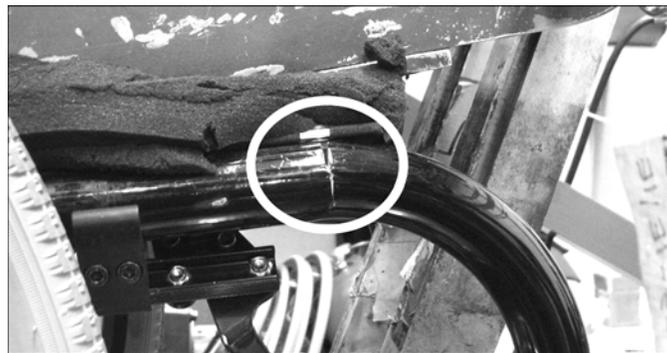


Appendix: Fatigue Failure Modes of Aluminum Ultralight Rigid Wheelchairs

TiLite AeroZ

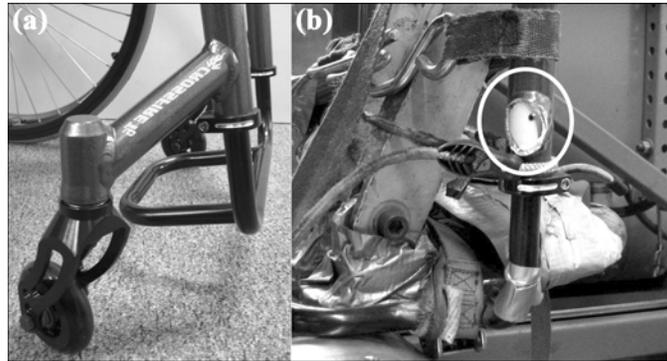
All TiLite AeroZ wheelchairs passed the fatigue standard. All the permanent frame failures were fractures at the first screw hole of the frame at the cantilever bend (**Appendix Figure 1**). Before the permanent frame failure occurred, wheelchairs had 2-5 minor failures, including footrests sliding down, screws loosened or fractured at the caster, seat pan, and rear wheel axles, and an aluminum seat rail fractured.



Appendix Figure 1. Frame Failure of a TiLite AeroZ wheelchair.

Invacare Crossfire

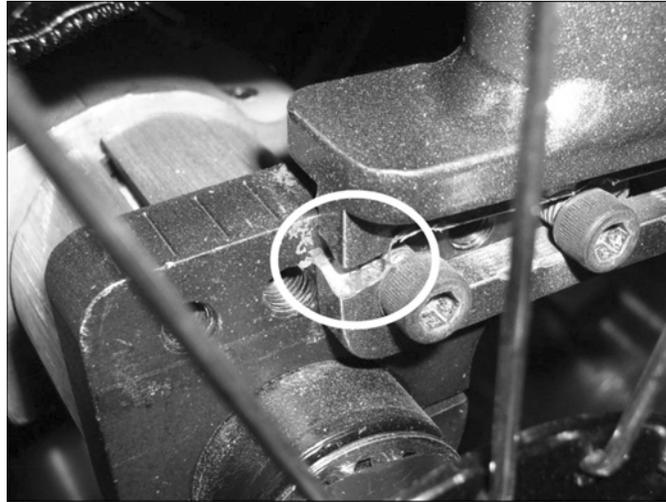
Two Invacare Crossfire wheelchairs had frame fractures at the welded areas at the caster tubes (**Appendix Figure 2**). One of them passed the fatigue standard. Before the caster tubes fractured, they had 1–2 minor failures, including footrests sliding down and one worn caster tire.



Appendix Figure 2. Caster tube failure of an Invacare Crossfire wheelchair. The left picture shows the original structure of the caster in relation to the footrest suspension tube. It was flipped horizontally to match the wheelchair orientation in the right picture. The circle in the right picture indicates the fracture surface where the caster was detached from the footrest suspension tube.

One Invacare Crossfire had a fracture at the camber tube support (**Appendix Figure 3**). This wheelchair did not pass the fatigue standard. At the completion of the test, it was noted that there were no washers between the socket screws and the camber tube supports. The camber tube supports were worn by the socket screws, and thus their strength was reduced. We checked the photographs of the wheelchair taken before starting any tests and realized that this chair did not have the washers installed by the manufacturer on both camber tube supports. This chair had one minor failure in that an axle bolt was loosened.

This article and any supplemental material should be cited as follows: Liu H, Pearlman J, Cooper R, Hong E, Wang H, Salatin B, Cooper RA. Evaluation of aluminum ultralight rigid wheelchairs versus other ultralight wheelchairs using ANSI/RESNA standards. J Rehabil Res Dev. 2010;47(5):441–56. DOI:10.1682/JRRD.2009.08.0137

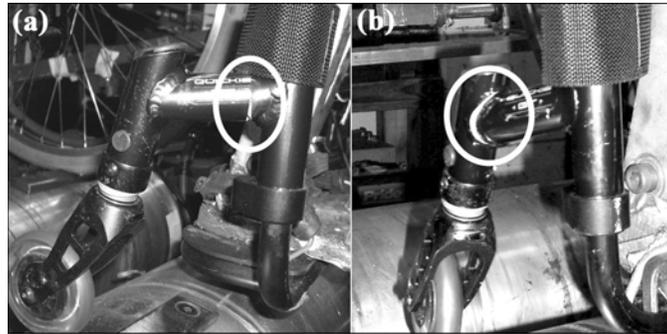


Appendix Figure 3. Camber tube support fracture of an Invacare Crossfire wheelchair. The circle indicates the fracture of the camber tube support.

Quickie GT

All of the Quickie GT wheelchairs passed the first iteration of the fatigue tests and thus the fatigue standard. During the second iteration of the fatigue testing, two Quickie GT wheelchairs fractured at weld areas on caster legs connected with the footrest suspension tube or the caster housing (**Appendix Figure 4**). One of them did not have any minor failures before the caster leg fracture. Another one had three minor failures including an axle bolt and the screw for backrest angle adjustment loosened coming out. The other Quickie GT had a backrest tube fracture at the screw hole for backrest angle adjustment (**Appendix Figure 5**). This chair had three minor failures, including the rear wheel axle shifting forward and a screw on the seat pan loosened.

This article and any supplemental material should be cited as follows: Liu H, Pearlman J, Cooper R, Hong E, Wang H, Salatin B, Cooper RA. Evaluation of aluminum ultralight rigid wheelchairs versus other ultralight wheelchairs using ANSI/RESNA standards. J Rehabil Res Dev. 2010;47(5):441–56. DOI:10.1682/JRRD.2009.08.0137



Appendix Figure 4. Two Quickie GT wheelchairs had castor leg fractures around the welding areas connecting to the footrest suspension tube **(a)** and the castor housing **(b)**.



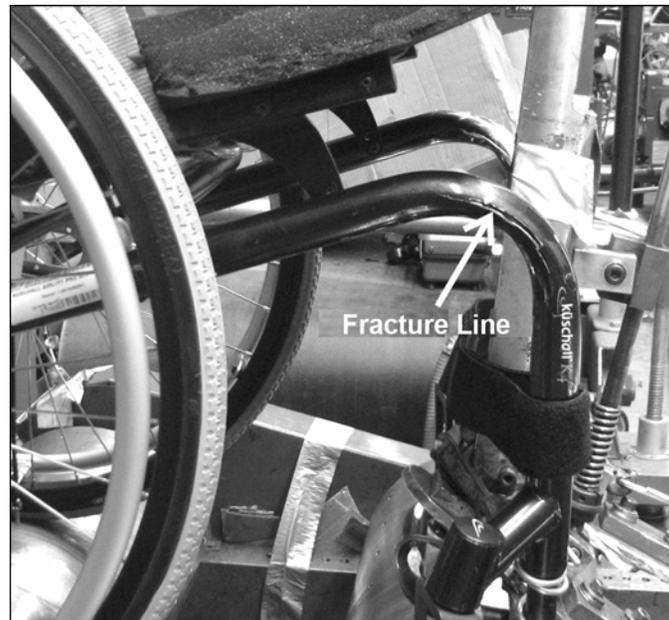
Appendix Figure 5. Quickie GT wheelchair had backrest tube fracture at the screw hole for backrest angle adjustment. The arrow indicates the fracture site on the backrest tube.

Kuschall AirPro

None of the Kuschall AirPro wheelchairs passed the fatigue standard. Two Kuschall AirPro buckled at the cantilever bends of their frames where the seat transitions into the footrest system **(Appendix Figure 6)**. One of them did not have minor failures before the frame failure.

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DOI:10.1682/JRRD.2009.08.0137

Another chair had one minor failure that the bolts underneath the seat loosened. The other Kuschall AirPro had a caster leg fracture at the connection with its footrest suspension tube. This chair did not have any minor failures before the frame failure.



Appendix Figure 6. Kuschall AirPro wheelchair buckled at the bend in the frame where the seat transitions into the foot-rest system.