Engineering Analysis of Component Parts of the Bobby Jack

Report No 3

By

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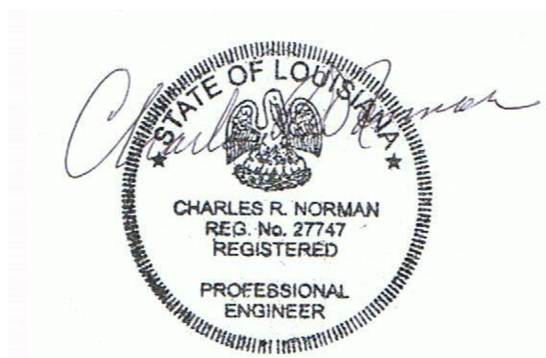

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Lake Charles, LA **September 12, 2024**

Introduction

The BobbyJack is an industrial jacking mechanism designed to lift pipe supported on beams in order to do inspection, maintenance and repair work under the pipe. By raising pipes from the support beam for inspection and maintenance, the BobbyJack incurs loads that cause stresses and deflection to its components. See http://thebobbyjack.com/

The original design Report No. 1 for the Bobby Jack was dated 7-19-13. This report analyzes new modifications of several component parts of the lifting mechanism for levels of stress and deflection. Not all components are analyzed, but the more critical components are evaluated. Free body diagrams are used to model the loaded components and the appropriate beam theory and stress analysis formula are used to compute stresses and deflection.

ASTM A516-70 low carbon steel is the material chosen to make the components. This is a high quality strength steel with a grain structure suitable for the intended applications of the BobbyJack.

The Engineering Design

Attached are referenced manufacturer drawings of the BobbyJack that show details of the design parametrics. See Figures 1, 2, and 3. The sizes and shapes of each BobbyJack component are shown along with an assembly drawing of the entire mechanism. The above referenced web site gives additional details and explanations of the installation and operation of the BobbyJack. There are limitations on the amount of weight or load that can be applied by the BobbyJack. These are represented in the specifications by the manufacturer.

The original engineering design of each BobbyJack has been tested for deflection and performance. This was accomplished on a test rack and witnessed and certified by a licensed professional engineer. As with any engineering design, there are limits to the application and design of the BobbyJack, and the user is referred to manufacturer for these limitations.

Engineering Analysis

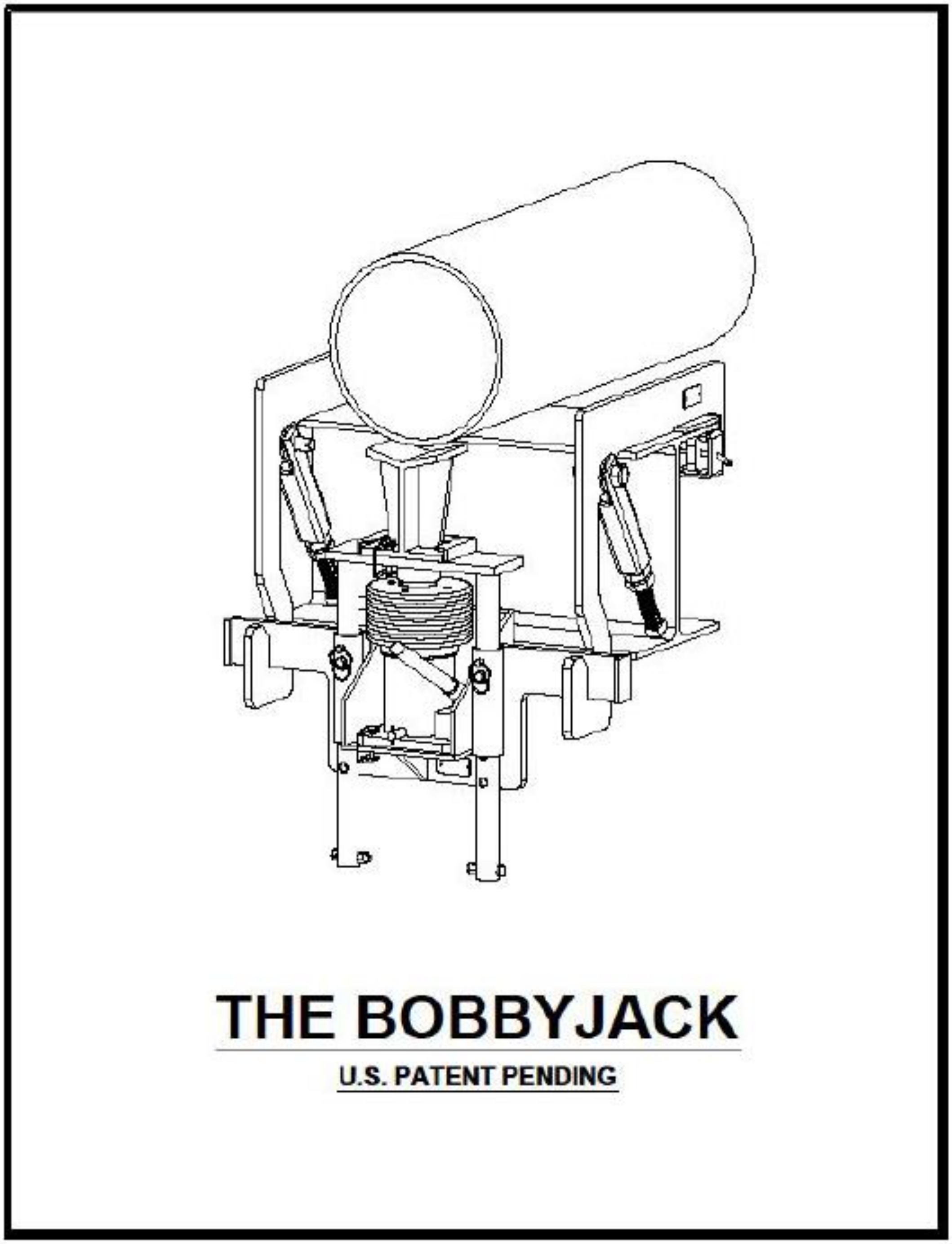
Following are engineering analyses of the new major load bearing components (arms and lifting extension) that are critical to the BobbyJack. The methodology used employs free body diagrams of the component parts with the applied loads and reactions. Loads up to 12000 lbs were considered for this analysis. Stress and deflection formulas are used to compute maximum stresses and maximum deflections. These values are compared to the yield and tensile strength of the ASTM A516 70 material.

Summary

Based on the above engineering review and analysis of the identified components of the BobbyJack with new design arms and a new lifting extension, the stress and deflection levels are within acceptable levels for the ASTM A516 70 material. The stress and deflection levels analyzed are within the elastic range of the subject material. As part of the material quality control, the manufacturer obtains MTR's for all components from the mill supplier.

The exact load being lifted by the Bobby Jack must be verified for the application of each lift prior to the lift.

User applications that exceed the load analysis of this report should contact the manufacturer for their application.



Assembled

Figure 1. Bobby Jack.

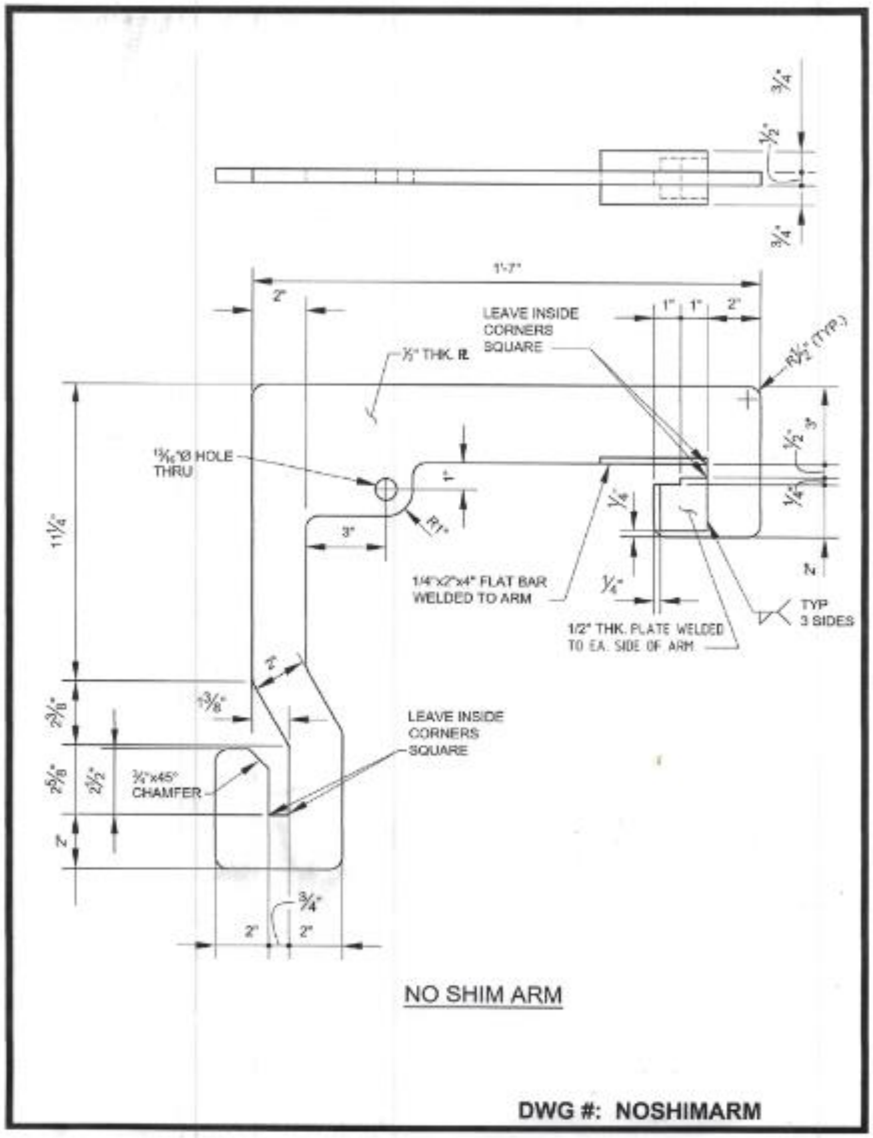
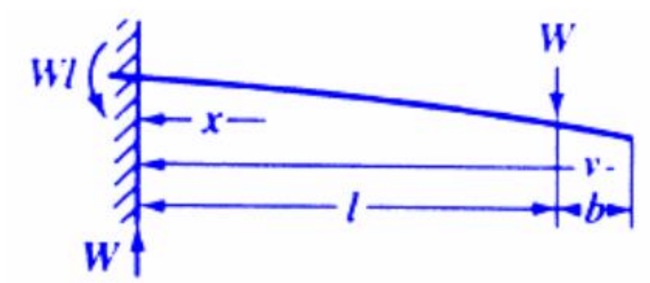


Figure 2. Support arm.

Figure 3. Bobby Jack OPS (offset pipe support).

<u>Stress and deflection analysis of arms that attach to I Beam and support jack mechanism</u>.



Beam Stress at specific point

$$s = \frac{W}{Z}(l - x)$$

Beam Stress at the support (must be constant cross section)

$$\frac{Wl}{Z}$$

Beam Deflection between support and load

$$y = \frac{Wx^2}{6EI}(3l - x)$$

Beam Deflection beyond load

$$y = \frac{Wl^2}{6EI}(3v - l)$$

Beam Deflection at load

$$\frac{Wl^3}{3EI}$$

Maximum Beam deflection at end

$$\frac{Wl^2}{6EI}(2l + 3b)$$

Modulus of Elasticity (lbs/in^2, N/mm^2) E =	30,000,000.0
Area Moment of Inertia (in^4, mm^4) *I* =	5.21
Load (lbs., N) W =	1286.00
Distance (in, mm) *l* =	10.000
Distance (in, mm) x =	0.000
Distance (in, mm) v =	10.000
Distance (in, mm) b =	0.000
Distance to neutral axis/plane (in, mm) z =	2.500
Results	
Stress at specific point (lbs/in^2, N/mm^2) s =	6170.825
Stress at support (lbs/in^2, N/mm^2) s =	6170.825
Deflection between support and load (in, mm) y =	0.0000
Deflection beyond load (in, mm) y =	0.0027
Deflection at load (in, mm) y =	0.0027
Maximum deflection at end (in, mm) y =	0.0027
Section Modulus (in^3, mm^3) Z =	2.084

Stress = 6170.825 psi **Material A 516 70**

Tensile Strength 70-90 ksi
Yield Strength 38 ksi

Safety Factor in Failure 70/6.170 = 11.3 Safety Factor in Tensile
38/6.170 = 6.1 Safety Factor over allowable

Stress and deflection analysis of support beam that supports cradle and jack-fixed end support.

Bobby Jack OPS (offset pipe support).

Modulus of Elasticity (lbs/in^2, N/mm^2) E =	30,000,000.0
Area Moment of Inertia (in^4, mm^4) *I* =	0.42
Load (lbs., N) W =	1000.00
Distance (in, mm) *l* =	5.000
Distance (in, mm) x =	0.000
Distance (in, mm) v =	5.000
Distance (in, mm) b =	0.000
Distance to neutral axis/plane (in, mm) z =	0.938
Results	
Stress at specific point (lbs/in^2, N/mm^2) s =	11166.667
Stress at support (lbs/in^2, N/mm^2) s =	11166.667
Deflection between support and load (in, mm) y =	0.0000
Deflection beyond load (in, mm) y =	0.0033
Deflection at load (in, mm) y =	0.0033
Maximum deflection at end (in, mm) y =	0.0033
Section Modulus (in^3, mm^3) Z =	0.448

Design Variables	
Modulus of Elasticity (lbs/in^2, N/mm^2) E =	30,000,000.0
Area Moment of Inertia (in^4, mm^4) *I* =	0.42
Load (lbs., N) W =	1200.00
Distance (in, mm) *l* =	4.000
Distance (in, mm) x =	0.000
Distance (in, mm) v =	5.000
Distance (in, mm) b =	1.000
Distance to neutral axis/plane (in, mm) z =	0.938
Results	
Stress at specific point (lbs/in^2, N/mm^2) s =	10720.000
Stress at support (lbs/in^2, N/mm^2) s =	10720.000
Deflection between support and load (in, mm) y =	0.0000
Deflection beyond load (in, mm) y =	0.0028
Deflection at load (in, mm) y =	0.0020
Maximum deflection at end (in, mm) y =	0.0028
Section Modulus (in^3, mm^3) Z =	0.448

Recommended support position for OPS is 4 inches from edge of support beam.

Design Variables	
Modulus of Elasticity (lbs/in^2, N/mm^2) E =	30,000,000.0
Area Moment of Inertia (in^4, mm^4) I =	0.42
Load (lbs., N) W =	1000.00
Distance (in, mm) l =	4.000
Distance (in, mm) x =	0.000
Distance (in, mm) v =	5.000
Distance (in, mm) b =	1.000
Distance to neutral axis/plane (in, mm) z =	0.938
Results	
Stress at specific point (lbs/in^2, N/mm^2) s =	8933.333
Stress at support (lbs/in^2, N/mm^2) s =	8933.333
Deflection between support and load (in, mm) y =	0.0000
Deflection beyond load (in, mm) y =	0.0023
Deflection at load (in, mm) y =	0.0017
Maximum deflection at end (in, mm) y =	0.0023
Section Modulus (in^3, mm^3) Z =	0.448

Tensile Strength 70-90 ksi
Yield Strength 38 ksi

Safety Factor in Failure 70/8.93 = 7.8 Safety Factor in Tensile
38/8.93 = 4.3 Safety Factor over yield