TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

On Going Projects Related To The PhD in Mechanical Engineering-Engineering Mechanics Program

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- **Run Flats**
  - Single Piece Run Flat
  - Multi-Piece Run Flat
  - Run Flat In Operation
  - Fracture Propagation In Multi-Piece Run Flats
- **Conclusion**

- **The U.S Army is always interested in new approaches to self life, manufacturability, weight and performance for Run Flats**

- **Run Flats play a pivotal role in mobility to the Soldier in the event of partial or complete loss of tire air pressure**

- **Run Flats provide a bead lock that prevents the tire from slipping off the rim should the tire lose air pressure**

- **Many companies have created unique multi-piece assemblies which help address self life, manufacturability, weight and performance**

- **A solid rubber insert that fits securely around a multi-piece, "flat base" rim.**
- **The device is inserted into a tubeless tire, which is in turn fitted around the wheel, thus becoming an "assembly" of complimentary components all designed to work together to provide optimum mobility.**
- **Specialty tools are required to install this type of assembly**
- **Installing a Single Piece Run Flat is a time consuming process, which is slightly simplified with the use of specialty tools**

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- **Specialty tools are available, however they tend to be very expensive**

Unclassified

- **Since specialty tools are not always readily available It is more common to install a run flat with a ratchet strap and grease.**

- **Video Illustrating the "Ratchet Strap Method"**
  - http://www.youtube.com/watch?v=0O2DT0kLKO8

- **An insert made of sub assemblies that when assembled together fit securely around a multi-piece, "flat base" rim.**

- **The sub assemblies are inserted into a tubeless tire, assembled with common hand tools and slid onto a rim, thus becoming an "assembly" of complimentary components all designed to work together to provide optimum mobility.**

- **Usually only standard hand tools are required to assemble the insert**

- **Assembly time is considerably less compared to that of a single piece run flat**

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- **The figures below demonstrate a typical multi-piece run installation process**

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- **The following video illustrates how a vehicle performs in run flat mode**

  - http://www.youtube.com/watch?v=IGxl4dTDWIM

- **Depending on the design and material used in a run flat there is a possibility of fracture**

- **In the following example we will focus on a Multi-Piece Run Flat that experiences failure due to Fracture**

- **An actual design was not used, this design was created for this class**

- **Testing is done utilizing a typical fatigue rated testing machine**

- **The following run flat is a multi-piece assembly that was casted in a certain material**

- **The gap between where the two sub assemblies meet is 10 mm**

- **Multi-Piece Run Flat is tested in the same manner as a Single Piece Run Flat.**

- **Once the load is applied the assembly deflects by 10mm at the compression point**

Casted Run Flat Section

Mounting Bolt

Completed Assembly

10 mm

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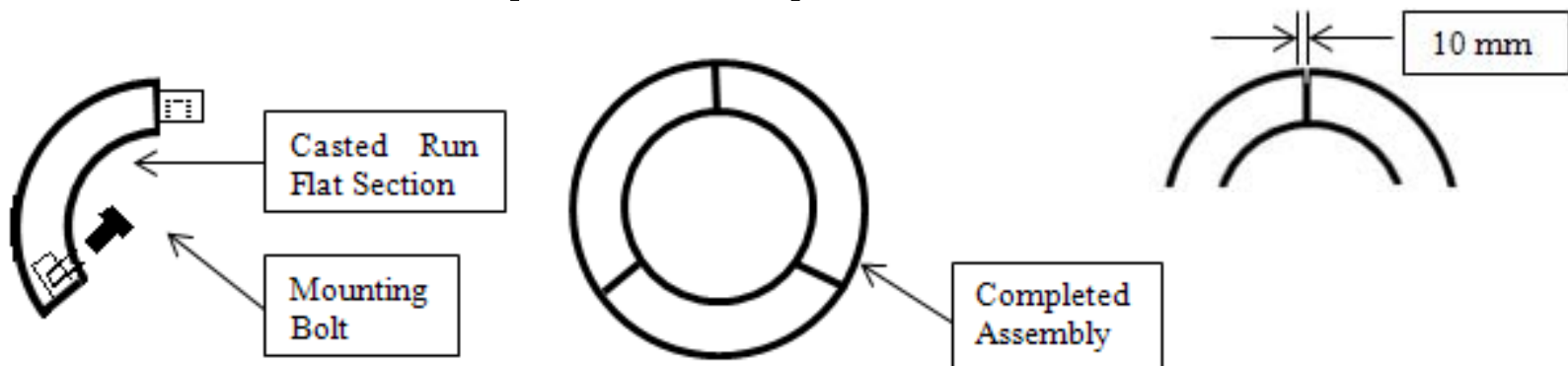
- **After testing the assembly it is found that it has a fracture at the mounting point and separates from the rim.**

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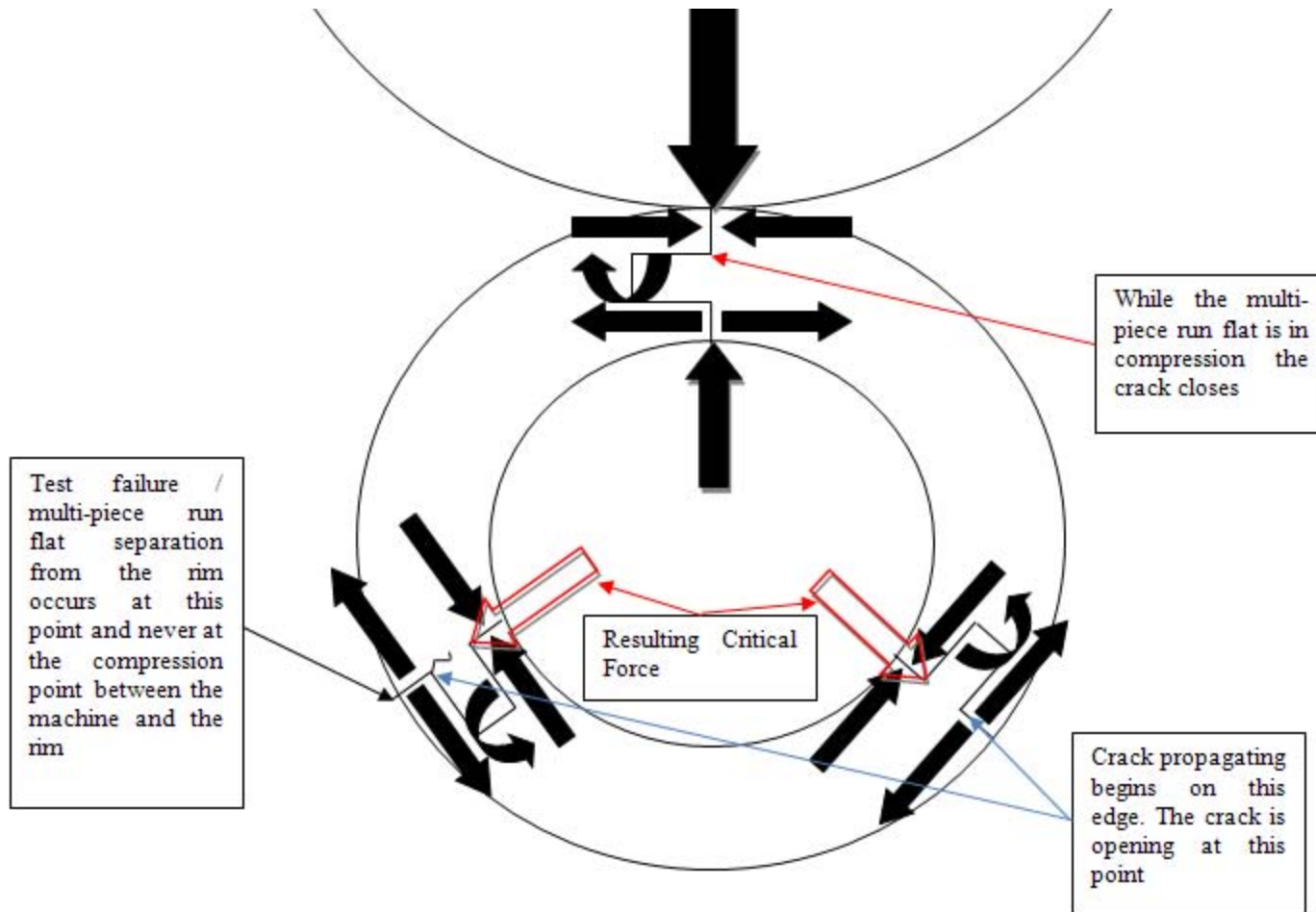
- **Causes to our Multi-Piece Run Flat Failure**
  - Test Equipment
  - Heat
  - Run Flat Material
  - Gaps Between Multi-Piece Run Flats (Non Smooth Transitions)
  - Deflection

While the multi-piece run flat is in compression the crack closes

Test failure / multi-piece run flat separation from the rim occurs at this point and never at the compression point between the machine and the rim

Resulting Critical Force

Crack propagating begins on this edge. The crack is opening at this point

- **Even though we have many factors which contributed to the failure of the Multi-Piece Run Flat controlling the gap is one of the most critical**
- **With the elimination of the gaps and careful monitoring of our other factors associated with the failure we should be able to control the fracture associated with the failure**

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- http://www.designarmor.com/Run_Flat_Tire_Inserts.html
- http://sk.stonecore.de/front_content.php?idcat=376
- http://flashoffroad.com/Maintenance/wheels_tires/tirechange.htm
- http://bulldogdirect.com/TP-humveerunflats.asp
- http://cgi.ebay.com/ebaymotors/NEW-HUMVEE-16.5-RUNFLAT-HALF-ONLY-P%2fN-12342638_W0QQitemZ120642415793QQcmdZViewItem?rvr_id=217590526618&adtype=pla&itemid=120642415793
- http://www.absolutearmour.com/run_flats.html
- http://www.rodgard.com/media/HutchinsonCRFInstall.pdf
- http://www.chantengineering.com/tiretesting.php

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