Safely Inspecting Fracture Critical Bridge Floor Systems – Efficient Rescue Techniques

Why and how do you perform a bridge inspection when the requirement is to be within arms reach of the floor system? This paper will discuss a few common methods used and then focus on rope access and personnel rescue considerations.

A fracture critical bridge is a steel structure that is non-redundant. Fracture critical members are structural components in tension within the bridge that do not have redundancy. We build these structures because they are efficient. According to FHWA fracture critical members required to have an arms reach inspection every 2 years. The importance of this inspection is to look for fatigue cracking or other small defects which can be small and difficult to determine without a close-up inspection. There are several methods used by engineers and technicians in order to access these structural components. This paper will focus specifically on accessing steel floor system components and the lessons learned.

Photo 1: 7th Street (Andy Warhol) and 6th Street (Roberto Clemente) Bridges in Pittsburgh, PA

The methods used to access fracture critical floor systems can include ladder, bucket or manlift, snooper, or rope access. At this time drones are neither permitted to inspect fracture critical structures, nor have they proved capable of the detail and crack identification methods required for this type of inspection. Drones will get better but it is anticipated that fracture critical inspections continue to be conducted within arms reach by the human eye.

Photo 2: Ladder and Wader.

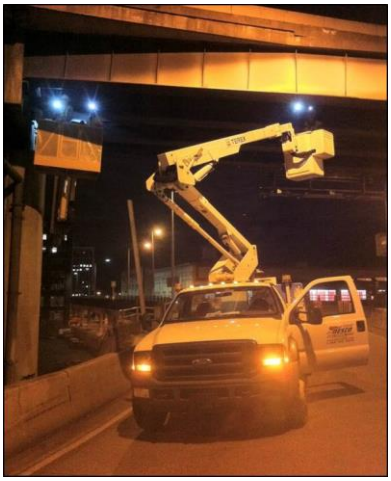


Photo 3: Bucket Truck

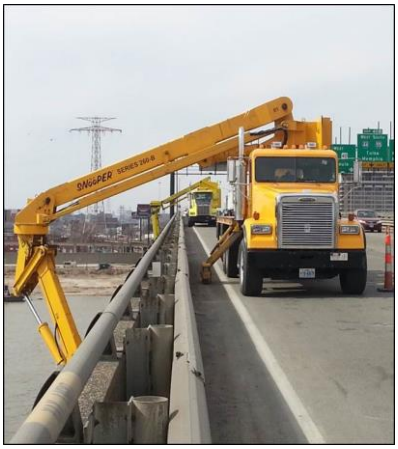


Photo 4: Snooper Truck

Photo 5: Drone from www.bridgeweb.com

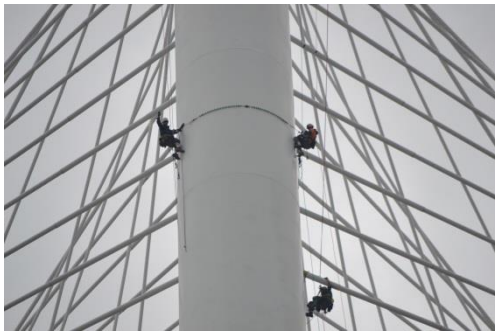


Photo 6: HDR Engineering Inc. Industrial Rope Access

Various techniques are used to inspect bridges including the use of mechanical lift equipment. While uncommon, mechanical equipment failure during bridge inspections can occur and the inspectors could need rescuing.

Photo 7: www.wpri.com

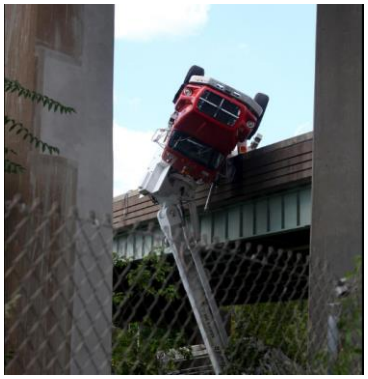


Photo 8: www.courant.com

Photo 9: Snooper Truck Pin Failure.

When mechanical lift failure is involved the inspector can either be suspended from a fall protection harness or stuck in the lift. If the inspector is suspended with a fall protection harness they will have limited time before suspension trauma effects can take place. It is prudent to

install relief step systems as part of the fall protection kit so the inspector can relieve pressure on their legs.

Photo 10: Miller fall protection relief step (www.northernsafety.com)

A combined inspection with rope access and mechanic equipment can achieve efficiency and also provide onsite rescue capability from both systems. A rope access rescue from a deployed fall protection system would include descending to the patient and attaching a haul system. The patient would be hauled to relieve the tension on the lanyard and then either lowered to the ground or hauled to the bridge deck.

The HDR Engineering Rope Access Bridge Inspection Team (HDR RABIT) has investigated the challenges associated with rescuing a patient from a rope access floor system inspection both from a failed mechanical lift and from rope access beam clamp. Several field trials have been completed and lessons learned. Rescue in the training center can be different from the field and this paper will discuss how the team was able to conduct several trials and bring what was learned back to the Ropeworks training center in Reno, NV to refine the approach and achieve efficiency.

Photo 11: Bridge Girder Inspection

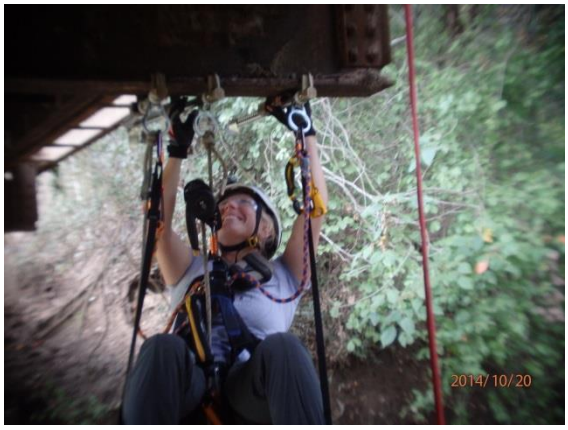


Photo 12: Bridge Truss Floorbeam Inspection

Typically an inspection team assigned to a bridge floor system via rope access consists of 3 or more people. The reason for 3 is due to the potential rescue scenario. Assuming the river or canyon below is not accessible by foot, an incapacitated worker would need to be extracted from under the bridge. It is best in that scenario to have one rope access level II or III person attend the injured worker and the other have the proper skills to run a haul system from above the bridge. The top deck person will also be able to notify Emergency Medical Services (EMS). The following is an illustration showing a typical rigging entry for a through truss bridge.

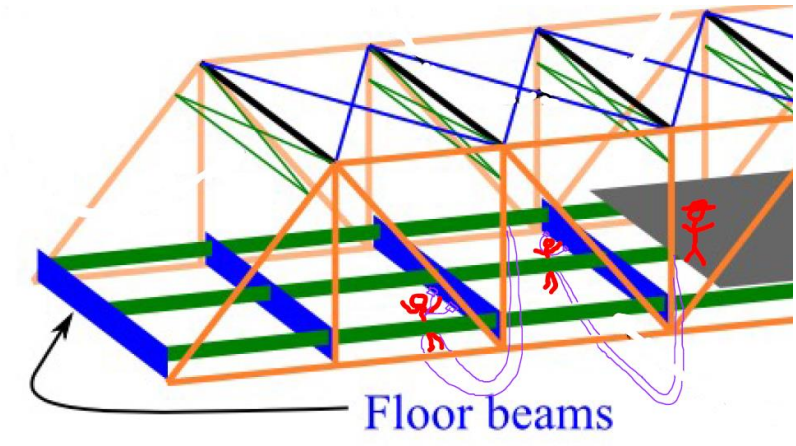


Figure 1: Rope Access Floor beam Inspection Illustration

Photo 13: Rescue from beam clamps in progress. Adjacent set of lines being used.

Several field trials have been conducted by the team each using adjacent ropes (Photo 13). The challenges with this method is the setup time and remembering all the gear needed. The average time for extraction with this method was approximately 25 minutes.

At the 2016 HDR refresher training Travis Ford, Matt Bruno, and Dave Nettle (Ropeworks) explored this rescue scenario and came up with improved methods reducing time and effort. The following procedure and illustrations is intended to communicate what was learned and is not intended to be used as an official procedure.

Preset Rigging for Success:

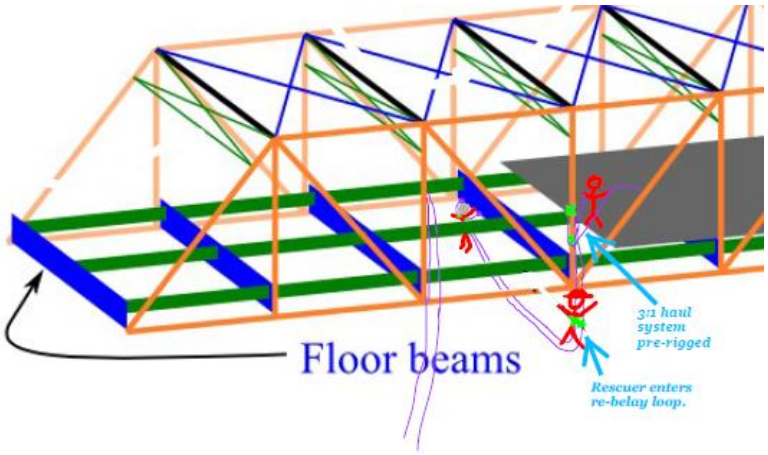
1. Rig to raise on both lines.
2. Have worker use beamclamps with carabineer, Grillon to Croll setup for primary and line with ID, ASAP, or Duck as a backup.

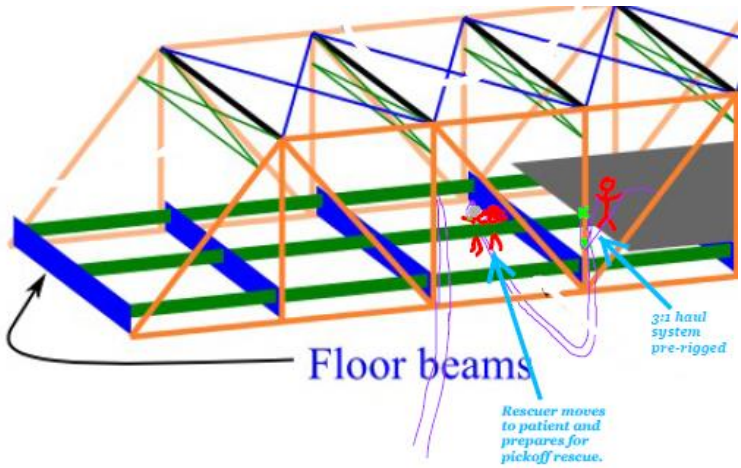
Photo 14: Worker using beam clamps with releasable attachment (Grillon).

3. No hard links or lanyards directly to beam clamps. Less likely to drop beam clamps during handling.
4. Have worker either lock off Grillon with overhead and/or leave ID on other working line.

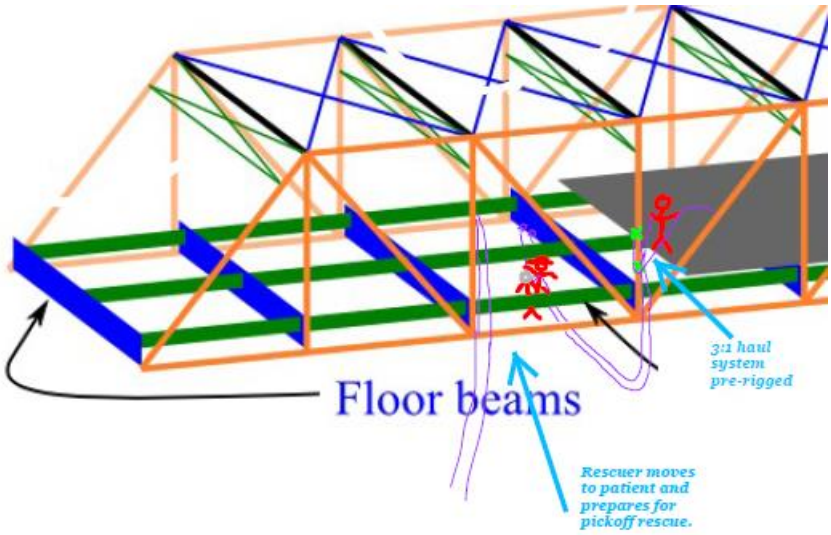
Rescue Procedure

1. Attempt to communicate with patient, if necessary have assistant notify Emergency Medical Services (EMS).
2. Rescuer goes to patient
    a. Descend down entry side of loop.
    b. Ascend to patient on casualty side of loop. Ascend patients backup line.

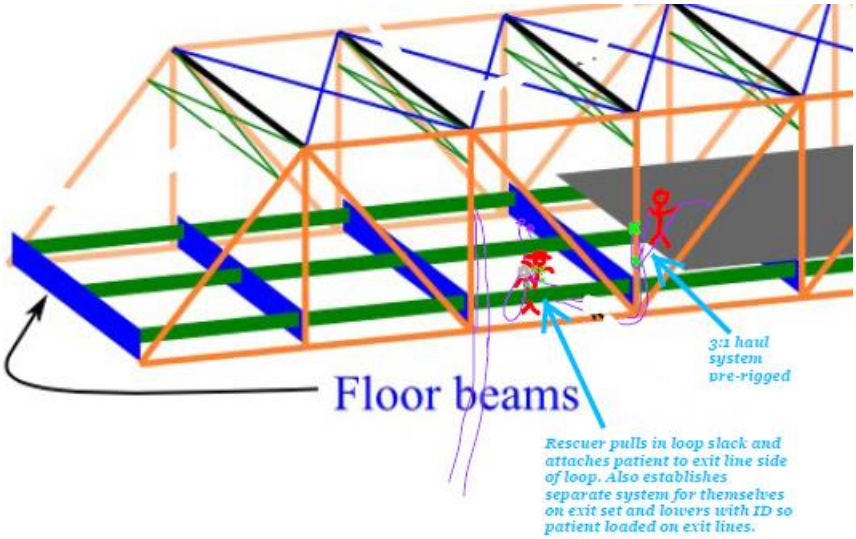




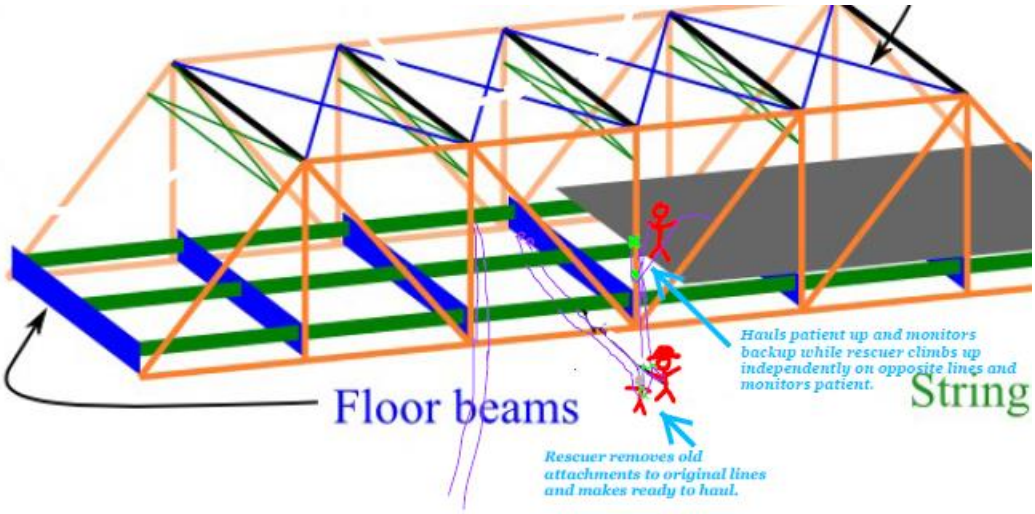
3. Assess patient.
4. Prepare for a patient pickoff from ascent: ID with extra carbineer and short strap, ASAP lock on backup line.
    a. Attach short strap to patient sternal.
    b. Attach their spare lanyard to your central.



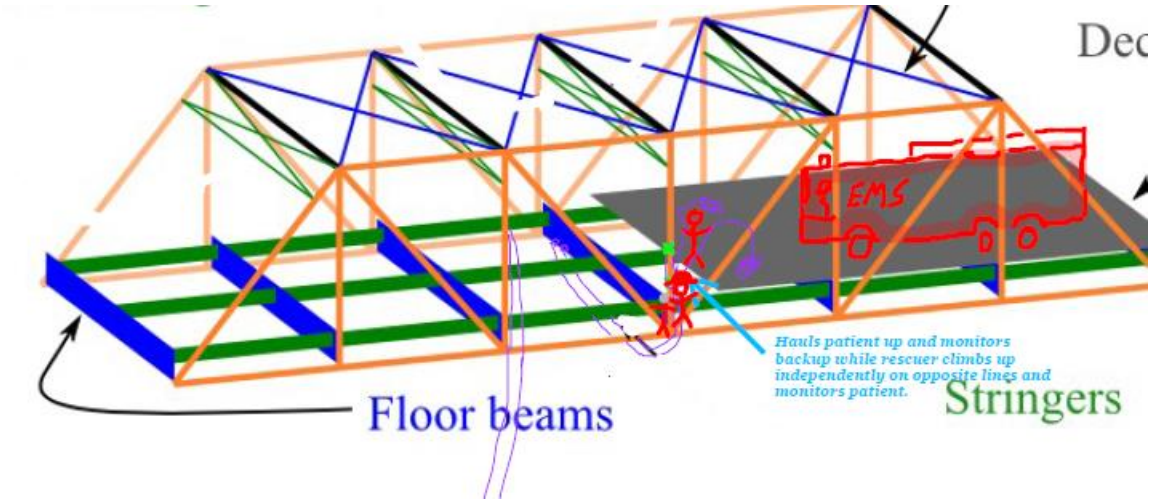
5. With two points of attachment to you, lower the patient from the beamclamps to you using the Grillon.
6. Attach patient to exit lines:
    a. Pull slack loop over and attach patients backup to exit line.
    b. Tie a tight butterfly in the haul line. Attach butterfly with carabineer to the patients sternal as tight as possible.



7. Create new ascent system for yourself on exit lines:
    a. Attach your backup to the patients working/haul line.
    b. Attach Croll and handle on their backup line.
8. Lower patient with you until they load up on exit lines via butterfly attachment.
    a. Monitor patients backup and positioning above your handle ascender. Adjust as needed or have person on deck haul some to prevent binding.
    b. Disconnect gear from old set (far side of loop).
    c. Each person has two points now so any extra connections (ID) can be removed.



9. Haul
    a. Rescuer can ascend along side patient insuring they are not caught under edges of the structure during haul.



This procedure outlined above was able to reduce the time for extraction from 25 min to 7-10 min. Further refinement and practice can reduce it further and will work for specific applications.