Mine Surface Structures -
Identifying Unsafe Conditions & Avoiding Failures

Plants, Conveyors, & Bins

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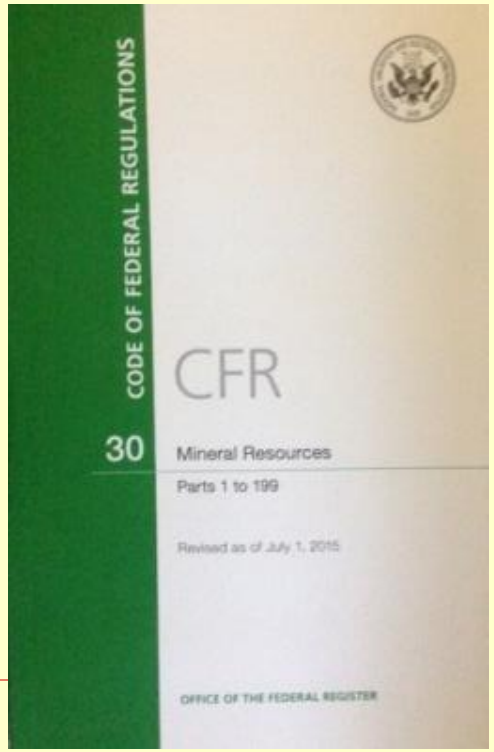
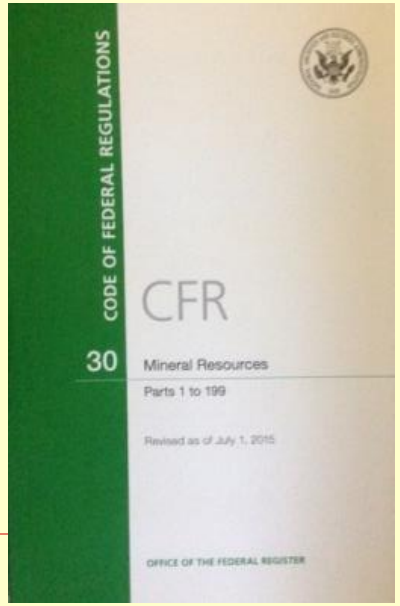
MNM Surface - 56.11001
MNM Underground – 57.11001
Safe Access

- Safe means of access shall be provided and maintained to all working places.



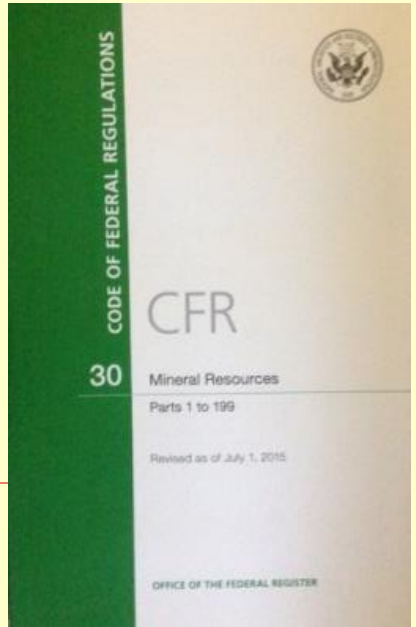
MNM Surface - 56.14100
MNM Underground – 57.14100
Machinery & Equipment – Safety Defects

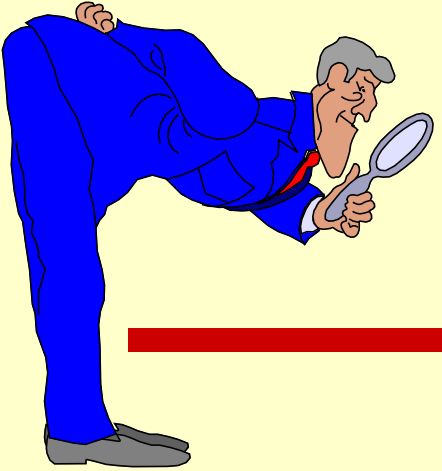
- b) Defects on any equipment, machinery, and tools that affect safety shall be corrected in a timely manner to prevent the creation of a hazard to persons.



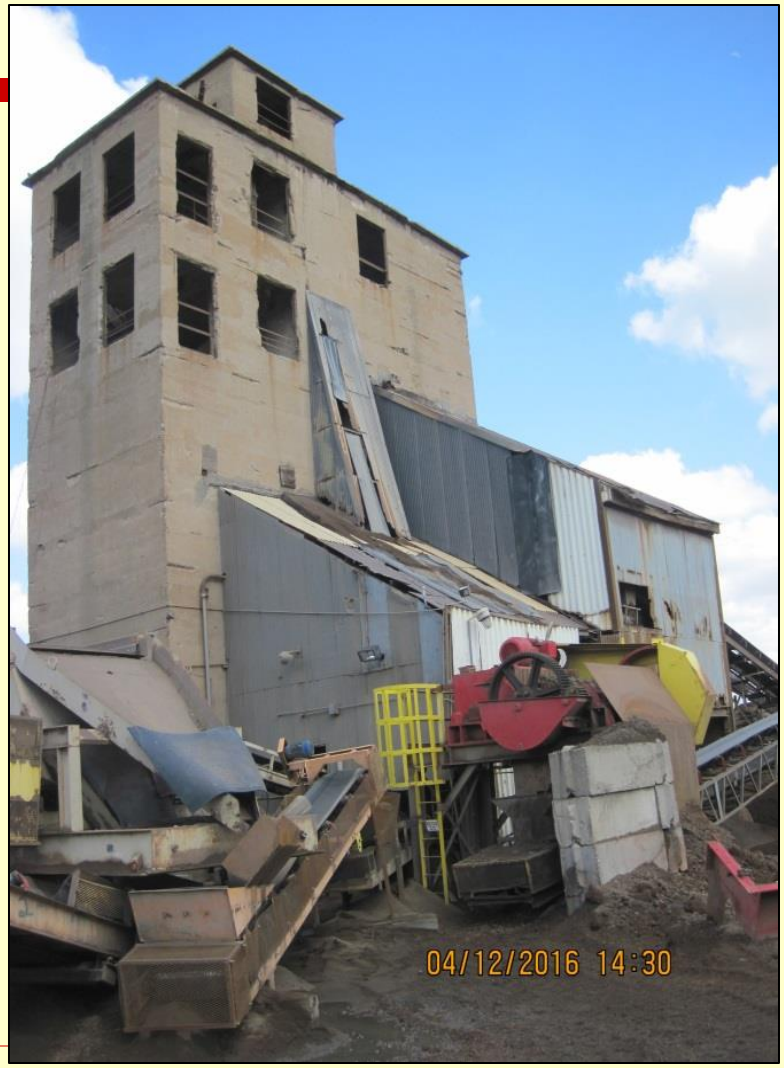
MNM Surface -56.14205
MNM Underground -57.14205
Machinery, Equipment, & Tools

- Machinery, equipment, and tools shall not be used beyond the design capacity intended by the manufacturer where such use may create a hazard to persons.

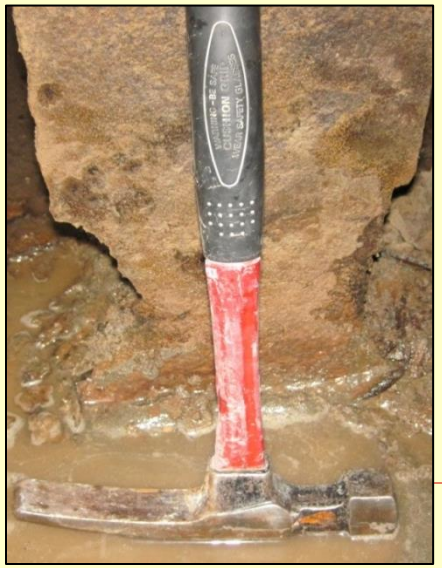




Inspection of Processing Plants



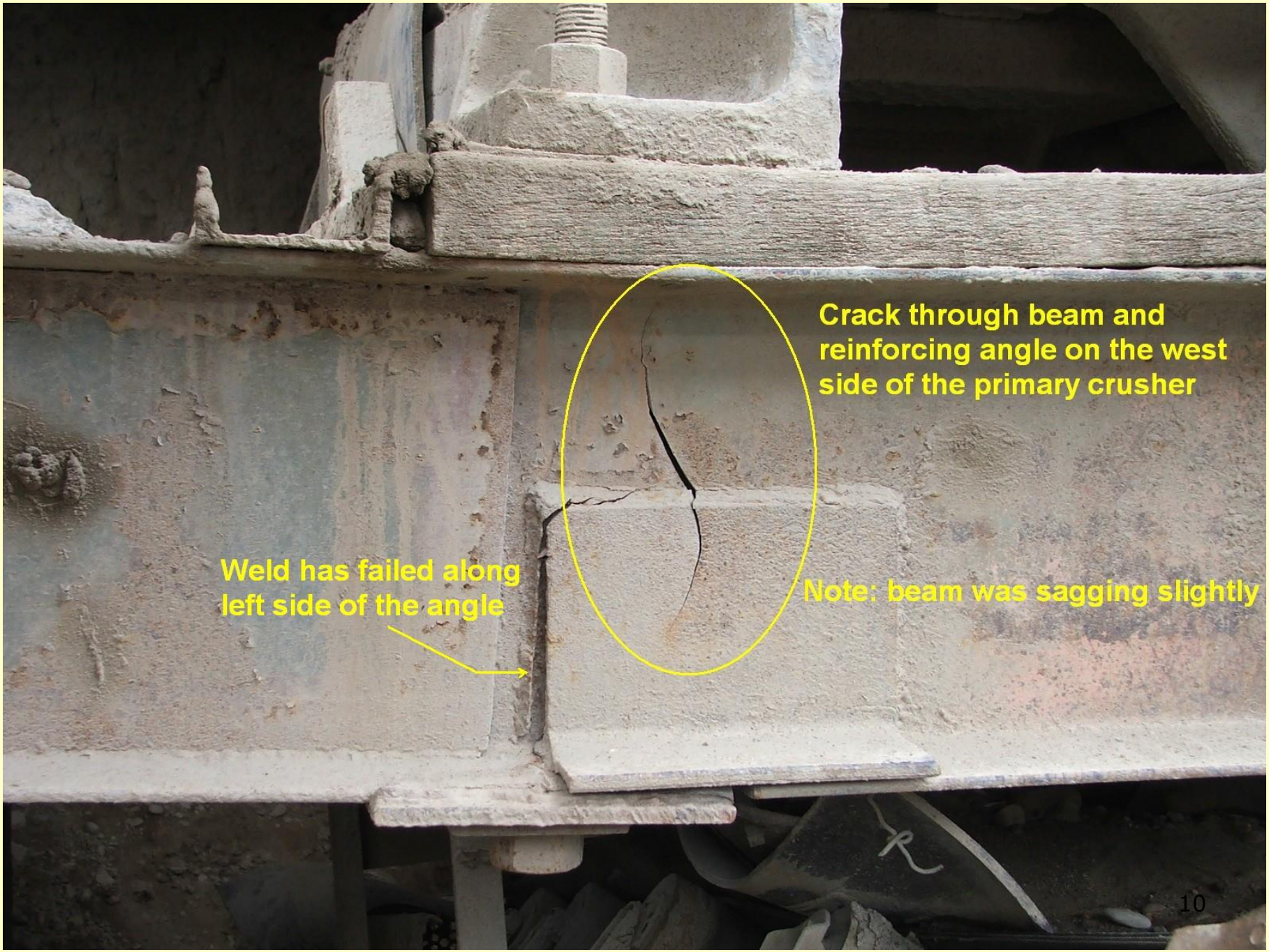
Corrosion holes and delamination of beams



Corrosion hole/notch near the beam end connection

Corrosion holes resulted in web collapse of the back beam.

Overloading!
Beam w/ a buckled web

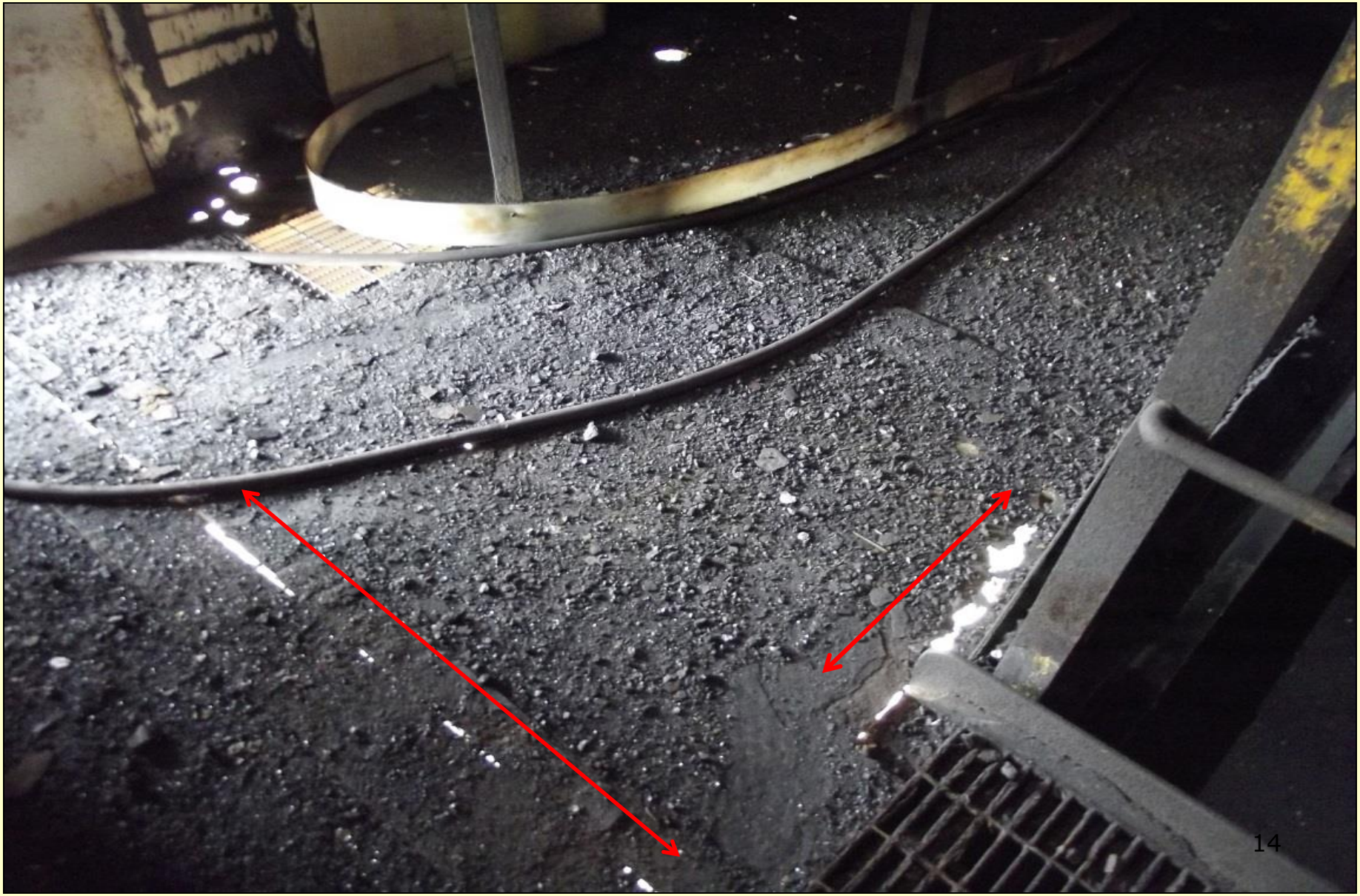

Crack through beam and reinforcing angle on the west side of the primary crusher
Weld has failed along left side of the angle
Note: beam was sagging slightly

Corrosion notches in flanges and holes in column webs – particularly right above the floor.

Hole in a column web – well above floor level

Corroded diagonal braces (and sometimes intentionally removed braces to accommodate equipment changes or access) should be repaired or replaced. Braces are necessary to resist lateral loads such as wind, earthquake, and vibration.

Lines of 100% corrosion along the edges of a floor plate



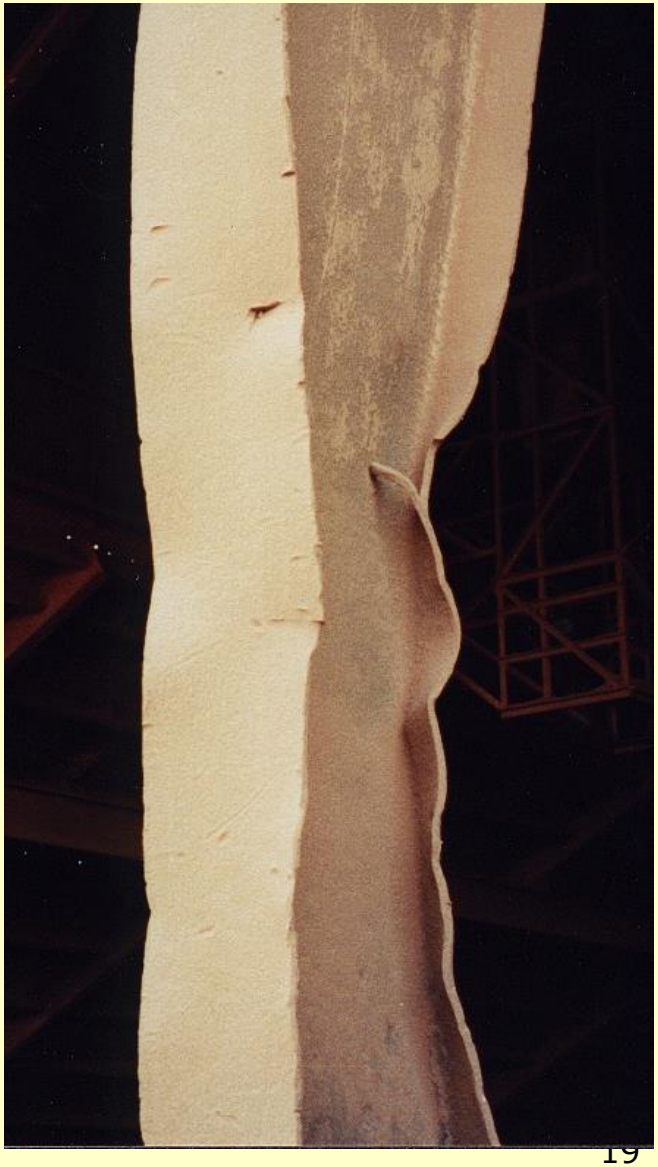
Material build up and sagging flooring

Corrosion at support edge of walkway grating, corrosion holes in a stairway channel stringer, and holes in an angle supporting a tread.

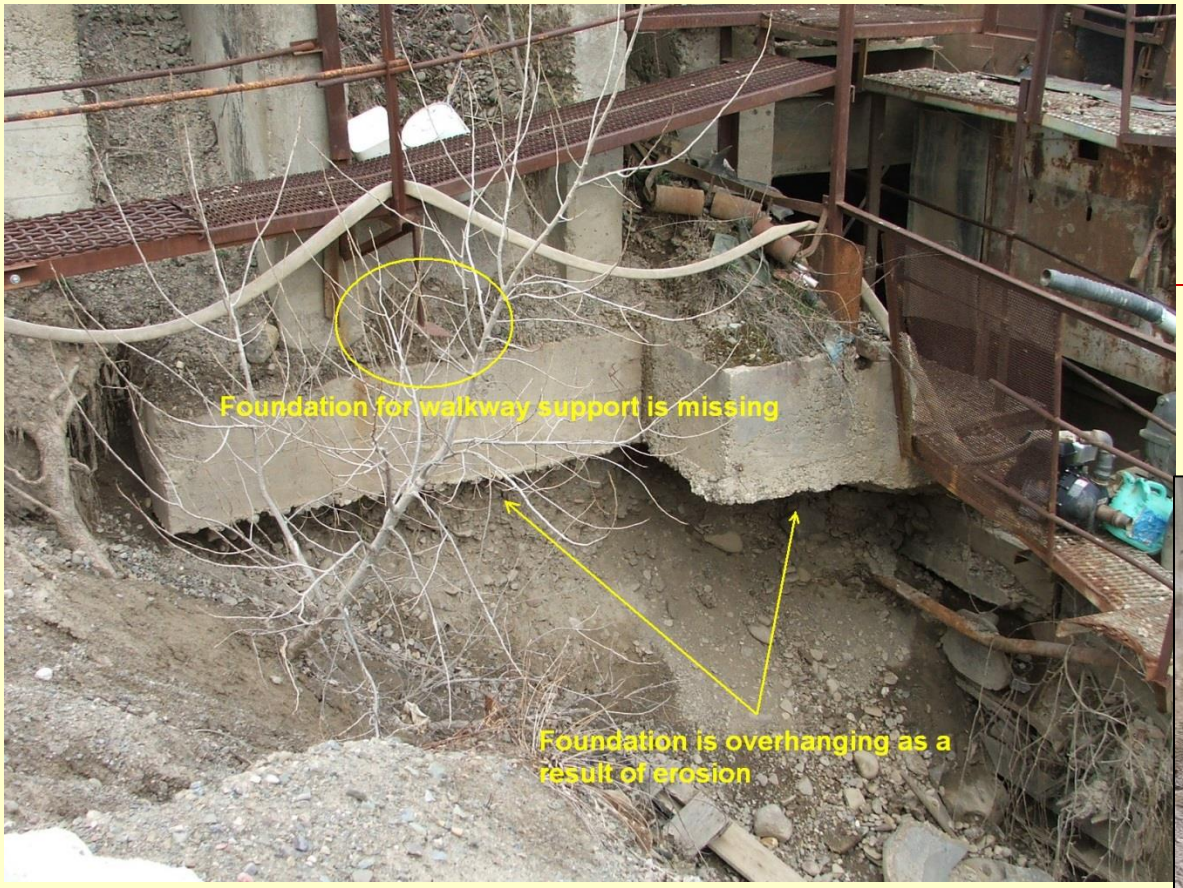
A miner was seriously injured at a limestone mine when the expanded metal walkway suddenly failed. He fell 10 feet to the ground. The expanded metal walkway was covered with conveyor belt to aid in shoveling spillage. The belting allowed corrosive material to accumulate and accelerated the deterioration of the expanded metal. Also the belting masked the signs of deterioration making examination difficult.

Buckled column

Equipment impact damage to columns

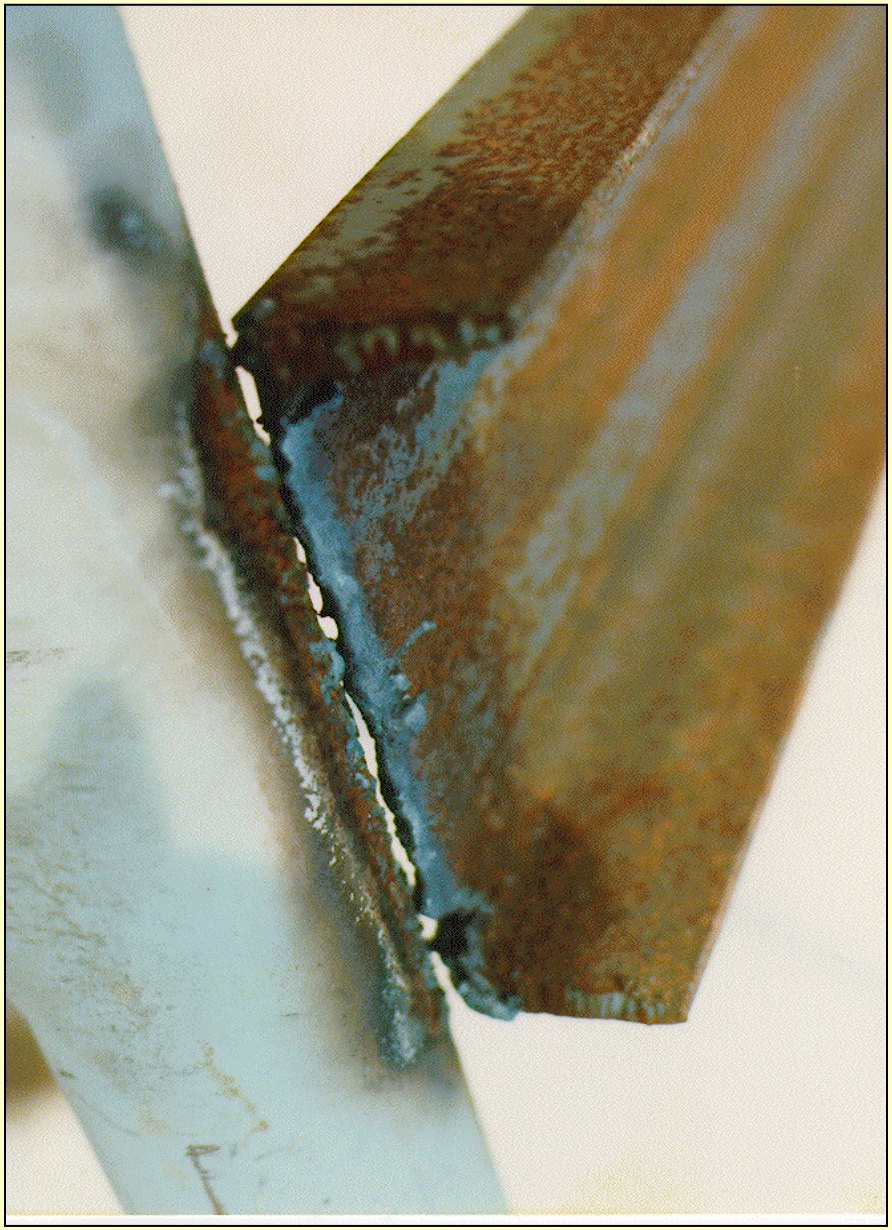


Expose column bases if surrounded by accumulations to assess their condition.



Also look at concrete footings and piers.

Poor quality welds



Corroded connections - nuts and bolts

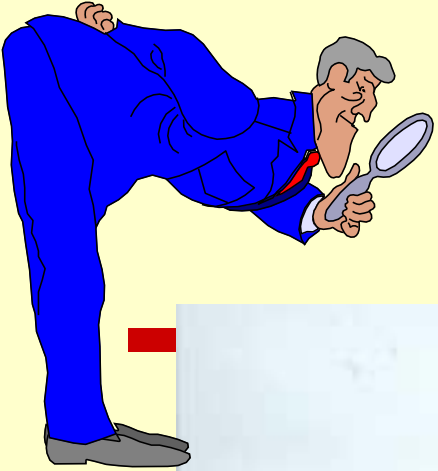
Inspect Handrail Systems

Structural modifications need to be engineered.

Material accumulations on a plant roof

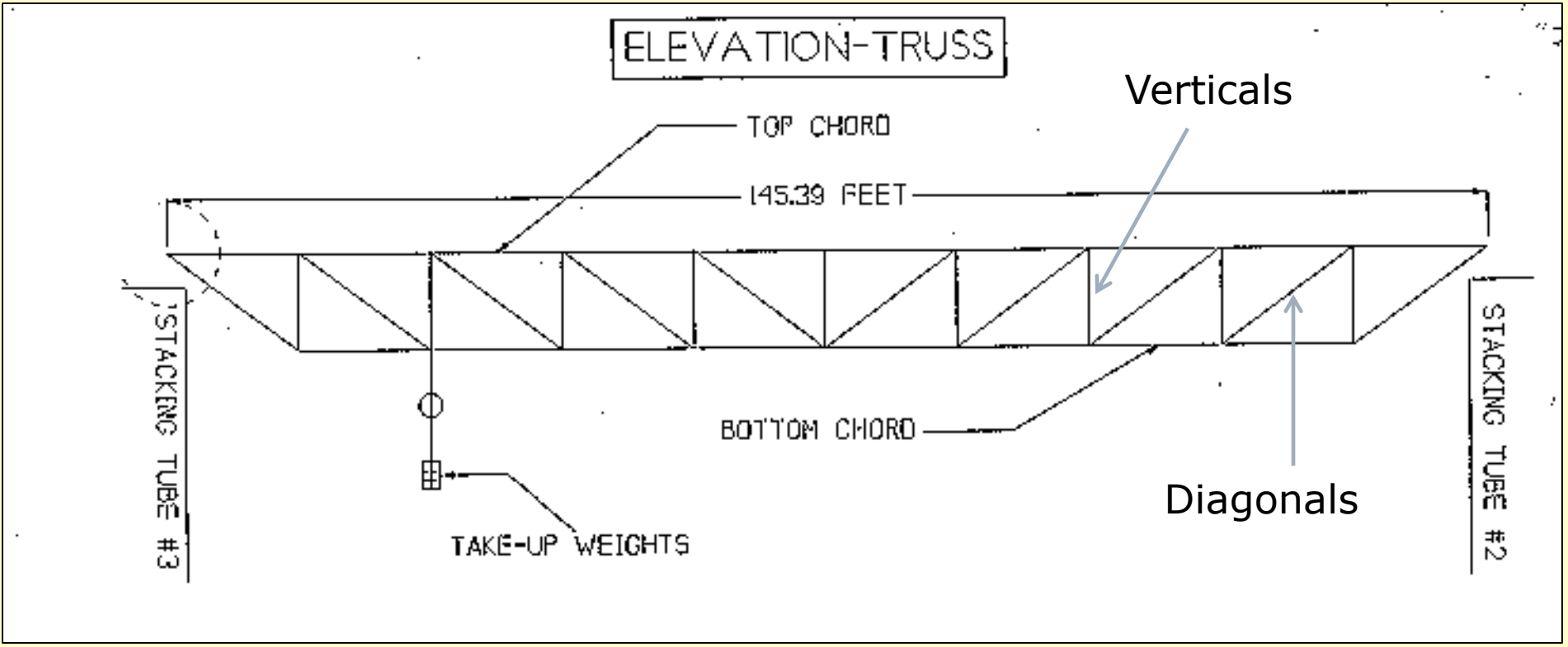
Overloaded sagging roof purlin as a result of material accumulations

Plant collapses can lead to multiple fatalities and can be very costly.

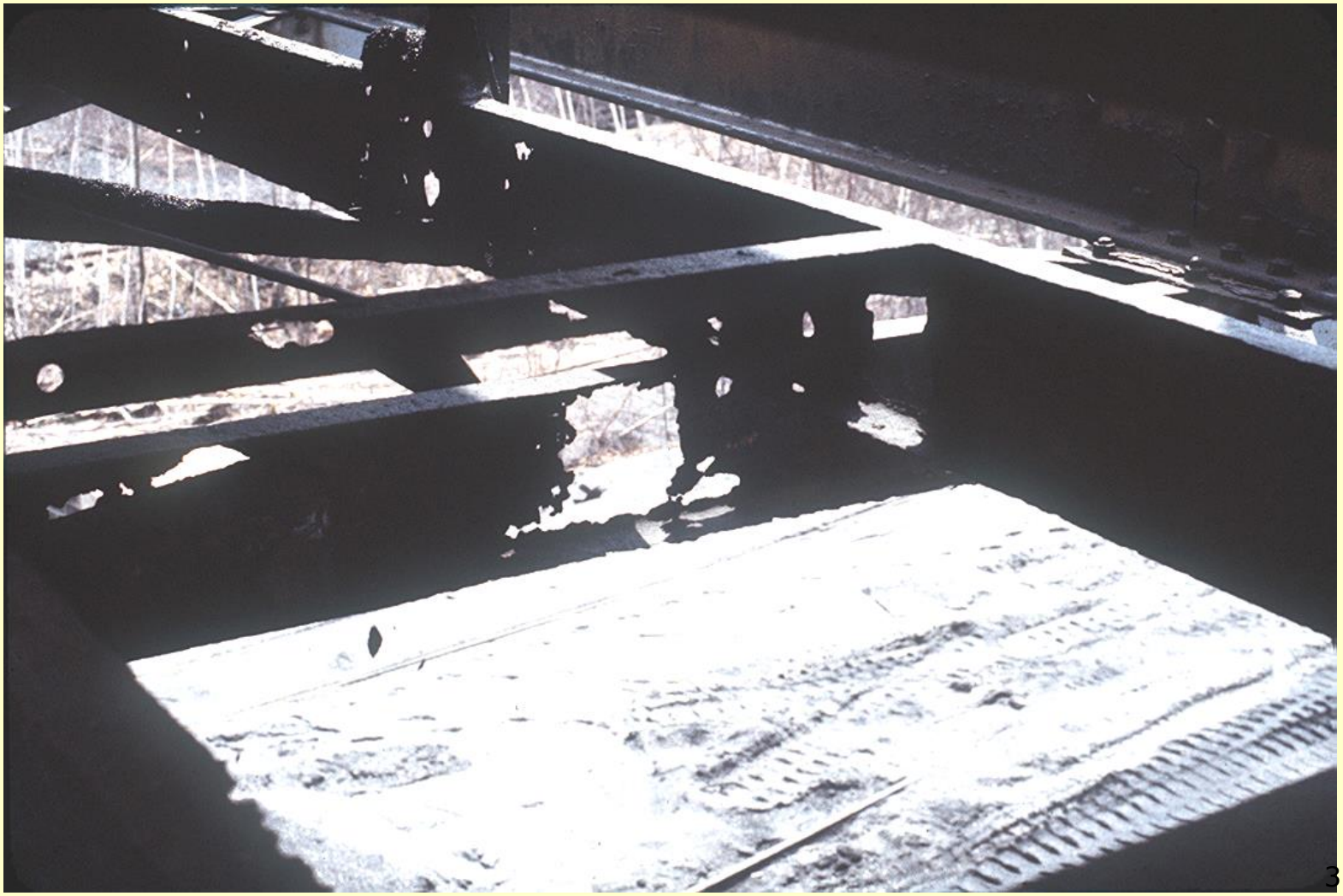


Inspection of Conveyor Belt Structures

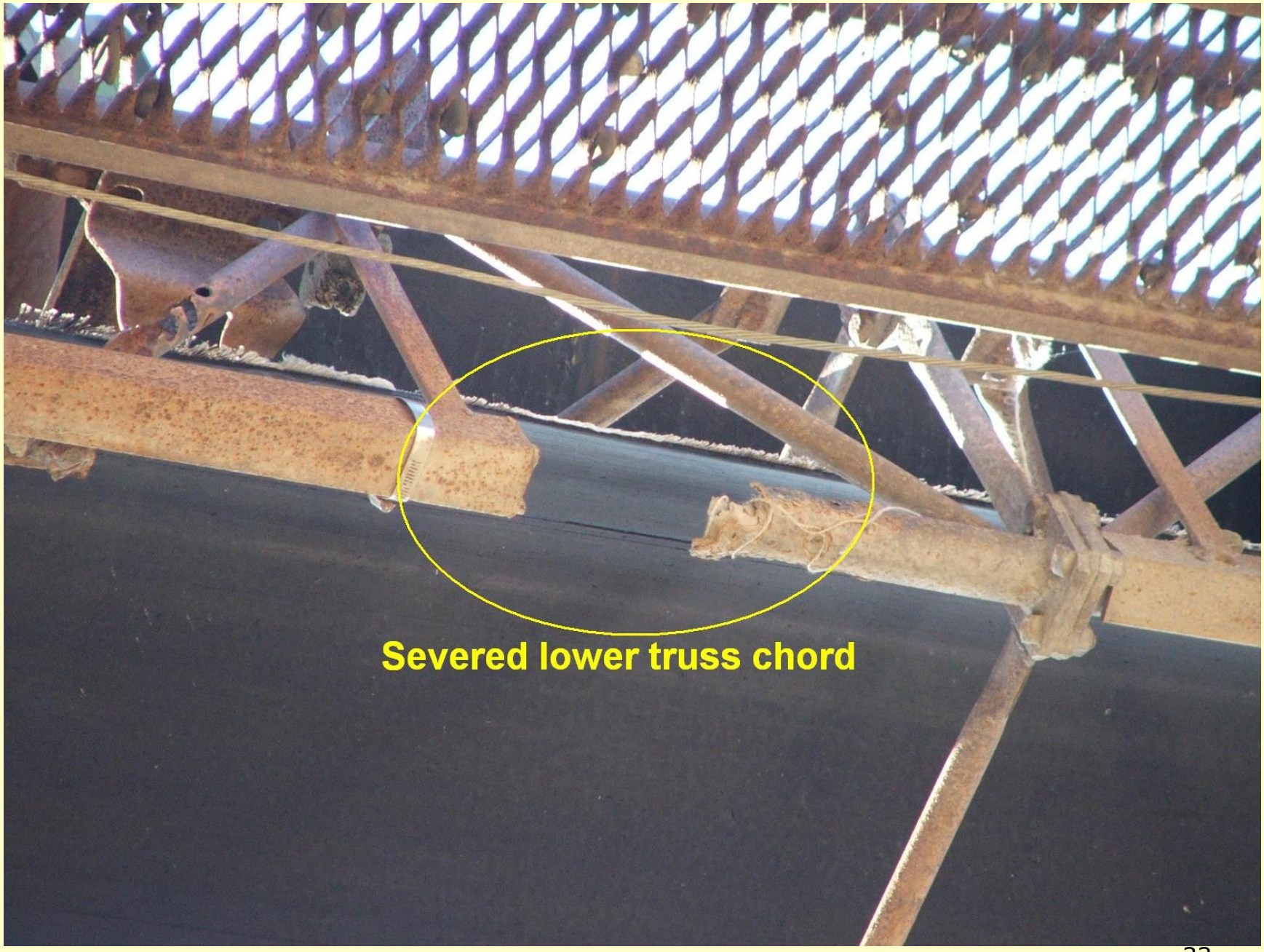
Truss member terminology



Corrosion holes in truss bottom chords & cross members



One leg of bottom chord angle corroded through and U-bolt walkway support was also severely corroded

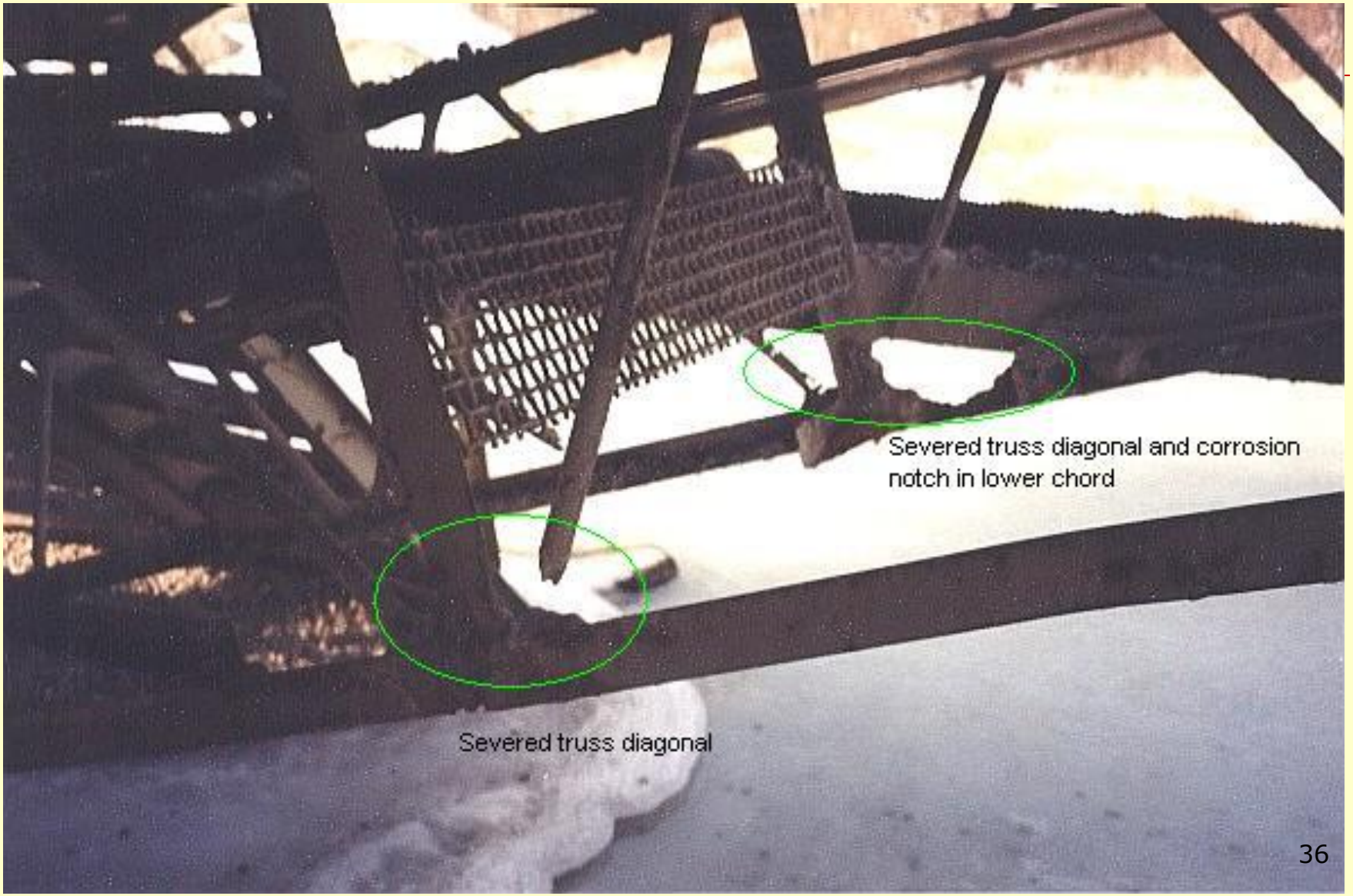


Fractured bottom truss chord

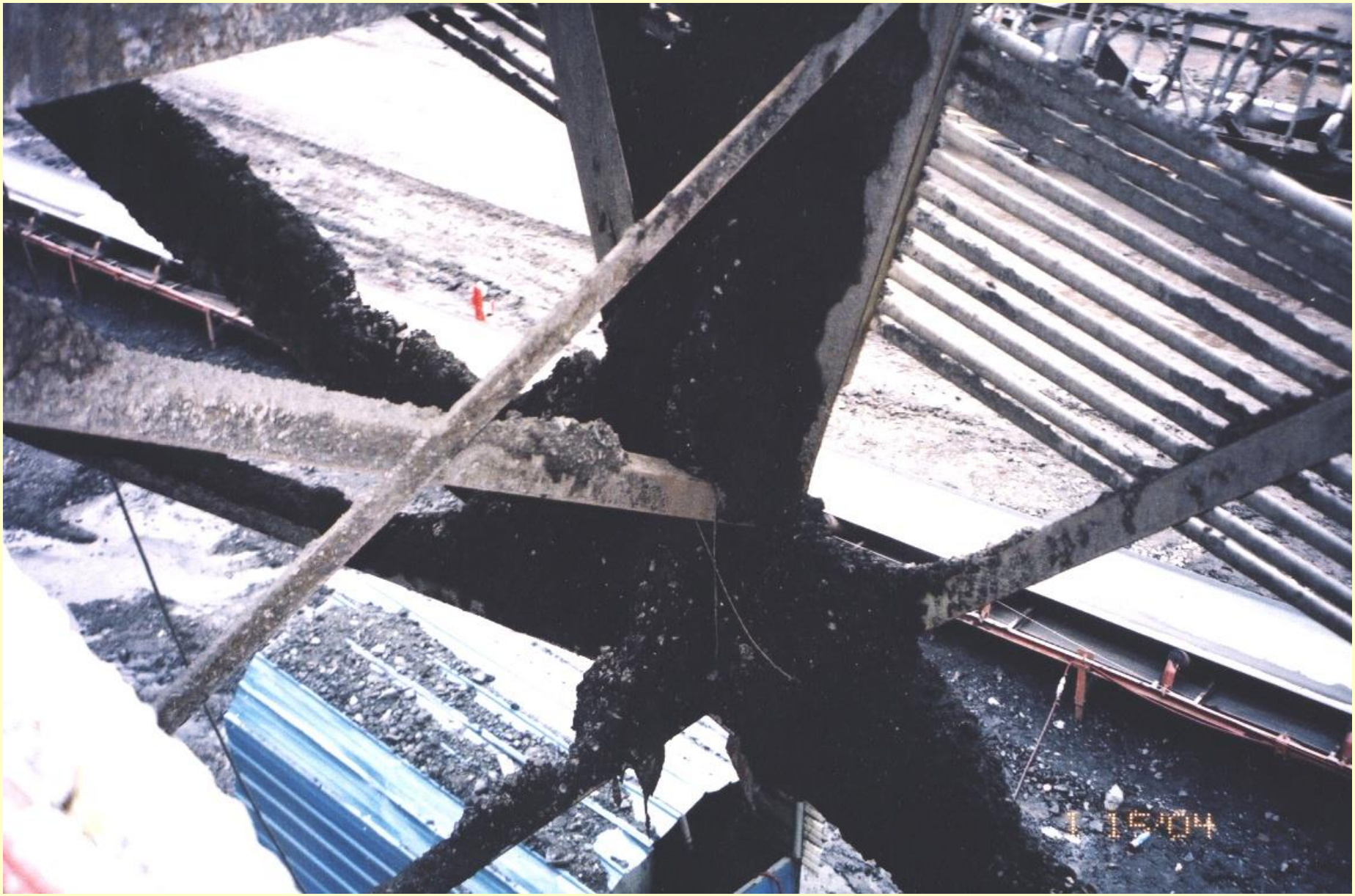

Detached catwalk supports

Belt abrasion notch in truss diagonal angle-shaped member. Section loss resulting in 50% loss of capacity!

Corroded and severed truss diagonals & chords



Fractured bottom chord angle section



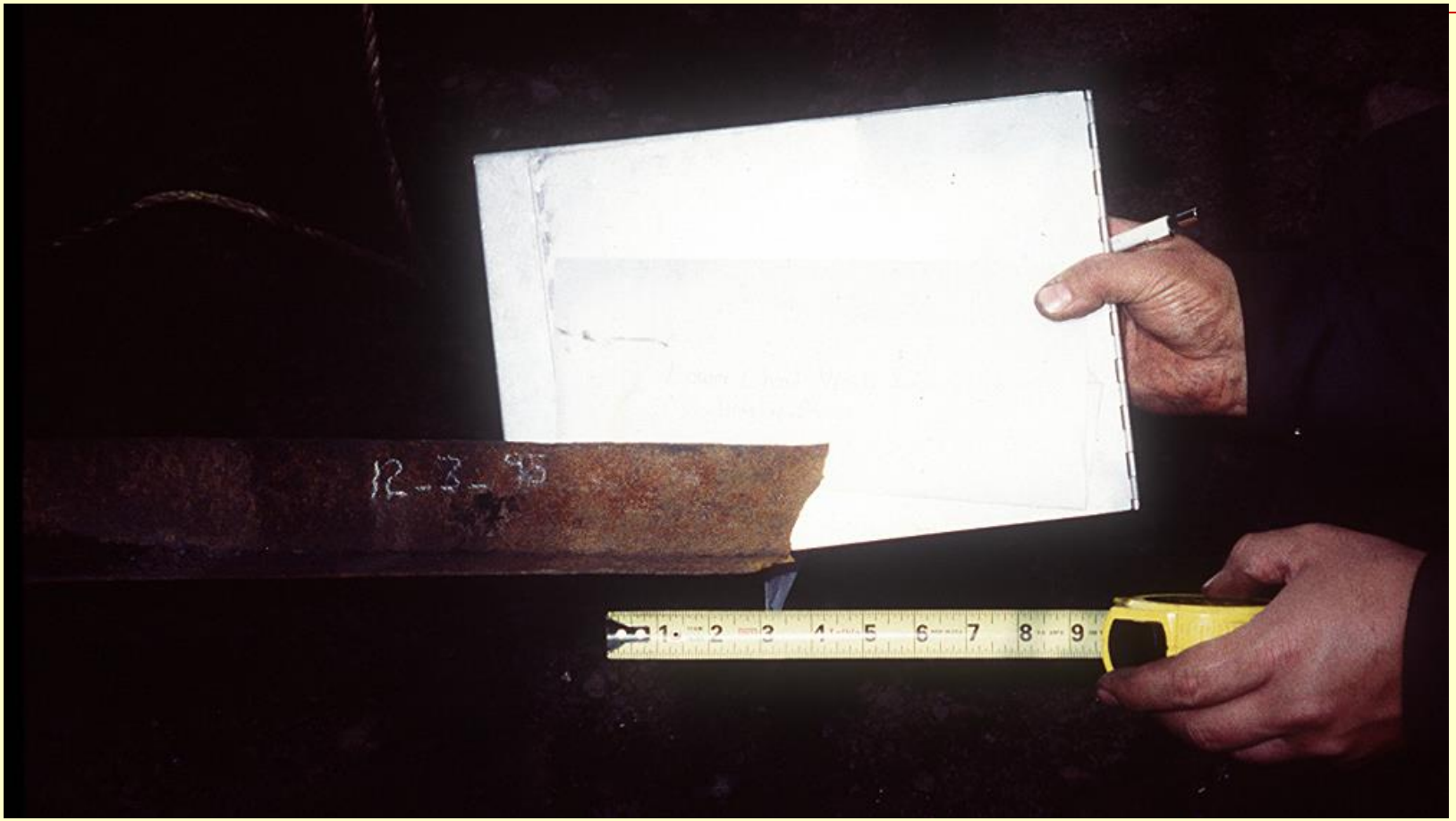
Accumulations on bottom chords and verticals add weight and may facilitate corrosion

Overall sag of a conveyor belt truss of approximately 2 feet.

Near Miss - May, 2015 at a sand & gravel mine - An inspection party walked up the wood plank walkway to inspect the conveyor head pulley. As they started back down a section of the walkway unexpectedly dropped out from beneath the MSHA inspector leading the party. He escaped the 30 foot fall to the ground by holding onto the

Corrosion caused fatal @ Drummond, AL - 1995

Fractured bottom chord angle section on the truss had 70% loss of cross-sectional area from corrosion.

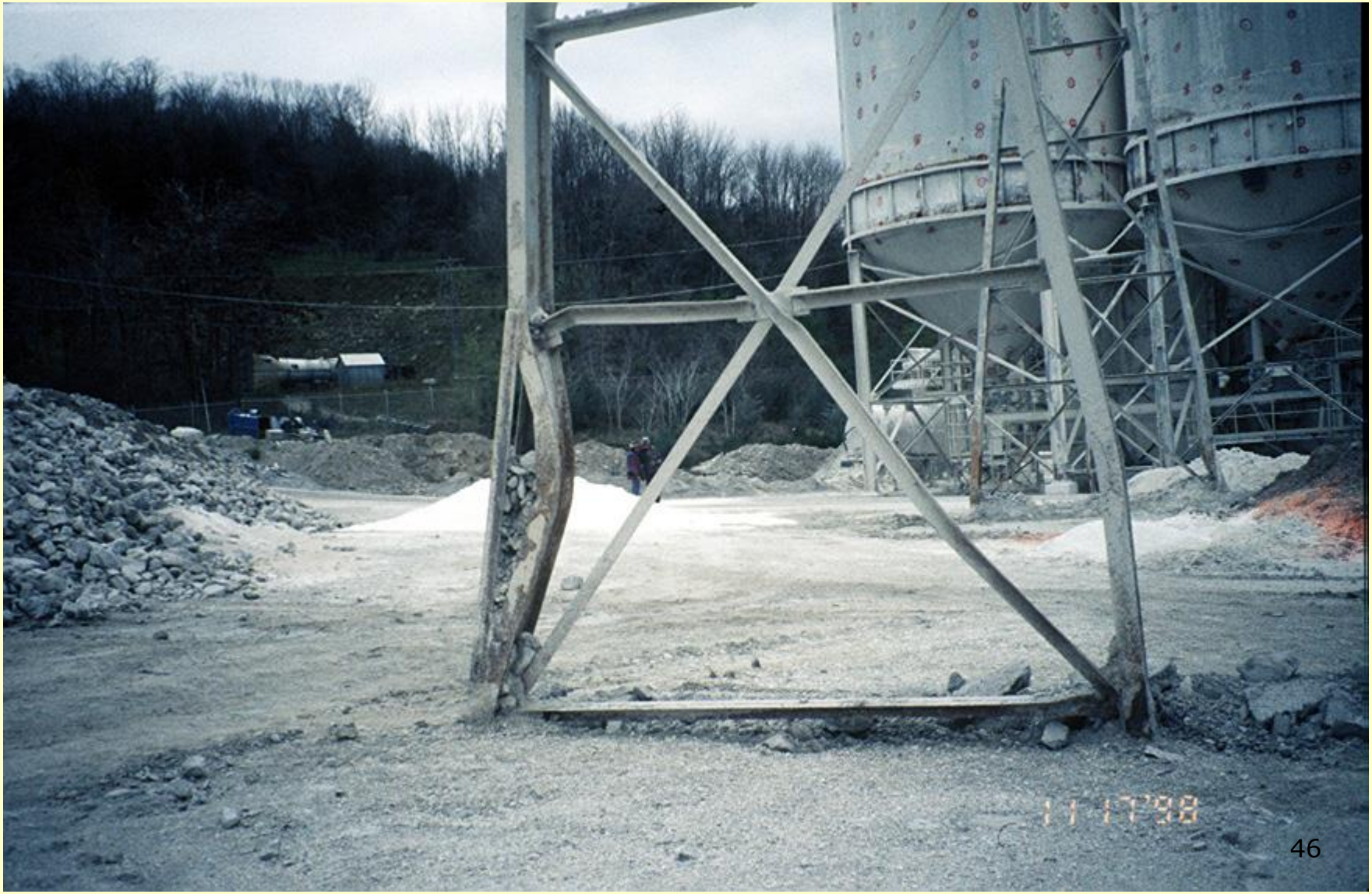


Buckled bottom chords of conveyor belt trusses

Deflected bottom chord that occurred because an added support post was not located at a joint

Buckled top chord

Impact damaged bent w/ inadequate repair



Impact damage to a conveyor bent and excessive material build-up

Impact damage - conveyor bent separated from the concrete foundation

Sand and gravel creativity!

Using an old conveyor truss as a support tower for another conveyor truss.

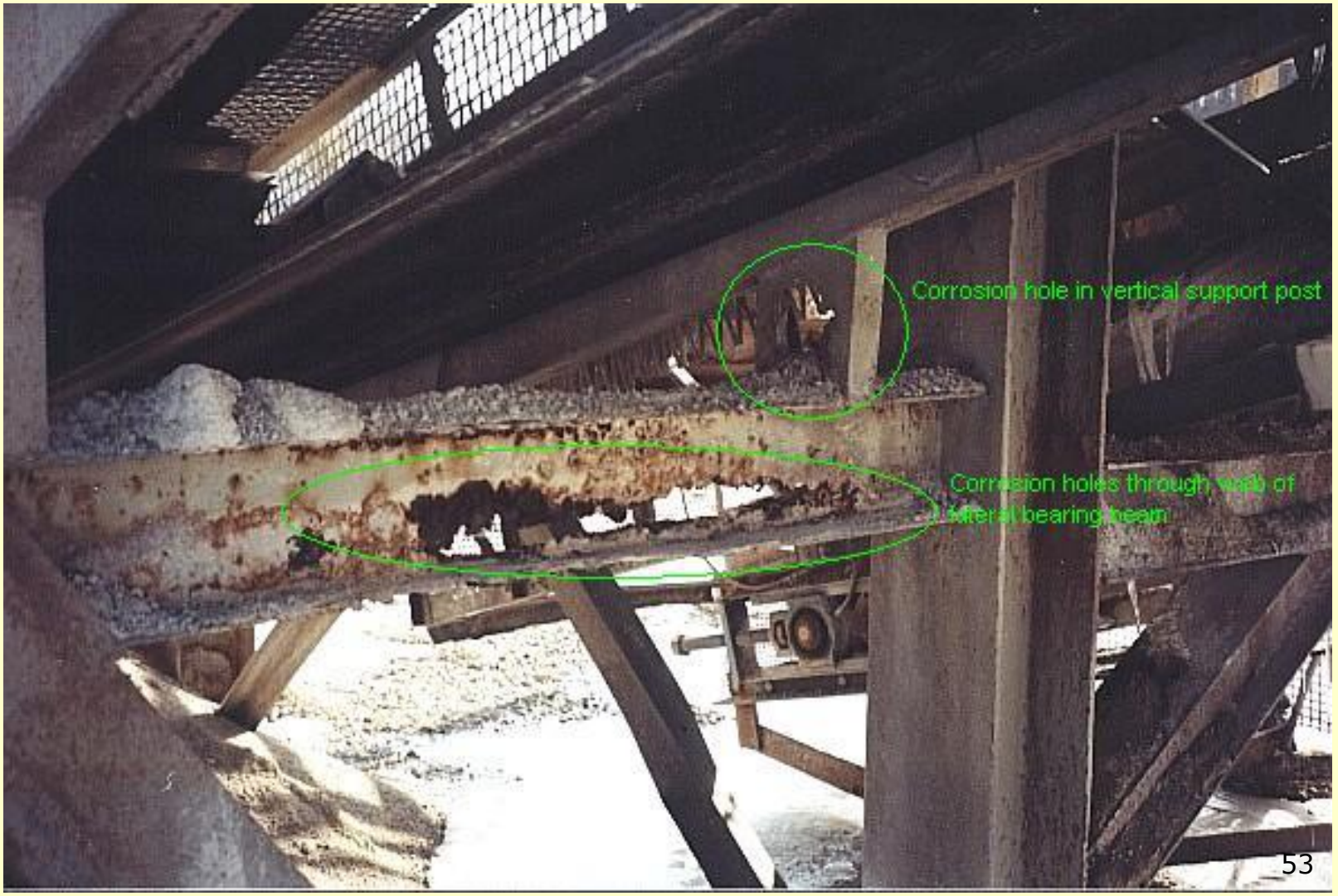
The drip pan stuck to the tower was a dead giveaway as to its past use….

If 1 brace is good, then surely 7 has to be even better!

Twisted bent

Corroded column at the base of a conveyor support bent.

Corroded conveyor belt supports

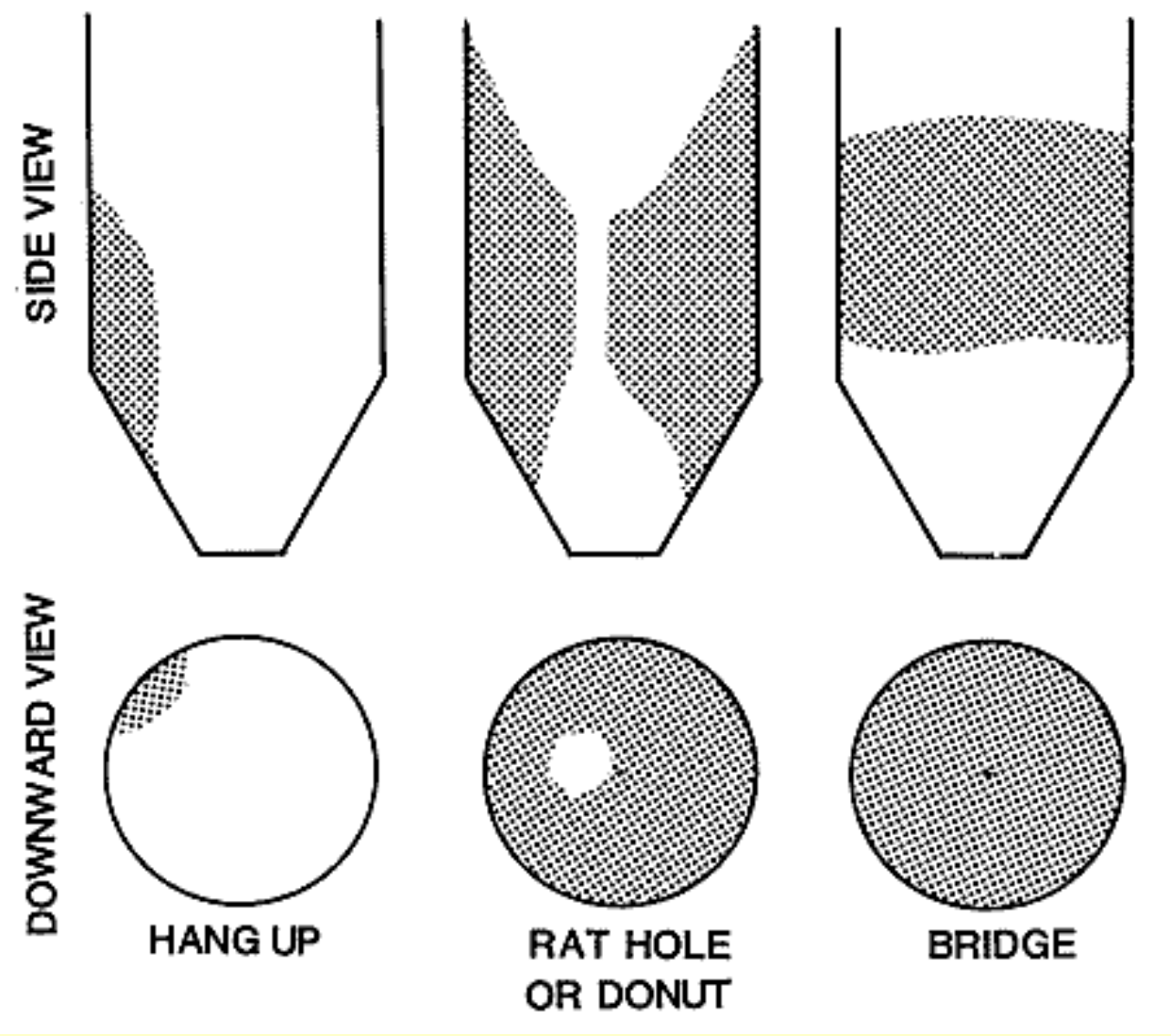


If a conveyor is in a draw-off tunnel, beware of the condition of the tunnel liner.

Inspection of Steel Bins – Problem Areas

- Corrosion - loss of area reduces capacity
- Corrosion and abrasion can cause wall openings - redistribute stresses
- Buckling of bin walls
- Impact damage to structural support members
- Flow-related problems…hang-ups, rat holes, and bridging
- Deterioration at the critical connection of the suspended hopper to the upper bin walls
- Shear tab failures in octagon shaped support frames

Material flow problems in bins



Rat hole

Bin wall buckling of a tall bin

Wear & corrosion holes in the cylinder of a waste rock bin

Corrosion holes in the cone at the junction with the cylinder. Aggregate was peaking through.

Corrosion-related partial failure of the cone to cylinder connection

Hopper separation from the bin wall.

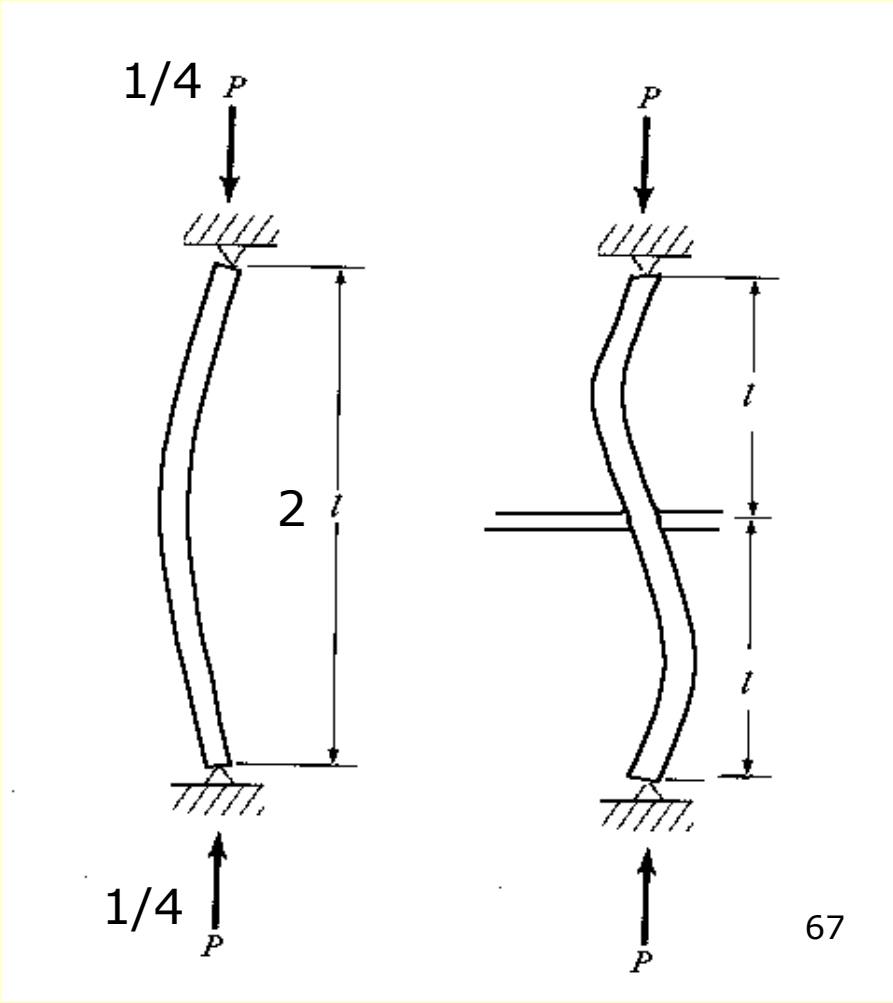
Light shining through detached bin wall at the hopper connection

Corrosion hole in cylinder of waste rock bin

Cracks in vertical bin walls

Lines of corrosion in the bin walls that were stuffed with rags and a weak polyurethane foam to prevent aggregate escape and contamination. However, the loss of structural integrity was not re-established.

Replace lateral bracing on bin columns if it has been removed or damaged as a result of equipment impact, or severely corroded - otherwise the column may buckle.



Damaged lateral beam supporting a bin column.

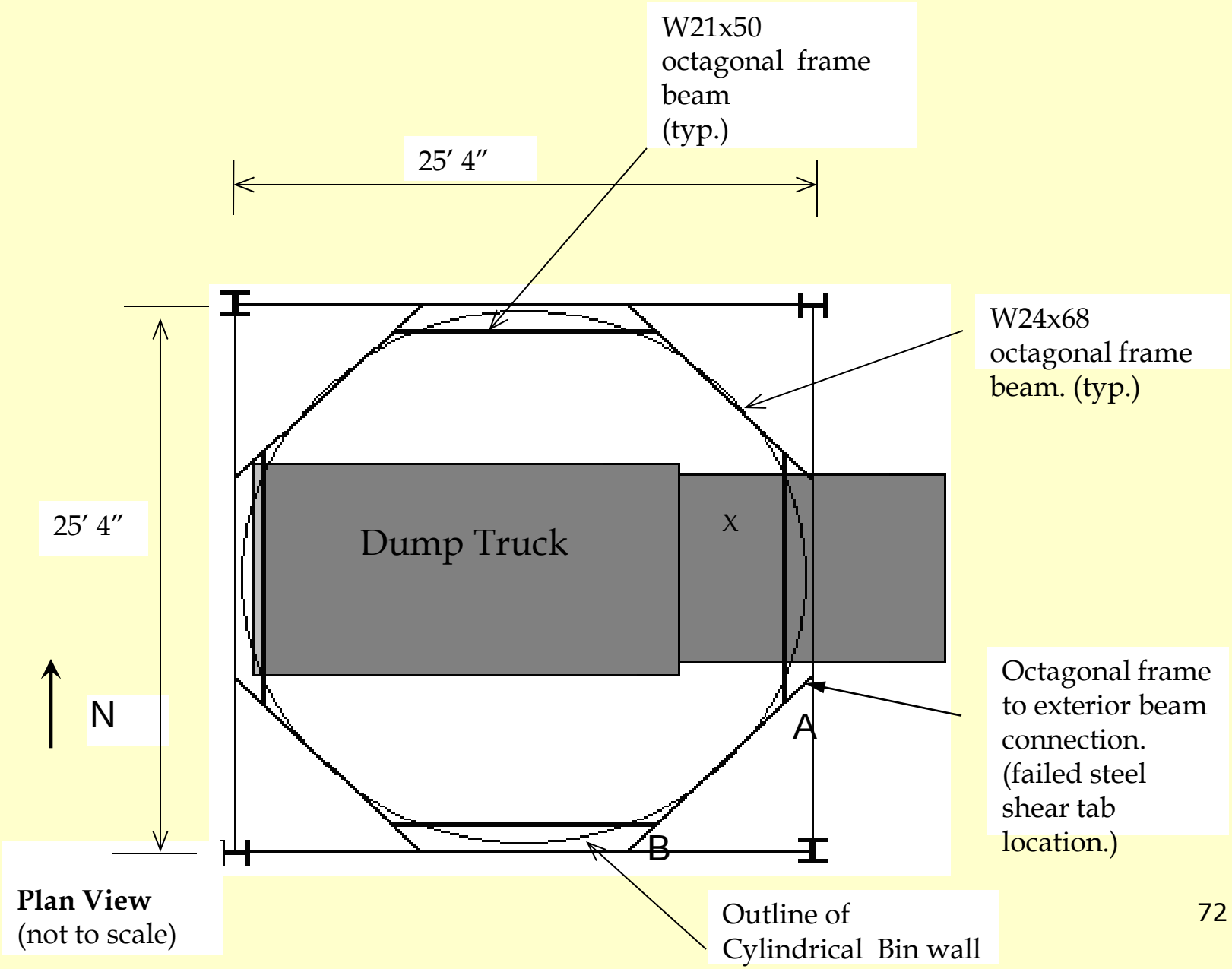
Pyramid-shaped hopper fell off a coal bin

Corrosion caused a 70% loss of cross-sectional area of the hopper plate resulting in the fracture.

Fatal Accident – March 2010

150-ton bin collapse

Elevated octagon frame supporting the bin. Beam failed at connections A and B

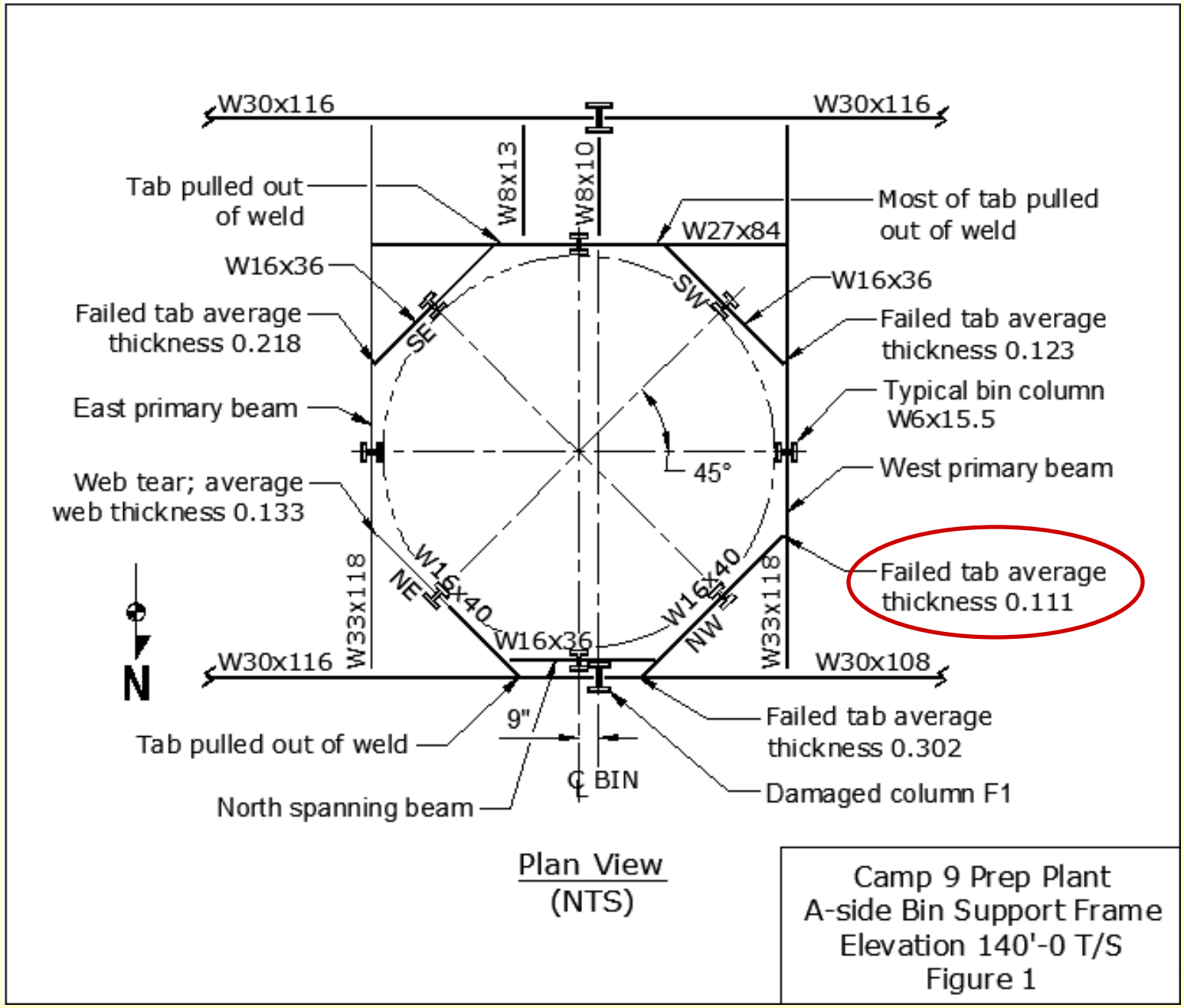


Plan View
(not to scale)

Failed shear tab “A” only 10% effective area remaining

Magnetite bin collapse May, 2014

Identical magnetite bin supported by an octagon frame at the same plant.



Plan View
(NTS)

Camp 9 Prep Plant
A-side Bin Support Frame
Elevation 140'-0 T/S
Figure 1

Remnant of northwest shear tab/plate failure. Avg. thickness = 0.1” compared to the original of 0.375”

Cement plant – Alabama - September 9, 2015 bin collapse.
Lower section of cylinder and cone tore off a 40 year old bin.

The bin fell through the floor. Just 10 minutes prior, there had been 5 miners under the bin on the bottom level.

Similar bin that did not fail. The failed bin had a 200 ton capacity and contained mill scale. The bin was 14’ in diameter and 34 feet tall.

Original bin plates were ¼” thick – 40 years later they were paper thin.

Luck Stone's Plant in Virginia.
Fatality at 6:15 am on August 13, 2015

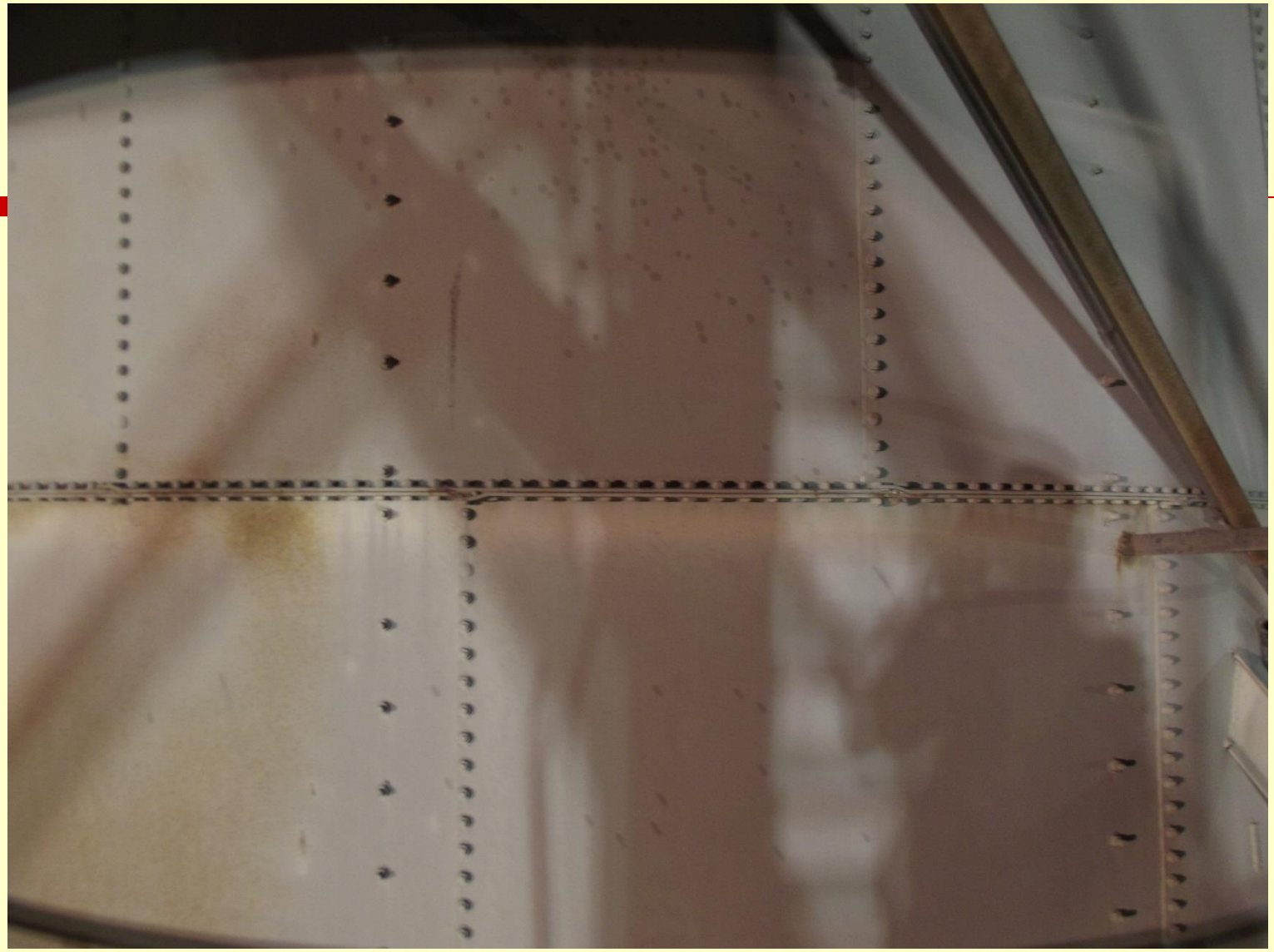
21.5’ diameter
56’ overall height
17.5’ tall conical hopper
23’ tall cylinder
Capacity - 734 tons of fine sands.
Estimated capacity at the time of failure - 522 tons.

Constructed using bolted connections in 1993.

A 2012 plate thickness survey by mine personnel showed nearly 50% section loss of the plates on the south side of the bin.

There was no abrasion liner in the cone.

Failed 1.5’ below the connection of the hopper to the cylinder.



Connecting bolt shanks and nuts on the plate sections looked good on the outside. In 2007, the bottom ring (of 3) of the hopper was replaced.

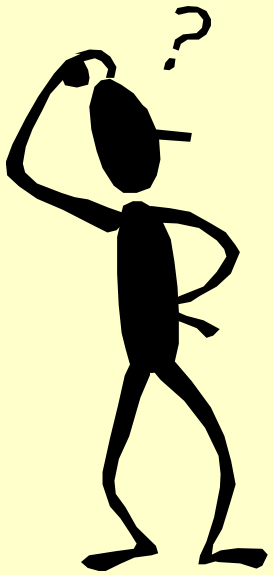
Bolt heads were abraded and corroded off on the inside. They were completely worn off on the south side, but not on the north. Material was static on the north side and flowing on the south side where the abrasion occurred.

In summary….
"You can pay now. . ."

- By using an engineer to inspect your structures and performing ongoing maintenance.
- The benefits are:
  - safe operation
  - continuous production
  - planned expenses

"Or...you can pay much more later!"

- By neglecting structural maintenance and inspection
- Costs are:
  - fatalities, injuries, near misses
  - disrupted production, severe downtime
  - unplanned expenses
  - legal fees, citation penalties
  - litigation…



Any Questions?

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U.S. Department of Labor
MSHA
Mine Safety & Health Administration