INSPECTION REPORT OF DAMAGED PEDESTRIAN SUSPENSION (CABLE STAYED) BRIDGE CROSSING THE MSUNDUZI RIVER JUST WEST OF CHIEF ALBERT LUTHULI BRIDGE (S1 – 36), PIETERMARITZBURG.

Report by: AJ Bresler PR.ENG. As requested by Msunduzi Manager O&M (Bheki Sosibo)

Date: 17 November 2022.

GPS Coordinates: -29.609306° S; 30.385169° E.

A) DESIGN:

1. **The suspension bridge consist of two components**:

1.1. Undercarriage:

An undercarriage which is made up of tie bars (all in tension) connected to (4x square and 2x round) support beams on which the walkway rests. The tie bars vary in diameter depending on the load/force working through them. The diameter of the 12x angled tie bars which connect to the 2x steel pylons / towers is 32mm.

1.2. Walkway:

A walkway section which consists out of two parallel longitudinal beams with bracing between them to assure lateral strength. The bracing is made up of angled round pipe sections and channel sections. Parapets on the sides of the walkway consists out of vertical posts with horizontal pipe sections which have been removed (expected stolen). The top of the parapet is rounded off by a wooden section (expected balau wood) of which part has also been removed. The floor section of the walkway consists of wooden tread planks (expected balau wood) of which 98% are still intact.

1.3. Connection between two components:

The above two components of the bridge are connected to each other by brackets made up of steel plates and threaded round bars contribute to friction joints between the two bridge components. The friction contact areas have a layer of malthoid which allows lateral movement between the two bridge components in the case of the build-up of a high lateral force between the two main bridge components, as a safety measure.

B) VALUE OF THE BRIDGE AESTHETICALLY AND IT'S FUNCTIONALITY:

1. The bridge has a very unique and sound design. Generally speaking, except for the damages occurred on the 9th November, and some vandalism to some of the components of the parapet, the bridge is still in a very good condition, with very little signs of corrosion.
2. The bridge also has a plaque which connects it to the Iron Bridge Association, 58 Pall Mall, London 1857. If well-kept the bridge has special value as a historic structure and is a tourist attraction. (Picture 10)
3. Lastly the bridge has value because it enables pedestrians to cross the Msunduzi River without being exposed to the safety risk by making use of the sidewalk of the very busy Chief Albert Luthuli Bridge, when crossing the Msunduzi River.

C) INSIDENT ON 9 NOVEMBER 2022:

1. On the afternoon of 9 Nov. there was a high downpour of rain in the catchment area of the upper Msunduzi River, resulting in a flash flood which caught a contractor, which is busy with dredging work in a section of the Msunduzi River upstream of the suspension bridge, off guard. Three components of the dredging equipment mounted on rafts became detached and were swept down the river where they collided with the under carriage of the bridge.
2. This collision caused damages to the bridge discussed below. One of the reasons why the equipment collided with the bottom of the bridge, was the exceedingly high level of the flood water in the river. A

comparison of the water level reached in the river below the bridge and available flood line studies, should be helpful in establishing whether the flash flood was maybe a 1 in 5 year flood or more.

D) DAMAGES DONE AND REQUIRED REPAIRWORK TO SUSPENSION BRIDGE:

(To better understand the damages occurred refer to the attached pictures in the addendum)

1. Damages and required repair work to undercarriage:
   1.1 One of the 12x angled 32mm dia. tie rods between the undercarriage and the steel pylon / tower on the western bank of the river broke off where it connected to the a support beam of the under carriage. It should be possible to fix this tie rod by adding a short length of 32mm dia. round bar to it. This can be done by cutting thread into the end of the existing shortened round tie bar and the round bar to be added and connecting them by screwing them into a threaded connecting bush. An angled structural component also needs to be made to replace the component through which the rod passes and against which it is bolted to transfer the load of the tie to the supporting beam. The component required, possibly dropped into the river and has gone lost when the angled tie rod broke off. (Refer Picture 1 for the position of the tie.)
   1.2 Horizontal bent tie rods. These tie rods need to be removed and straightened out in a work shop and then put back. Before these rods are however removed, a temporary connecting steel strap or something similar needs to be installed between the two structural members which the tie rods connect, to temporally take over the ties function. This is to make sure that the structural integrity of the bridge is not compromised. (Refer Pictures. 2 & 3)
2. Damages and required repair work to the walkway:
   2.1. Three of the pipe sections which form part of the bracing between the main walkway beams; broke loose when the bolts connecting these braces sheared where the braces were bolted to connecting plates. New galvanised high tensile bolts, grade 8.8 need to be used to reconnect the braces to the connecting plates. Replace the bolts either side of the brace. (Refer Pictures 4 & 5)
3. Damages and required repair work to the connecting brackets between the under carriage and the walkway:
   3.1. At two places where the walkway shifted horizontally with about 10 cm. on the support beams of the walkway, the 4x (damaged connecting brackets) need to be replaced with new similar brackets.
   3.2. While these brackets are being replaced, the shifted walkway needs to be moved back to its original position by means of horizontal jacking. (Refer Pictures 6 & 7)
4. Damages done to abutment brickwork into which the walkway ties, either side of the bridge:
   4.1. The brickwork on the downstream side of both abutments broke away from the rest of the abutment due to the lateral force applied to it by the walkway. The walkway needs to be shifted horizontally to its original position both sides and the damaged brickwork reinstated.(Pictures 8 & 9)
5. Re-adjustment of the tension on all ties:
   5.1. Because of the abnormal loading which the connecting ties forming part of the undercarriage of the bridge was exposed to, it appears that some of the ties were exposed to loads which exceeds their yield strength resulting in some ties slightly becoming longer and now have a slack. All these ties need to be inspected and where they have a slack, the slack needs to be rectified by tightening the provided bolts where the ties connect to the undercarriage.
6. Re-instatement of corrosion protection:
   6.1. Where ever work was done on sections of the bridge and the applied paint which forms part of corrosion protection has been damaged, the applicable section has to be wire brushed and the paint re-instated by applying one layer of undercoat plus two layers of high quality exterior weather proof paint of similar colour as the existing paint.

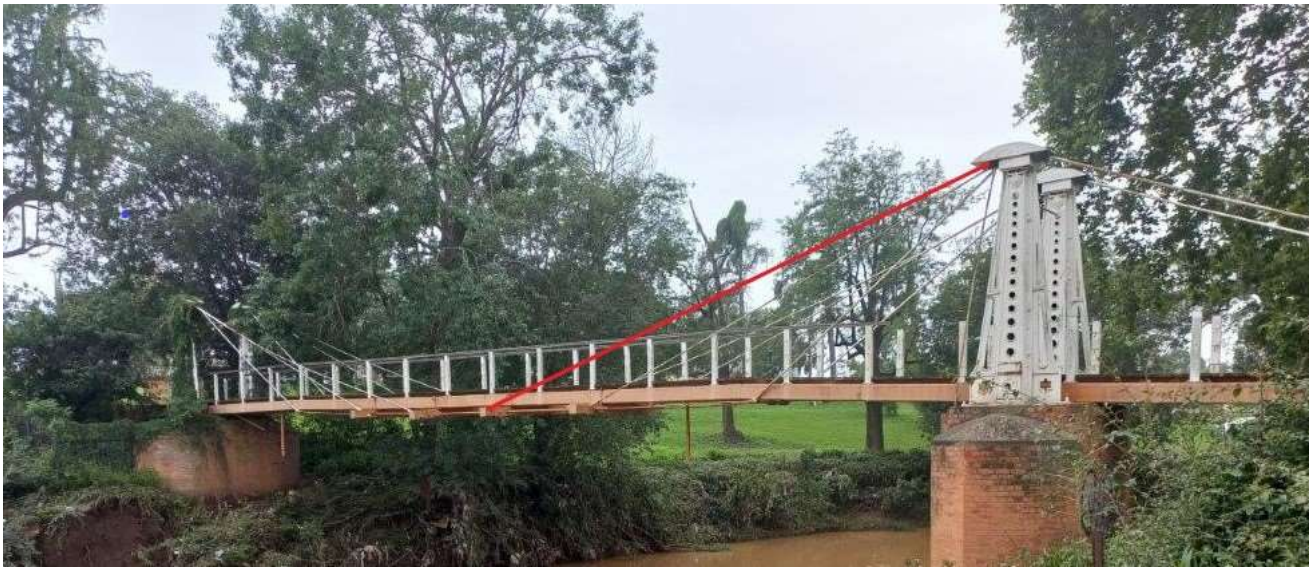
E) VANDALISM (STOLEN PARTS OF PARAPET) (Refer picture 11)

1. Unfortunately over and above damages occurred on the 9th of November, the bridge has also been the target of opportunistic theft. In picture 10 it can be seen that horizontal pipes which form part of the parapet, have been illegal removed (stolen). Part of the wooden handrail (probably made from balau) has also been removed. It would make sense that these stolen components also be replaced while the bridge is being repaired.
2. This work would however have to be treated as a separate cost item not linked to the cost occurred due to the damage incident which occurred on the 9th November. To make theft of the horizontal pipes more difficult, it is suggested that they be welded to the vertical posts of the parapet and not bolted to the posts with brackets which can easily be unbolted.
3. The option of installing a security camera to monitor the bridge 24/7 can also be considered as part of a crime prevention strategy. This camera can form part of a camera monitoring system to beef up security for the whole CBD; something which the private sector would be happy about and probably also be willing to contribute towards the implementation and running cost. Camera monitoring system is being implemented in several of South Africa's metros.

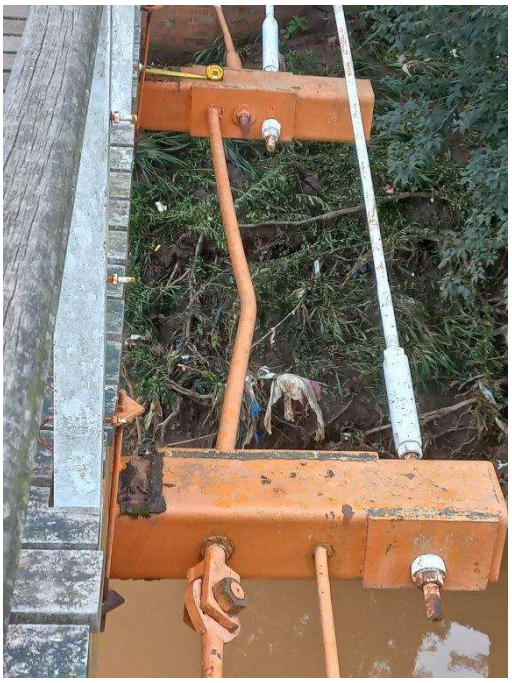
F) <u>THE WAY FORWARD</u>:

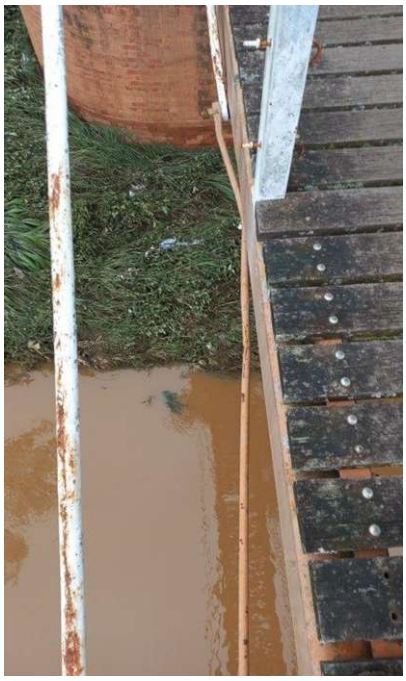
1) It is suggested that the contractor responsible for the damages done to the bridge take full responsibility for the repair work and that the cost involved be claimed from his insurance. It is vital that the team responsible for the repair work is qualified to do the work and will deliver a professional job. It is also vital that an experienced professionally registered structural engineer oversee the repair work.
2) After completion of the repair work to damages occurred on the 9th of November, it should be considered to also replace stolen components removed from the parapet to prevent possible claims against the municipality due to the bridge being a safety risk.
3) It is finally important that signs be put up warning the public that the bridge is unsafe for use and that the bridge be cordoned off until repaired. It is also possible that more damages can occur to the bridge, if people use it in its present condition. The reason is that some structural members are now overloaded above their design strength where they have to compensate for damaged dysfunctional and missing structural components.

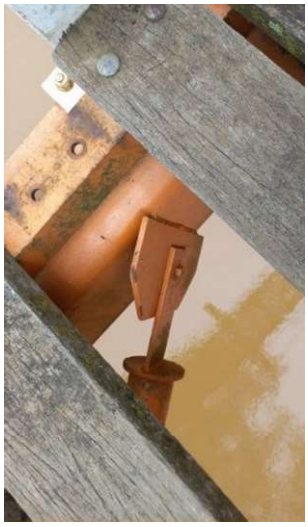
AJ BRESLER:



Picture 1 Angled tie to be re-instated, shown with red line:

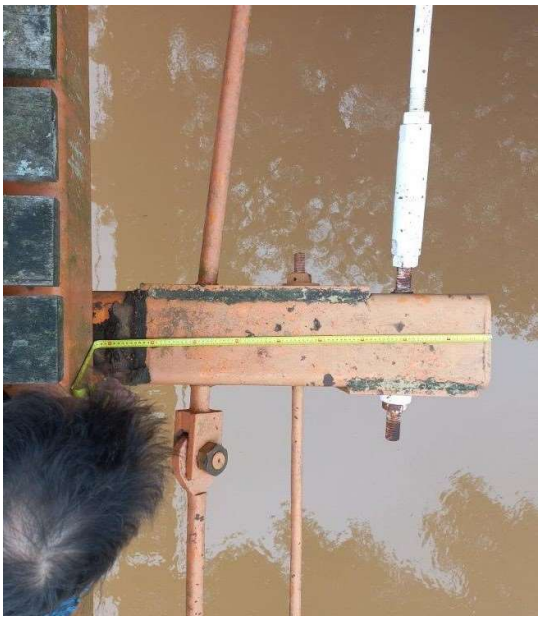


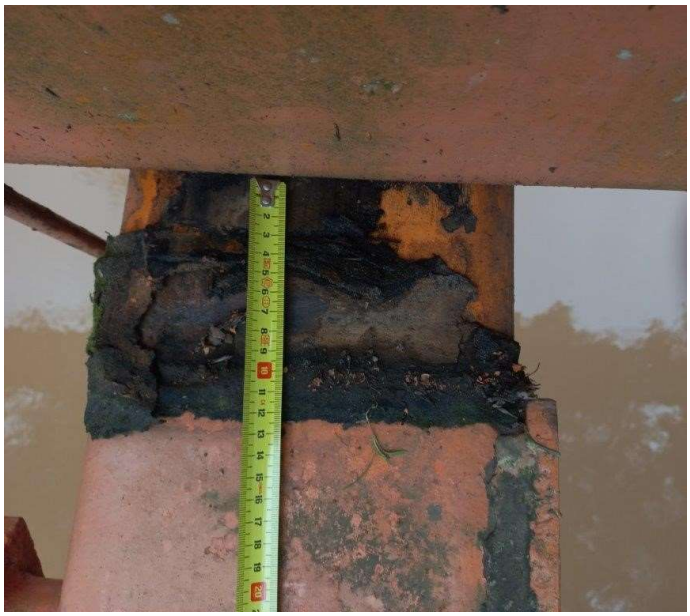




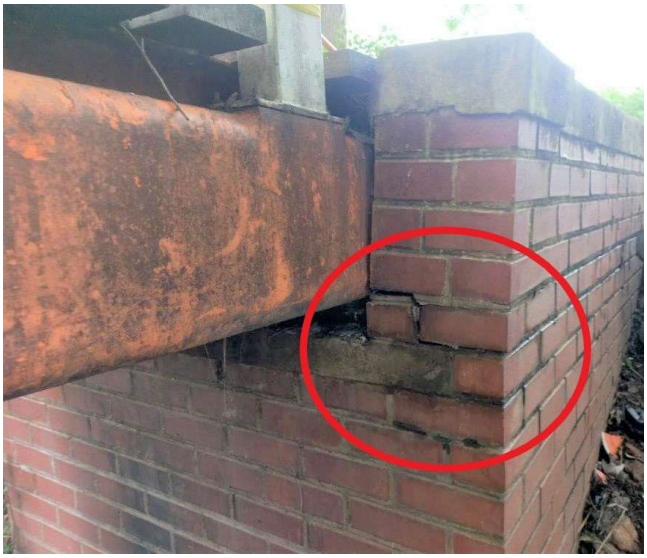
Picture 2 Bent tie rod downstream. **Picture 3** Bent tie rod upstream. **Picture 4** Connecting bracket pipe brace

Picture 5 Pipe braces which form part of walkway to be fixed by replacing sheared bolts.

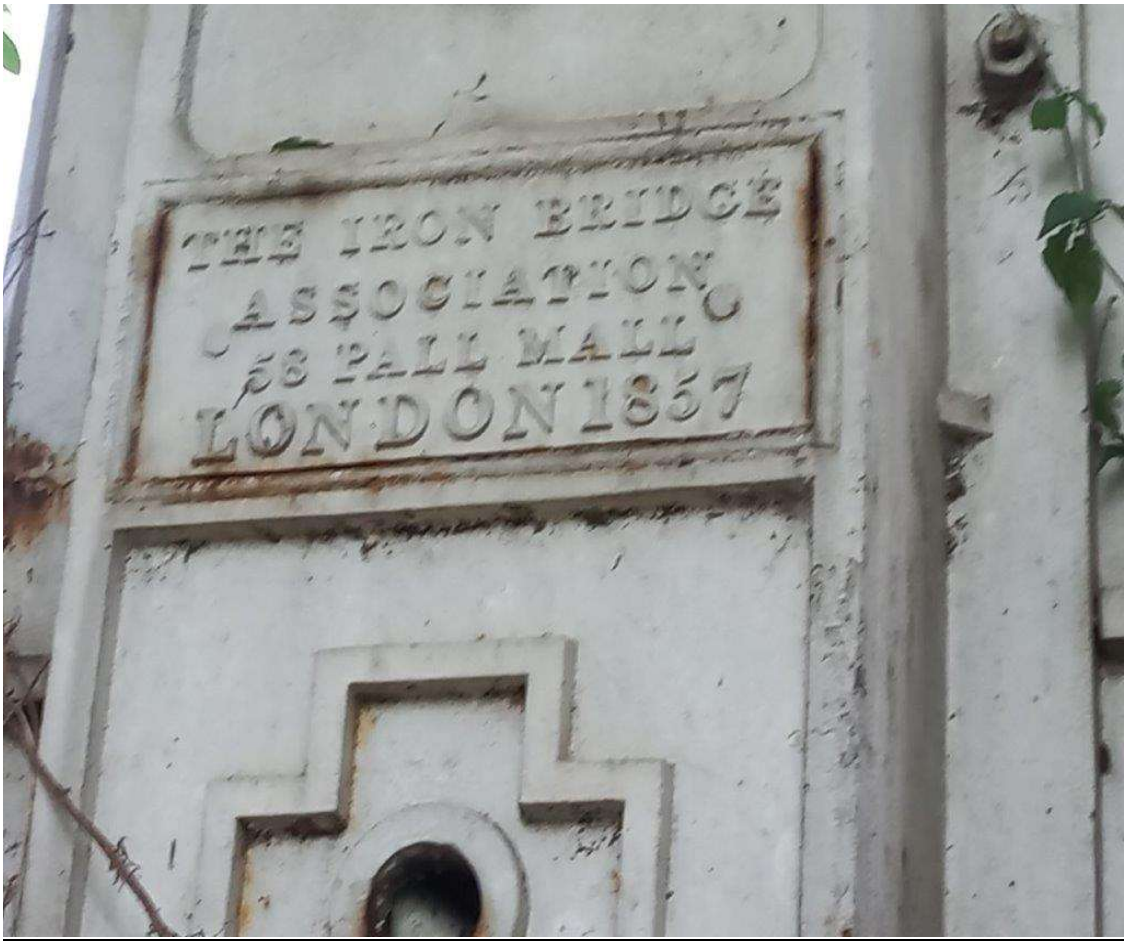




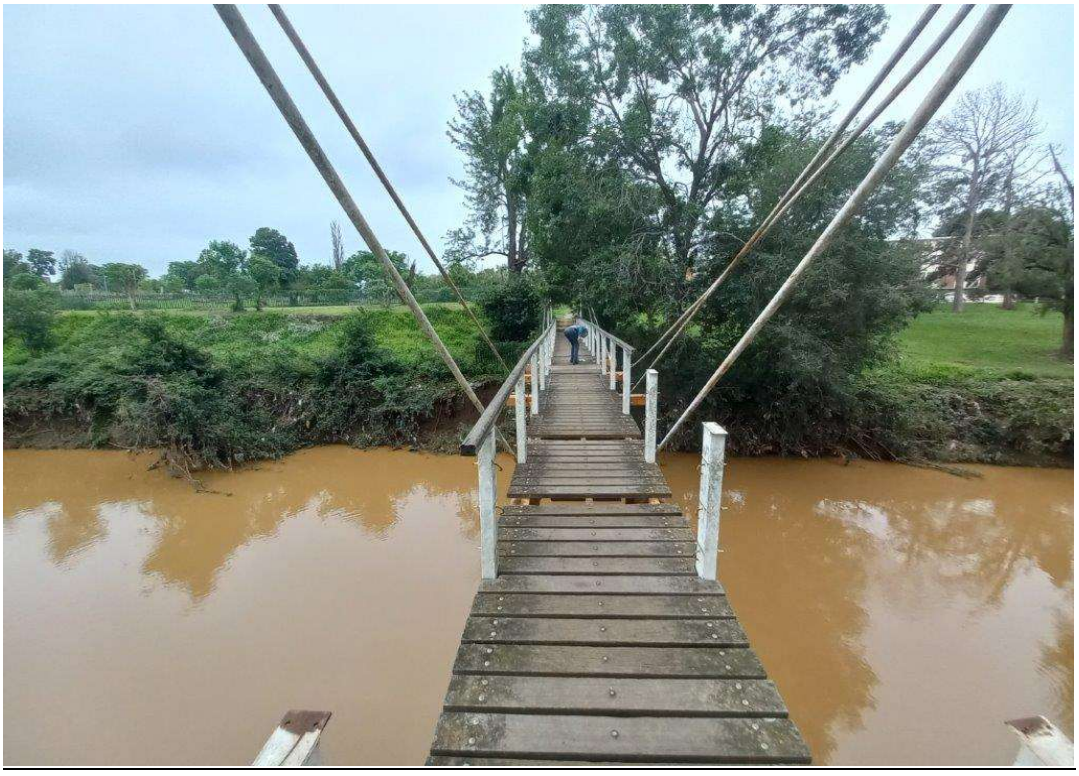
Pictures 6 &7 Walkway shifted 10cm relative to support beam of the under carriage, at two places.



Pictures 8 & 9 showing damage to brick work where walkway ties into the abutments.



Picture 10 – plaque connecting the bridge to “THE IRON BRIDGE ASSOCIATION”



Picture 11 showing missing components removed (Expected stolen) from walkway