

Safety Bulletin 194

Excavator emergency access & egress systems

Appendix

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OBSERVATIONS FROM TESTS ON SPECIFIC BRANDS AND MODELS

Tests were carried out on the excavator brands & models tabled below:

| BRAND | MODEL | APPROXIMATE TONNAGE |
|-------------|----------|---------------------|
| Caterpillar | 6040 | 400 |
| | 6060 | 550 |
| Hitachi | EX1200 | 110 |
| | EX3600 | 360 |
| | EX5500 | 520 |
| | EX5600-6 | 550 |
| Komatsu | PC4000-6 | 400 |
| | PC3000 | 250 |
| Liebherr | R996 | 670 |
| | R9350 | 300 |
| | R9800 | 800 |

Photos and notes about the tests are shown below, sorted in order of brand and model. Each heading refers to a different test. Common issues may have been found between tests.

1 CATERPILLAR

1.1 Caterpillar 6040

- Whilst the excavator retractable ladder was in the process of lifting, a CMW positioned himself facing the machine room wall. The ladder completed its lifting cycle and trapped the workers foot under the rotating handrail.

The ladder control switch does not require the operator to keep their hands on it (The notes above refer to an 'incident', rather than the 'tests' or 'inspections' referred to below.)

1.2 Caterpillar 6060 (1)

- From the engine level access platform, the operator activated a control which started lowering the retractable stairway. Once the control was activated the stairway continued lowering whilst the operator walked to the access stairway and then out onto it. He proceeded to walk out onto the stairway as it was lowering and rode it down to its resting position on the ground. This behavior is absolutely unacceptable as it exposes the worker to the hazard of getting caught in the stairway mechanism.
- This would not have been possible if the operator had to maintain the engagement of the control whilst the stairway was lowering or raising.
- In addition, this excavator had a hanging rope that was designed for lowering the machine's stairway from ground level, however it was too high to be reached from the ground.

1.3 Caterpillar 6060 (2)

- There were potential pinch points evident when the steps were lowering and raising. The control used for raising and lowering the access didn't require the presence of the operator to keep the control engaged, subsequently the operator pushed the control and then walked to the top of the access steps whilst they were still lowering down.
- There was no means of lowering the access ladder from ground level in the event of the operator becoming incapacitated.

1.4 Caterpillar 6060 (3)

To gain access from ground level in an emergency, a cable hanging from the machine had to be pulled.

- The cable end was too high to access from ground level. (See Figure 1) We were informed that on both the left and right of the excavator, a rod with a hook was stored within the track frame. This could be used to reach the cable.
- On the side nearest to the cable, the bracket holding the rod had broken off, resulting in the loss of the rod. (See Figure 2). On the opposite side, the brackets were still in position, but there was no rod.
- In case of an emergency where the operator needs to be assisted from ground level, rescuers will struggle to access the machine in a timely fashion.

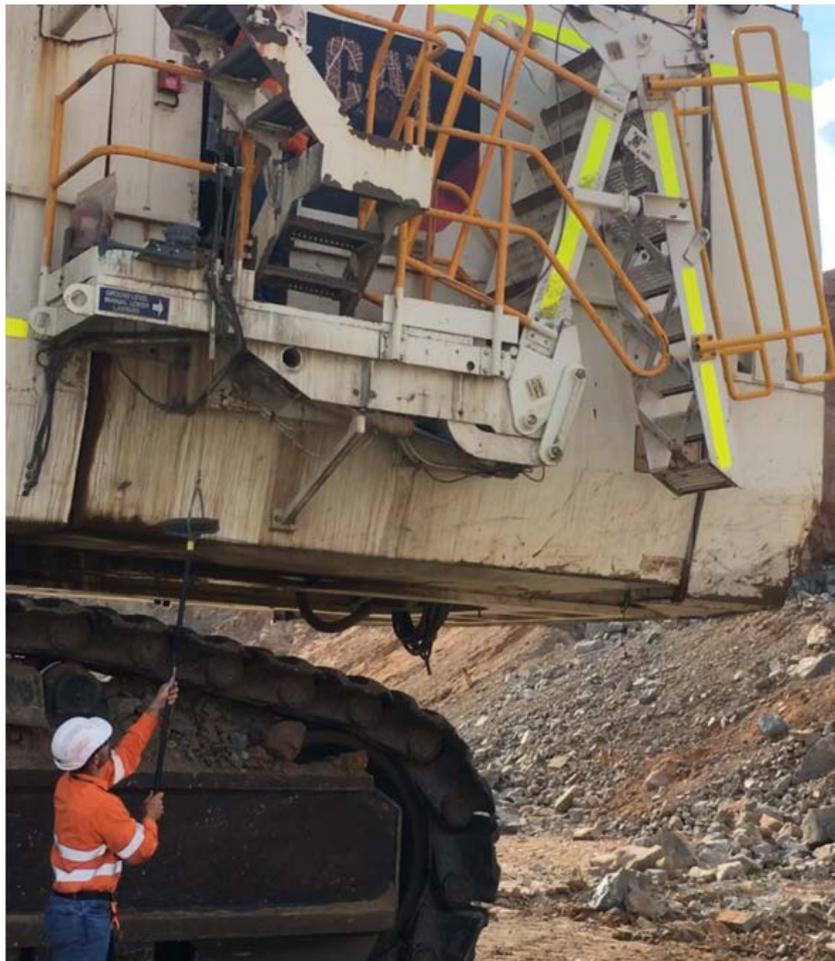


Figure 1 - Pull wire too high to reach

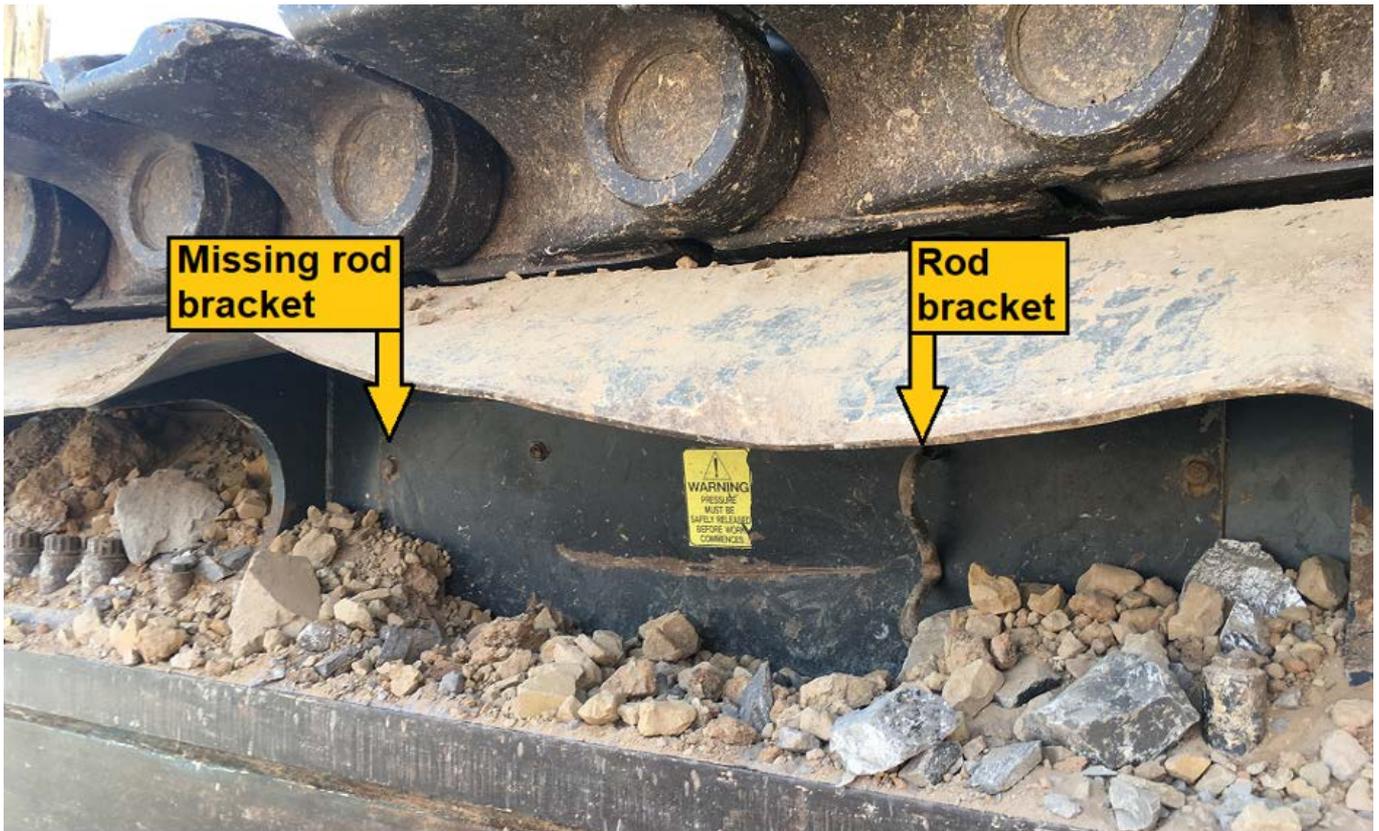


Figure 2 - Missing rod and bracket for pull cable

2 HITACHI

2.1 Hitachi EX1200

- A fall-protection chain that was meant to be across the opening at the top of the secondary egress ladder was not in place.

2.2 Hitachi EX3600 (1)

- The access ladder could not be lowered from ground level without assistance from on-board.
- The secondary egress ladder on the front of the machine had suffered significant damaged and was not safe to use.

2.3 Hitachi EX3600 (2)

The emergency stop rope under this excavator was broken off and could not be used from ground level.

- There was no means of lowering the excavator's stairway from ground level.

2.4 Hitachi EX5500 (1)

- There were some unguarded pinch points along the swiping radius of the retractable stairway.

Note: The hazard from pinch points may exist both in emergency and routine access or egress systems.

2.5 Hitachi EX5500 (2)

- There were potential pinch points evident when this access ladder was lowering and raising.
- The ladder could not be lowered from ground level.

2.6 Hitachi EX5600-6

The excavator had one retractable main access ladder for both routine and emergency use. We were informed that there were also supposed to be 2 emergency access ladders to the side and front of the operator's cabin respectively. During testing the following was noticed:

- The front emergency ladder was missing.
- From a lifted main ladder position, an attempt was made to lower it from ground level. An unmarked cable was hanging from the bottom of the machine near the main ladder pivot point. It appeared to be the emergency ladder release cable. (Drawing a parallel from other excavator brands). The bottom of the pull cable was too high and could not be reached from ground level.
- The operator was still on board and was able to reach this cable. He pulled it, but the ladder didn't lower.
- Another unmarked cable was hanging from below the machine near the service tail. It could be reached but pulling it had no effect as it was jammed inside its guide tube.
- We later learned that the service tail is lowered with this second cable. Once the service tail is lowered, switches within the tail can be used to lower the access ladder. None of this was communicated by signage or otherwise. (See Figure 3). Operators were unaware of this arrangement.
- It took a considerable length of time to eventually lower the main access ladder. Thus in the scenario where the operator had been incapacitated on board, rescuers would not have been able to access the machine in a timely fashion.



Figure 3 - Switch for lowering access ladder from ground is in the service tail

3 KOMATSU

3.1 Komatsu PC3000

- The access ladder couldn't be lowered from ground level unless the engine was stopped first. There were no signage to indicate that the engine had to be stopped first.
- Three cables were hanging from below the machine-house floor. When pulled, their functions were respectively to lower the service tail; to emergency stop the engine and to emergency lower the access ladder. There wasn't signage to communicate these functions.

3.2 Komatsu PC4000-6 (1)

- Both with a running and with a stopped engine, the ladder failed to lower when a person on ground level pulled the emergency ladder cable.

3.3 Komatsu PC4000-6 (2)

- The release mechanism for the access ladder was tested from ground level. We noticed that the ladder could only be released if the engine is running i.e. when the release mechanism is pulled without the engine running, the ladder doesn't lower.

4 LIEBHERR

4.1 Liebherr R9350

- This excavator had a rope hanging from under it that was an emergency stop designed to be used from ground level, however a person of average stature would not be able to reach this rope due to its height from the ground. There was no means of lowering the excavator's access stairway from ground level.

4.2 Liebherr R996 (1)

- The emergency egress ladder was manufactured in two halves, the upper part being mounted on the house and in front of the cabin. The lower half was mounted on the track frame. At the time of inspection, the house was rotated 180 degrees with regards to the trackframe, resulting in the lower half being away from the upper section. (See Figure 8).
- It became apparent that this ladder can only be used if the two halves are both pointing forward relative to the track frame. (Depending on the type of emergency, it may not be possible to turn the house such that the ladder halves align.)

Note

This issue may be resolved by installing a suitable roll-up ladder on the house and near the bottom end of the upper half of the ladder. It will rotate with the house and be available regardless of how the house is turned. (Figure 4 shows a similar ladder mounted on the track frame.)



Figure 4 - Roll-up ladder from front of track frame to ground level

4.3 Liebherr R996 (2)

- The containment box for a roll-up ladder for escape from the engine room was mounted upside down, making successful deployment unlikely.
- There were no signage with operating instructions on how to use this roll-up ladder. As a result, the person assisting removed a pin from where the ladder was suspended from. The pin was easy to remove without tools and appeared to be the right thing to do for the deployment of the ladder. In an emergency, a person using the ladder would probably have fallen to the ground with it.

4.4 Liebherr R9800 (1)

This excavator has one retractable main access ladder for both routine and emergency use. There are also 2 emergency egress ladders to the side and front of the operator's cabin respectively. (See Figure 5)

During testing the following was observed:

1. From a lifted main ladder position, with the engine on, the emergency ladder release cable was pulled from ground level. The ladder lowered as required. Thus in the scenario where the operator had been incapacitated on board, rescuers would have been able to access the machine.
2. From a lifted ladder position, with the engine off, the emergency ladder release cable was pulled from ground level. The ladder did not lower as required. With further attempts, the cable broke from its attachment point. Thus in the scenario where the operator had been incapacitated on board, rescuers would not have been able to access the machine.
3. Following (2), the operator, still on board, attempted to start the engine, but it wouldn't because the release cable, during (2), simultaneously activated an emergency stop switch. The switch could not be reset because it was not accessible either from on board or from ground level.
4. The operator, stuck on board, attempted to egress from the emergency ladder to the left of the operator's cabin. The release pin was stuck due to the pin-holes being misaligned and it took him approximately 3 minutes to get it out and for the ladder to fall to the ground. (See Figure 6)

Note that, for an excavator on fire, 3 minutes is a very long time

5. Near the end of its downward trajectory, the ladder in (4) was supposed to have been stopped by 2 brackets. The welds for both brackets broke and the ladder fell further down than it should have. In this position, the operator could not safely access this ladder. (See Figure 7)
6. Because of the rotation of the house relative to the tracks, safe egress or access from the ladder to the front of the cabin was not possible. (See Figure 8).



Figure 5 - Ladders for emergency and routine use



Figure 6 - Top of emergency escape ladder near operator's cabin. Misaligned holes caused the release pin to be stuck. The inserted photo is from a similar machine at another mine site, also showing misalignment. Note the undercut bracket welding



Figure 7 - Welds on both stopper brackets failed when the ladder was released

4.5 Liebherr R9800 (2)

- From a lifted main ladder position, an attempt was made to pull the emergency ladder release cable from ground level. The bottom of the pull cable was too high and could not be reached. Thus in the scenario where the operator had been incapacitated on board, rescuers would not have been able to access the machine. To continue the test, and after a significant amount of time, a flagpole was found and used to access the rope. The ladder then lowered as required.
- We tested the emergency egress ladder to the left of the operator's cabin. The release pin was sticky and it took approximately 35 seconds to get it out. The ladder eventually released and fell to ground level as required. It appeared that the 3 items where the pin went through were not aligned, resulting in it being sticky. Note that this time is unacceptably long. (It may be even longer for a person with lesser physical strength.)
- Because of the 180 degrees rotation of the house relative to the tracks, safe egress or access from the emergency ladder to the front of the cabin was not possible. (See Figure 8)



Figure 8 - Misalignment of ladder halves. House is rotated 180 degrees relative to track frame