:

   It is recommended that the monitoring systems installed in the medium term be maintained in place also in the long term, to protect residents in extreme weather events and assess the long-term effectiveness of the implemented measures.

4. Additional documentation

Pictures and drone images

Assessment of Landslide in Matale

Location (N, E): *7°52'31"N - 80°67'80.9"E*

Date of assessment: *14/12/2025*

Participants:

- *Prasad Dharmasena and Chinthaka Rathnasiri, National Building Research Organisation*
- *Joseph Logeswaran, Road Development Authority*
- *Paolo Putrino, Italian Team, Italian Civil Protection Department;*
- *Stefano Melosi, Italian Team, Italian Red Cross*

1. Description of the landslide

Three landslides were identified along the Gammaduwa–Karagahathenna road. The primary landslide is of rotational type, evolving into a flow, and consists of two bodies, the larger of which extends approximately 200 m at the crown and about 2 km in length. The other two landslides could not be surveyed by drone due to site inaccessibility and increased wind conditions. The landslides were triggered by the nature of the terrain (highly altered and unstable metamorphic rocks), the slope of the rock layers, degradation from vegetation roots, and recent exceptional rainfall.

Photo 1 - Overall view of the landslide.

2. Observed damages and causes

Investigations conducted on the ground and by drone revealed three large landslides along the slope, the most significant of which caused the death of 2 people and the destruction of 4 buildings, as well as the interruption of road links to inhabited areas. The adjacent landslide, which was equally significant in size, also caused the destruction of roads, but did not result in any casualties. Further drone inspections were not possible due to the inaccessibility of the sites and strong winds. However, it was concluded that, at present, the conditions in the area require continuous monitoring of the situation, which is still evolving due to the presence of water in the landslide and movements that are likely still ongoing.


Photo 2 – Detailed views of the landslide.

3. Recommendations

1. Short Term:

   The entire area examined is characterized by the presence of highly altered metamorphic soils with a predominantly gravelly matrix, which are highly permeable and susceptible to landslides, some of which are significant, due to the abundance of water. Due to the damage to the only access road caused by at least three landslides, it's recommended that any residents in the area be evacuated and access to the area be prohibited, especially during intense weather events. Not only in the areas affected by landslides, but also on nearby slopes, an assessment of the post-event risk is recommended to monitor the possible evolution of the observed phenomena, including through the use of drones. It is also recommended to install a slope monitoring systems, including rapid or temporary ones, connected to an early warning system (EWS) for the protection of the resident population.

2. Medium Term:

   The presence of significant surface water and groundwater within the landslide-affected area may contribute to further slope instability in both the affected and surrounding areas, potentially resulting in additional damage and loss of life. Considering the large volume of the landslide body, priority should be given to the implementation of surface and subsurface drainage measures to reduce groundwater pressures within the landslide mass and adjacent slopes. These measures should be complemented by progressive slope regrading and reshaping interventions aimed at reducing overall slope angles and mitigating the risk of future landslide reactivation. Monitoring systems (satellite imagery, LiDAR or inclinometers) must be installed covering the entire intervention area to verify the effectiveness of the hydrogeological risk mitigation and drainage measures and to plan any further stabilization work in the area, through slope modelling and instability containment measures. It is suggested to implement a systematic maintenance of the slope, drainage system, and protective works. It is also suggested to establish an in-situ monitoring system (satellite imagery, LiDAR or inclinometers) with periodic review and validation of the EWS, incorporating lessons learned from future events and climate change projections to localize rainfall thresholds of the EWS.

3. Long Term:

   It is recommended that the monitoring systems installed in the medium term be maintained in place also in the long term, to protect residents in extreme weather events and assess the long-term effectiveness of the implemented measures.

4. Additional documentation

Pictures and drone images

Summary of drone surveys

Location (N, E): several

Date of assessments: 12-13-15-16-17-18/12/2025

Drone Pilot:

- *Stefano Melosi, Italian Team, Italian Red Cross*

1. Description of the drone surveys

During the mission, 17 drone surveys were conducted: 5 on landslides, 11 on bridges, and 1 on railway tracks.

The surveys were carried out using a DJI Mavic 3 Enterprise (Mavic 3E), selected for its rapid deployment and high photogrammetric performance. Key characteristics include a 4/3 CMOS 20 MP wide-angle camera with mechanical shutter (minimising rolling-shutter distortion for mapping), a dedicated tele camera for inspection support (up to 56× hybrid zoom), omnidirectional obstacle sensing, a robust O3 Enterprise digital link, and endurance up to 45 minutes (manufacturer data). The platform supports precise mission planning and repeatable data capture through waypoint/grid-based flights and can be integrated with RTK workflows where required.

Flights were conducted both in manual mode—used for close-range visual inspection, tactical positioning, and fine framing of critical details—and in automated mode using DJI Pilot 2. For automated sorties, pre-programmed missions (e.g., waypoint, grid and corridor patterns) were configured to enforce consistent altitude, speed, overlap and camera settings, improving data homogeneity and enabling repeatable re-flights for monitoring and comparison.

Each flight was pre-authorised by the Civil Aviation Authority of Sri Lanka (CAASL), which provided full operational support throughout the mission. Clearances were obtained in advance for each site and sortie, ensuring alignment with local airspace constraints, security requirements and any site-specific restrictions, and enabling timely execution of surveys in coordination with local stakeholders.

Some of the surveys were conducted with live streaming of images from the site, allowing those connected to make an initial and immediate assessment of the situation. Simultaneously, the acquired files were sent to the Italian Red Cross's UAS aerial photogrammetric processing team in Italy, to speed up the process. All of this was done via software Dji Flight Hub 2 and Starlink connection.

The survey initially provided photos (jpeg) and videos (mp4) for an initial evaluation and overview.

Afterwards post-processing was performed using DJI Terra for photogrammetric reconstruction and initial deliverables. The work was carried out on site and largely remotely from Italy with the support of the UAS aerial photogrammetric data processing Team of Italian Red Cross. The following deliverables were produced from the collected datasets:

- **2D products (DJI Terra outputs):**
    - Georeferenced orthomosaics / orthophotos (e.g., GeoTIFF) suitable for mapping and measurement.
    - 2D measurement outputs and annotated maps for assets and affected areas.
    - Flight trajectories and mission metadata exports for traceability and audit.

- **3D products (DJI Terra outputs):**
    - Dense point clouds and/or 3D reconstructed surfaces generated in DJI Terra as the base dataset.
    - Textured 3D meshes/models of bridges, landslides and railways for visual inspection and stakeholder briefing.
    - 3D measurement outputs.
    - Export packages in standard formats (as required by the client) for integration into GIS/CAD or visualisation tools.

2. Examples of delivered products

Examples of processed products are reported in the following.

Photo 1 Example of photo(.jpg) - Photo 2 – Example of video (.mp4)

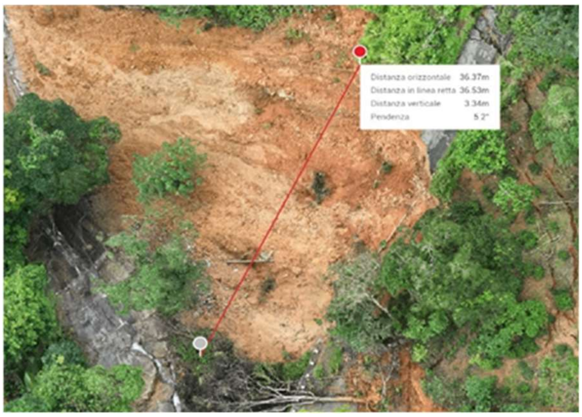
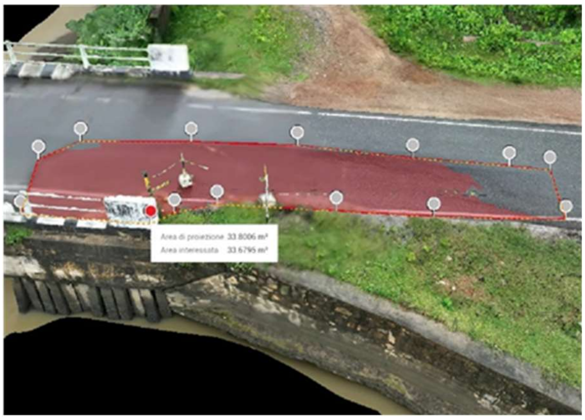


Photo 3 ortofoto (.tif/.geotiff) – Photo 4 ortofoto (.tif/.geotiff) linear and aerial measurement


Photo 5 Point Cloud (.las/.ply) – Photo 6 Mesh 3d (.obj/.b3dm)



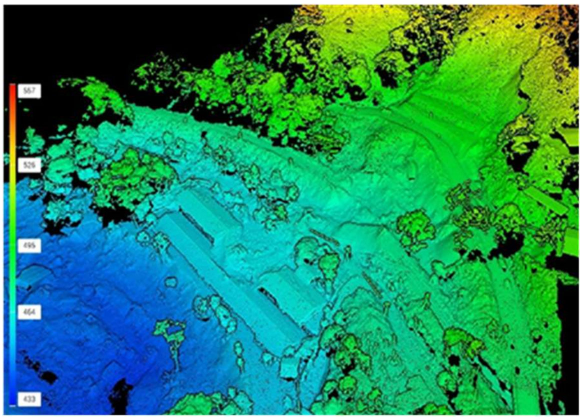


Photo 7 Mesh 3d area measurement – Photo 8 Dem (.tif)

3. Additional documentation

For each resource, the shared evaluation folder includes all outputs generated from drone surveys, where such surveys were conducted.

Specifically, the zipped folder for each survey contains:

- Photos (.jpeg) and videos (.mp4)
- Photos used for the survey (orthophotos and obliques)
- Orthophotos (.tif or .kmz)
- Point clouds (.las/.ply)
- 3D meshes (.obj/.b3dm)
- Digital Elevation Model Dem (.tif)