To Predict ▶ To Design ▶ To Perform

College of Engineering
Department of Mechanical & Industrial Engineering

ME, ECE, BE Capstone Design Programs

Team #28: Control of Fastener Tension & Preload

Cortland Cicardo, Ian O'Neill, Derek Sherwood, Virginia Stewart & Jack Walton

CAMERON

Background & Objectives

- **Problem**: Cameron's current preload application methods do not suitably indicate the actual bolt preload leading to possibility of failures in oilfield applications.
- **Objective**: "*Design and build or modify a testing apparatus to evaluate available preload measurement systems, and determine which system accurately measures the preload in oilfield applications.*"

Bolt failure due to improper preload

Concept Description

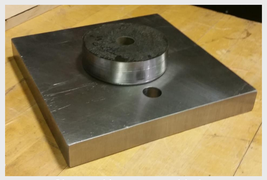
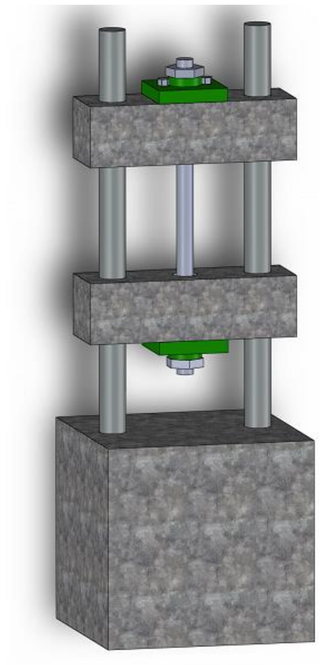


Plate and insert assembled

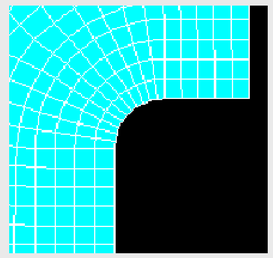
Specialized grips, consisting of a 4140 steel alloy plate and A514 (T1) insert, were designed and manufactured to be used with a standard tensile tester.



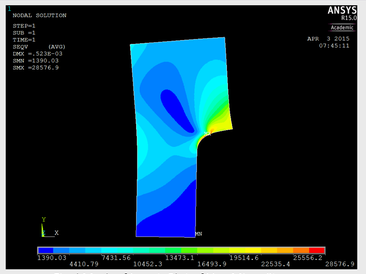
Tensile tester (grey) with grips assembled (green)

Engineering Analysis

Component, Stress Type	Stress Value
Plate, Bending	26,228 psi
Insert, Stress Concentration	34,896 psi
Insert, ANSYS Max Von Mises	28,577 psi



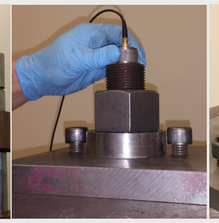
Close-up of 0.05 Mesh



Final Mesh of Insert, Plot of Von Mises Stresses

Accuracy & Practicality Testing

Installing 1 7/8" stud



Applying transducer to 1 7/8" stud

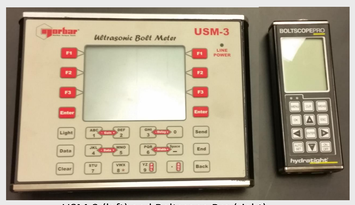
Testing Standard DTI Washers

Testing performed at Accurate Weldment Testing (left) to determine accuracy of different systems and at Cameron Berwick (right) to show employees how they work.

Showing Cameron employees how to use USM-3

Preload Measurement Systems Tested

- Belleville Washers from Solon Manufacturing
  - Concave washers calibrated to flatten at a set load
  - Available in diameters of ½" to 4 ¾"
- Standard DTI Washers from Turnasure LLC
  - Washers with protrusions that fatten at a set load
  - Available in diameters of ½" to 4 ¾"
- USM-3 from International Bolting Technologies
  - Ultrasonic device used to measure bolt elongation
  - Accurate for rods up to 45'
- Boltscope Pro from Hydratight
  - Ultrasonic device used to measure bolt elongation
  - Accurate for rods up to 4'



USM-3 (left) and Boltscope Pro (right)

Standard DTI Washer

Belleville Washer

Budget

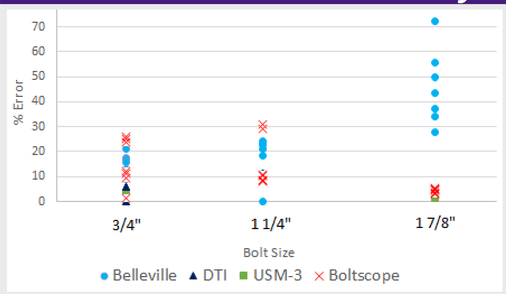
Component	Price
Testing	$1,468.75
Belleville Washers	$613.75
Boltscope Rental	$389.00
Grip Material	$209.28
Studs	$195.38
Total	**$2,876.16**

- **82%** of $3,500 budget spent
- **$623.84** under budget

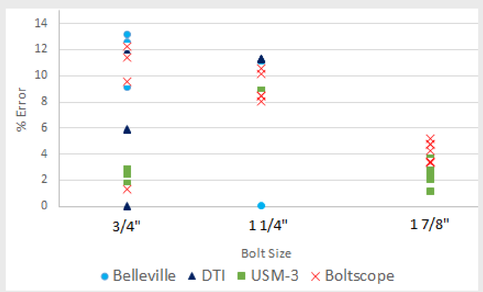
Acknowledgements

We would like to thank Cameron, Accurate Weldment Testing, and Taylor Tool & Supply for their support.

Data Analysis & Conclusions



Error Distribution



Close-up of Error Distribution

Average % Error	¾"	1 ¼"	1 7/8"
Belleville Washers	15.2%	17.2%	45.7%
DTI Washers	5.1%	10.4%	-
Boltscope Pro	2.6%	8.6%	2.7%
USM-3	15.7%	15.1%	4.2%

Criterion	Weights	Standard DTI Washers	USM-3
Accuracy	10	0	+
Integrity of Assembly	9	-	+
Time Required for Measurements	8	+	-
Objectivity	7	-	+
Durability	6	+	-
Amount of Training Required	5	+	-
Lifetime Cost	4	-	0
Totals		-1	+7

Sponsors: Joe Gross & Brandon Nowak

Adviser: Dr. Moldovan