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Case Study: Aluminum Flatbed Trailer Failure

By

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Subject

Examination of 1996 Raven aluminum frame flatbed trailer to determine the reason for failure. The trailer was put into service in 1997. The trailer suspension separated from the frame while the driver was negotiating a turn on an Interstate off ramp. The useful life of aluminum flatbed trailers is ten to fifteen years. The trailer was over 20 years old at the time of the failure, and had been repaired once prior to the accident.

Trailer Examination

Figure 1 – Manufacturer's Identification Tag Containing Manufacturing Date

Figure 1 shows the vehicle identification tag for the trailer that was examined.

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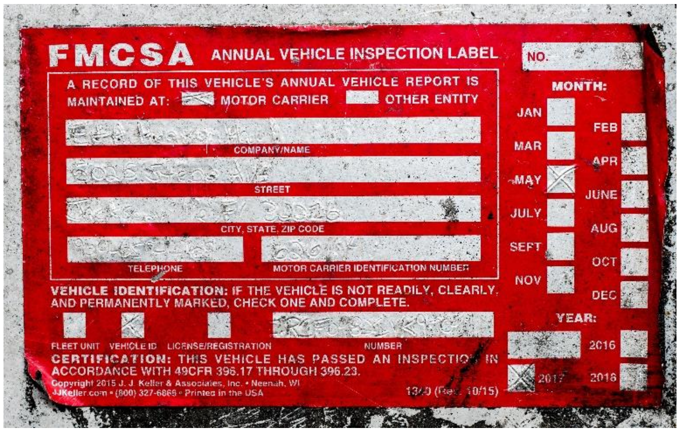

Figure 2 – Vehicle Inspection Label

Figure 3 – Manufacturer's Identification

The label showing the last inspection in May of 2017 is shown in Figure 2. The inspection procedure, specified as 49 CFR 396.17 through 396.23, is basically a records review of maintenance and repair and has nothing to do with the cause of failure of this trailer, although a visual inspection by the user is required every time the trailer is used.

Figure 3 shows the attached manufacturer's plaque.

Figure 4 – Rear of Driver's Side of Trailer

The rear of the driver's side of the trailer is shown in Figure 4. The rear set of duals on this side appear to be distorted. Other than the distorted duals, there was no other visible damage. There was also no evidence of any repairs having been made on this side of the trailer.

Figure 5 shows the most damaged, or passenger, side of the trailer. There had been weld repairs made to the trailer frame in the area supporting the front set of duals. The rear set of duals had separated from the trailer frame.

Figure 5 – Damaged Passenger Side of Trailer


Figure 6 – Damage Shown from Rear of Trailer

The rear of the trailer is shown in Figure 6. The right side of the duals had moved to the rear.

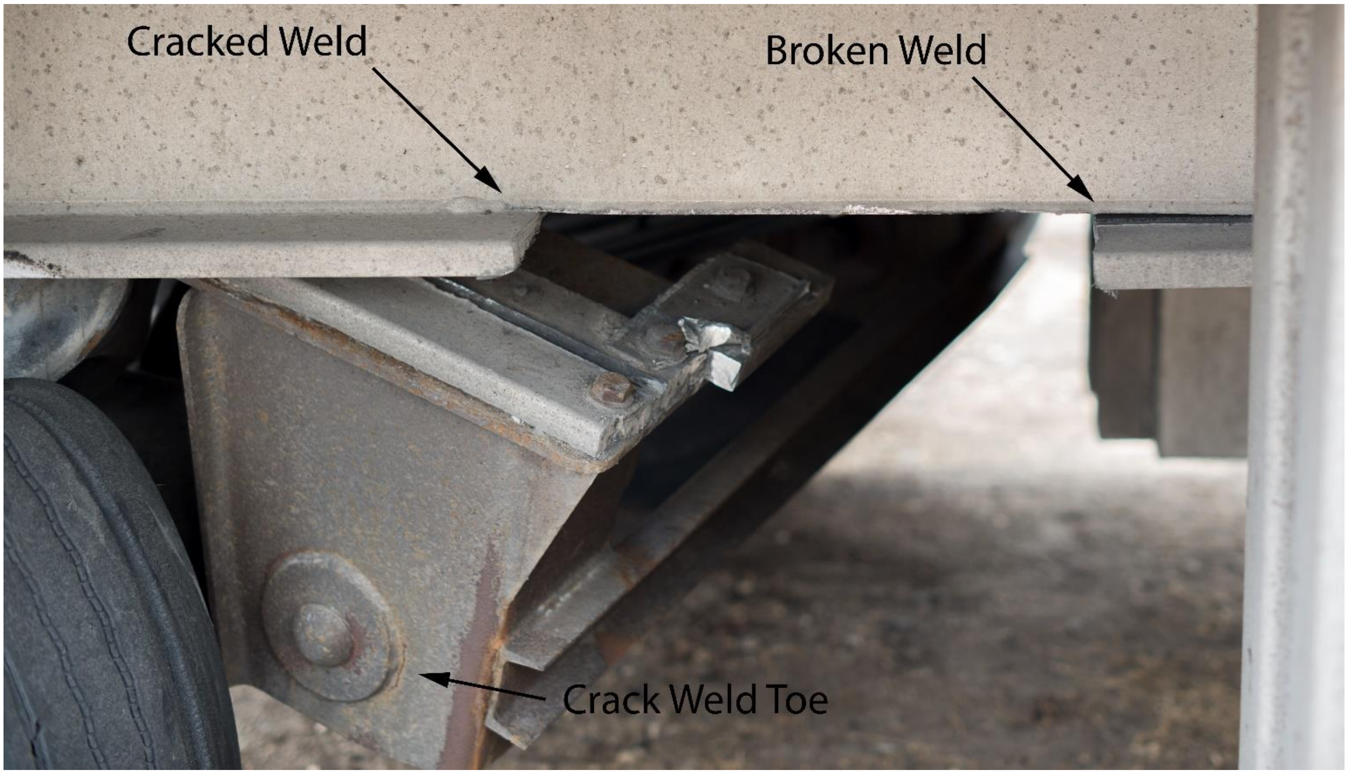

Figure 7 – Passenger Side of Trailer Frame and Suspension

Figure 7 shows the damage on the passenger side of the trailer frame. The flange of the frame where the suspension was bolted had broken free of the frame. The weld was broken, and the flange was broken in two locations. Normal visual inspection would not likely have detected the crack between the weld and flange. There was also a crack (Crack Weld Toe) in the steel of the suspension frame.

Figure 8 – Frame Repair ahead of Front Duals

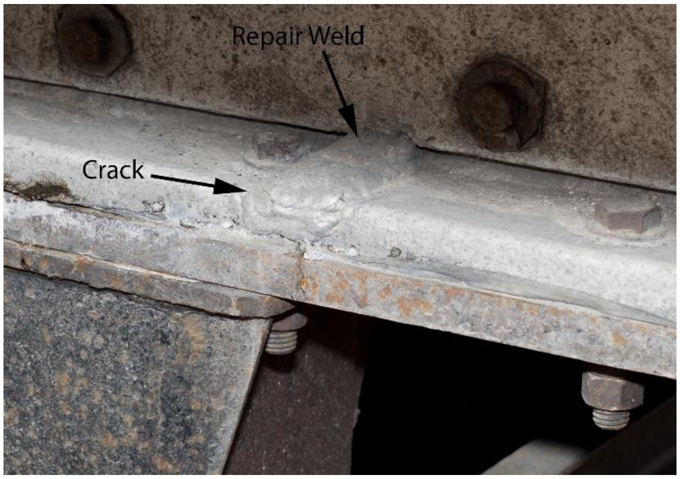

Figure 9 – Frame Repair Weld

The repair location ahead of the front duals on the passenger side of the trailer is shown in Figure 8. The frame flange was repair-welded, and the reinforcing plate was added to the frame gusset. The cracked repair weld is shown in Figure 9.

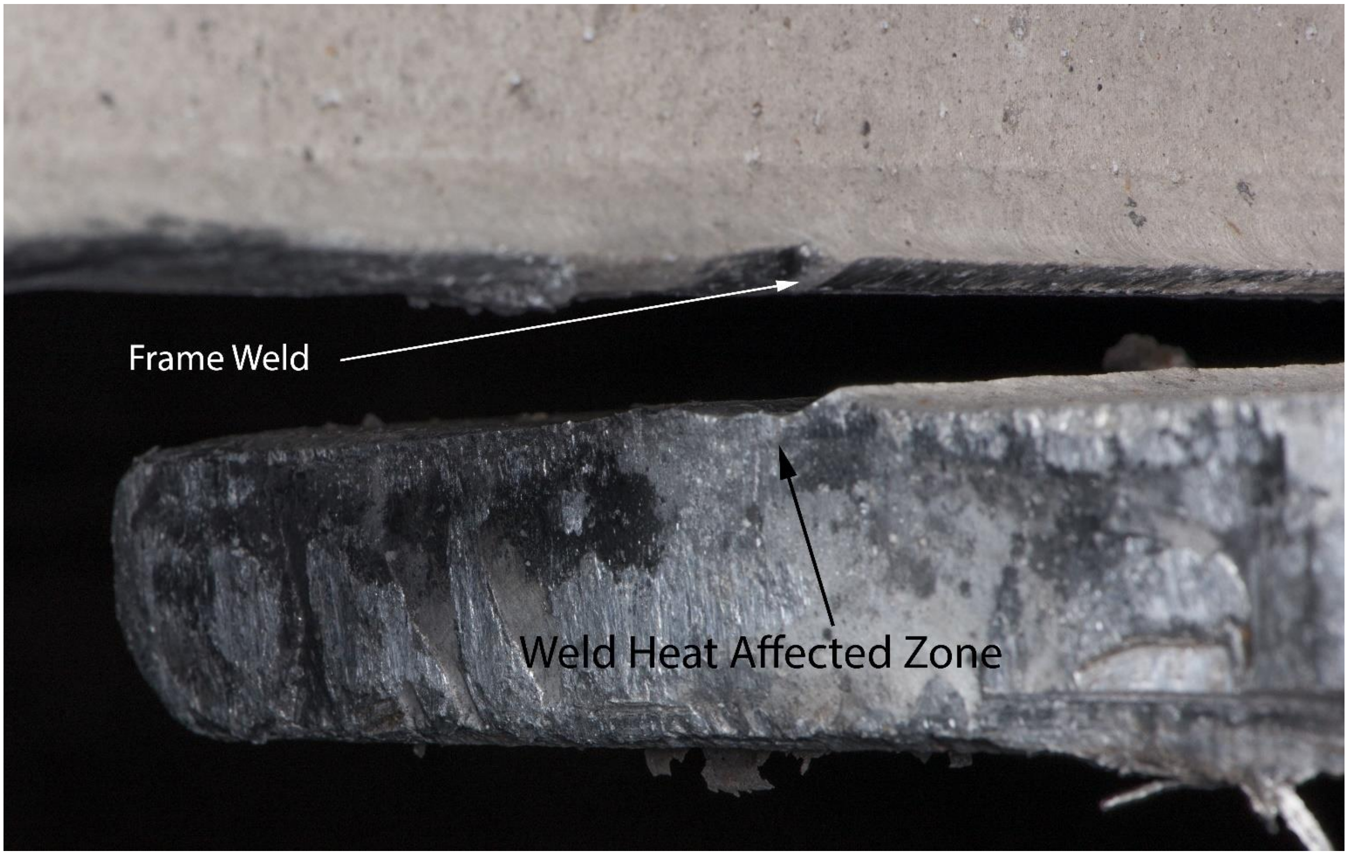

Figure 10 – Weld Failure in Frame-Flange Weld HAZ

The weld holding the frame web and flange together broke, Figure 10. The fracture was in the weld heat affected zone and was likely fatigue. The fracture surfaces on the frame weld were heavily Brinelled, and fatigue striations and beach marks were not visible. It is likely that the weld failed prior to the flange failing.

Figure 11 shows visible fatigue striations on the flange fracture surface, indicating that the fatigue is low cycle fatigue that started in the flange opposite the weld.

The fracture shown in Figure 12 is also fatigue, but this section of the flange failed in three cycles. The third cycle failure was by shear fracture. The failure was in the flange in the frame near the rear of the trailer, as shown in Figure 7.

Figure 13 shows fatigue fracture of one of the brackets bolted to the rear suspension.

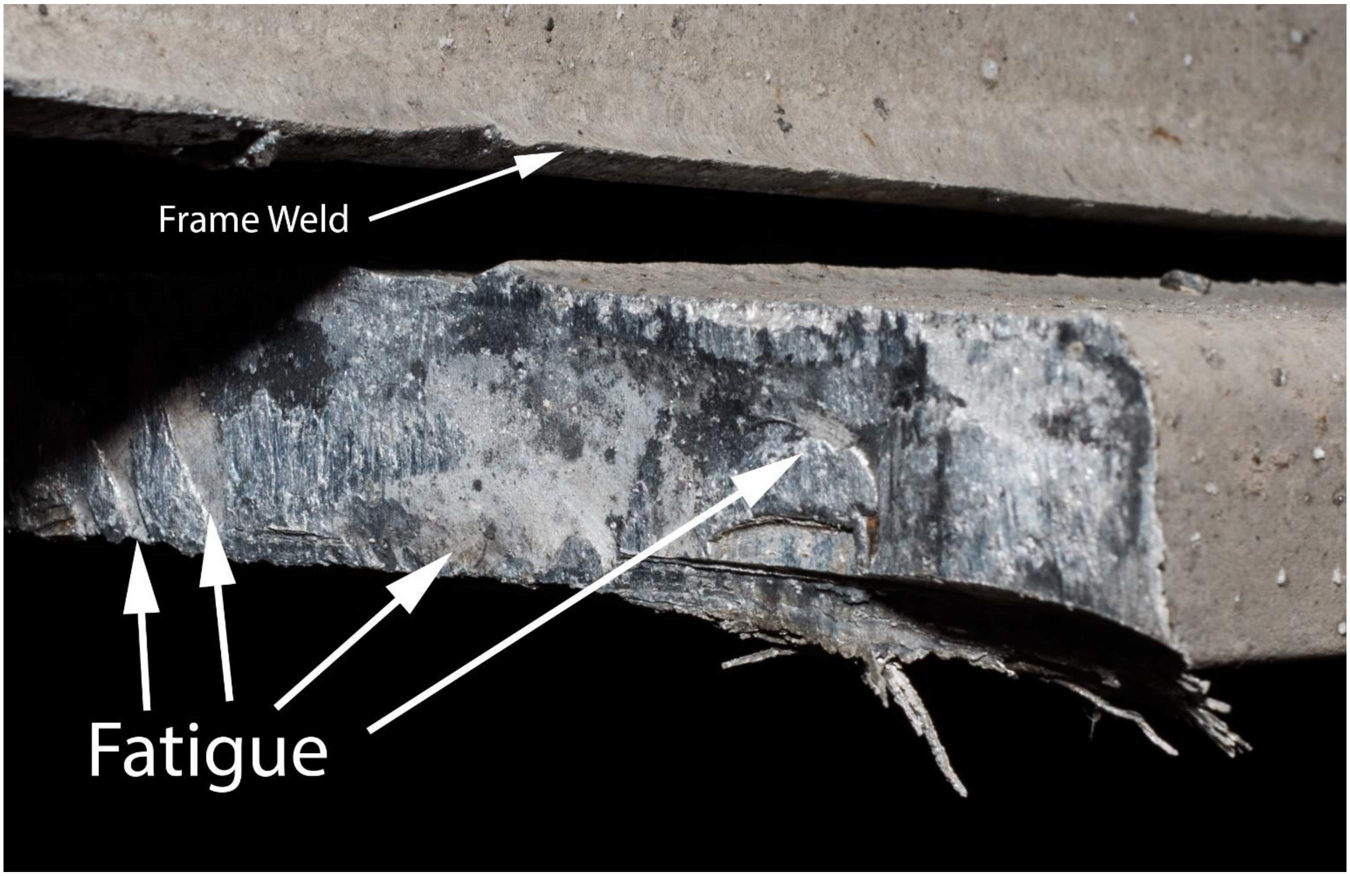

Figure 11 – Fatigue on Flange Fracture Surface

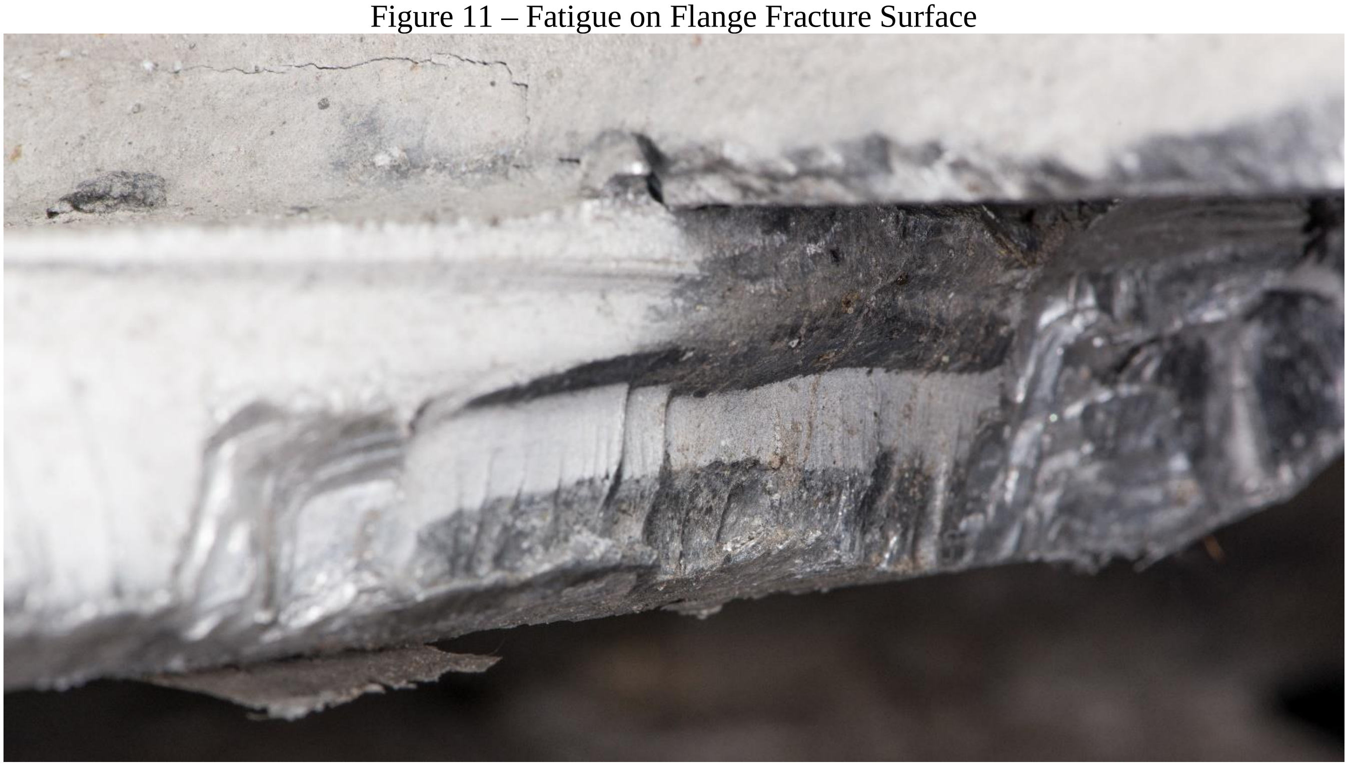

Figure 12 – Flange Fracture

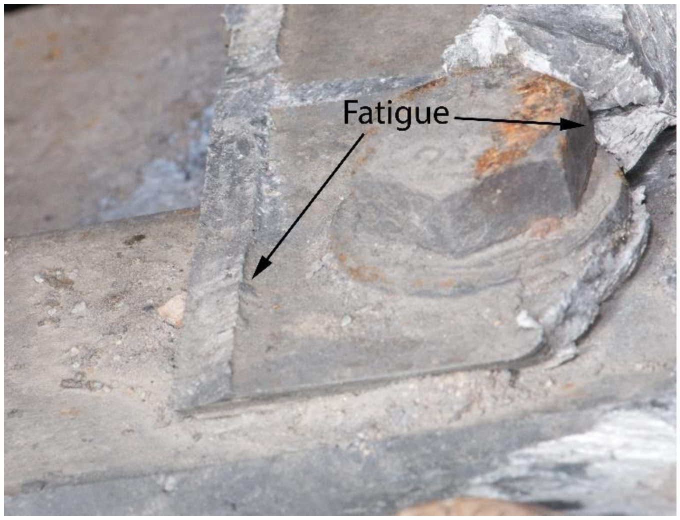

Figure 13 – Bracket Fatigue Fracture

Conclusion

Fatigue is the most common failure mode for aluminum and aluminum alloys. Any cyclically stressed aluminum alloy will eventually fail by fatigue. However, the trailer frame could have failed due to impact loading, or corrosion. Corrosion fatigue was a possibility. Careful examination was necessary to isolate the primary cause of failure.

It was my conclusion that the weld between the frame web and flange failed by fatigue, followed by failure of the flange, also by fatigue, causing the passenger side rear suspension to come loose from the trailer.