MAE 4300 Design Project

Introduction

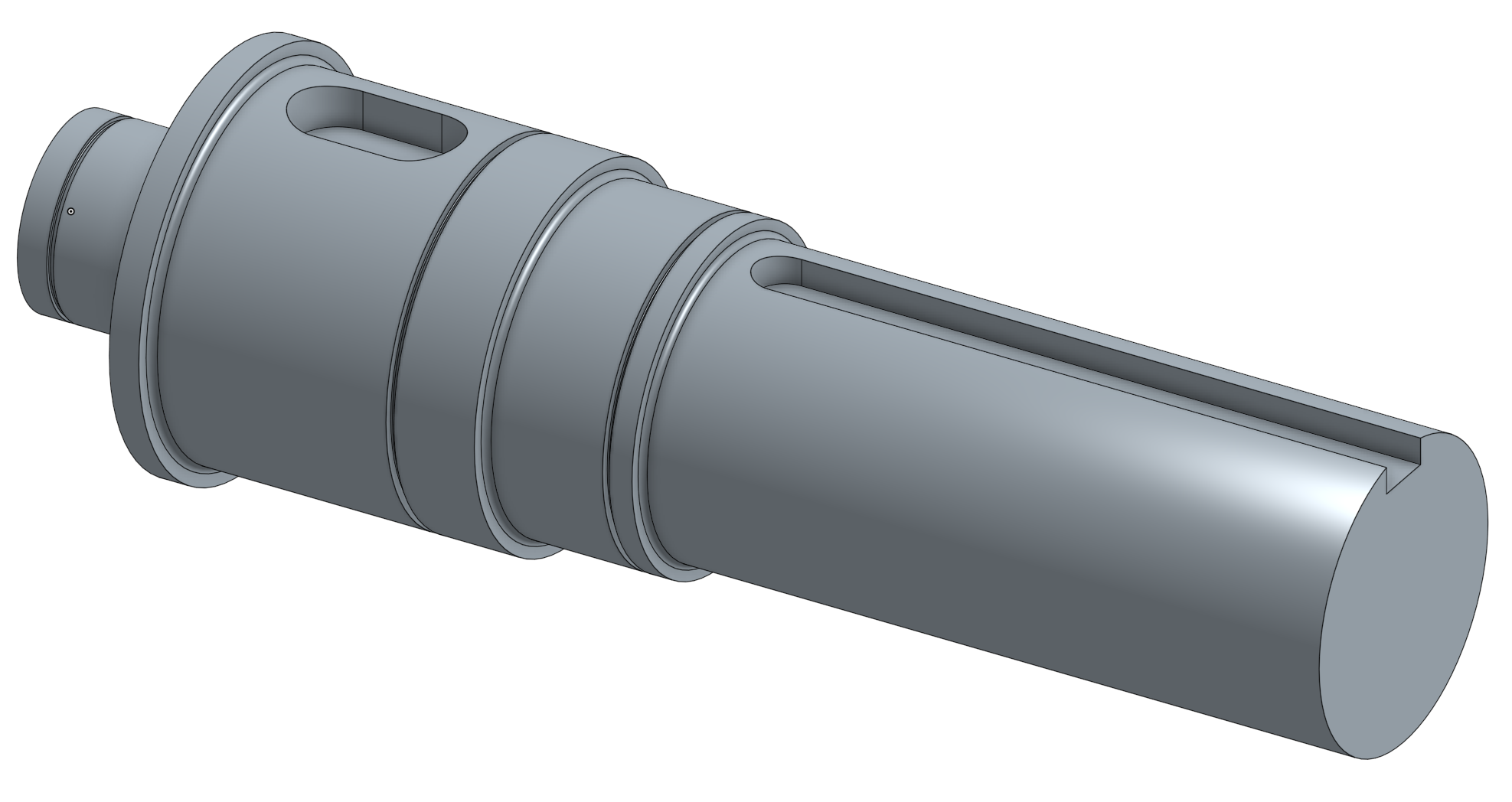
The purpose of this design report is to analyze the output shaft of a gear box. The system was geared such that 720.29 in\*lbf torque would result in 14586 in\*lbf output torque. To do so, it required four gears and three shafts. The objective of this report was to analyze the last of the three shafts in the gear box and determine proper dimensions such that the safety factor of each feature on the shaft would be above 1.5. A major goal is to minimize diameters but retain the necessary strength as well as reaching maximum fatigue life.

There are many obstacles to overcome when developing a reliable output shaft. First the internal forces were found by determining the resulting forces acting on the shaft. A bearing must be fitted to the shaft that can withstand the static bearing force, and from that bearing a diameter can be determined for those points on the shaft. The bearings that were selected were two cylindrical roller bearings NF208 and NF214. Those diameters set the presidents for the safety factors in the shaft as the diameters are determined for each point on the shaft I through R (see Fig 3). Iterations of calculations are made to determine those diameters.

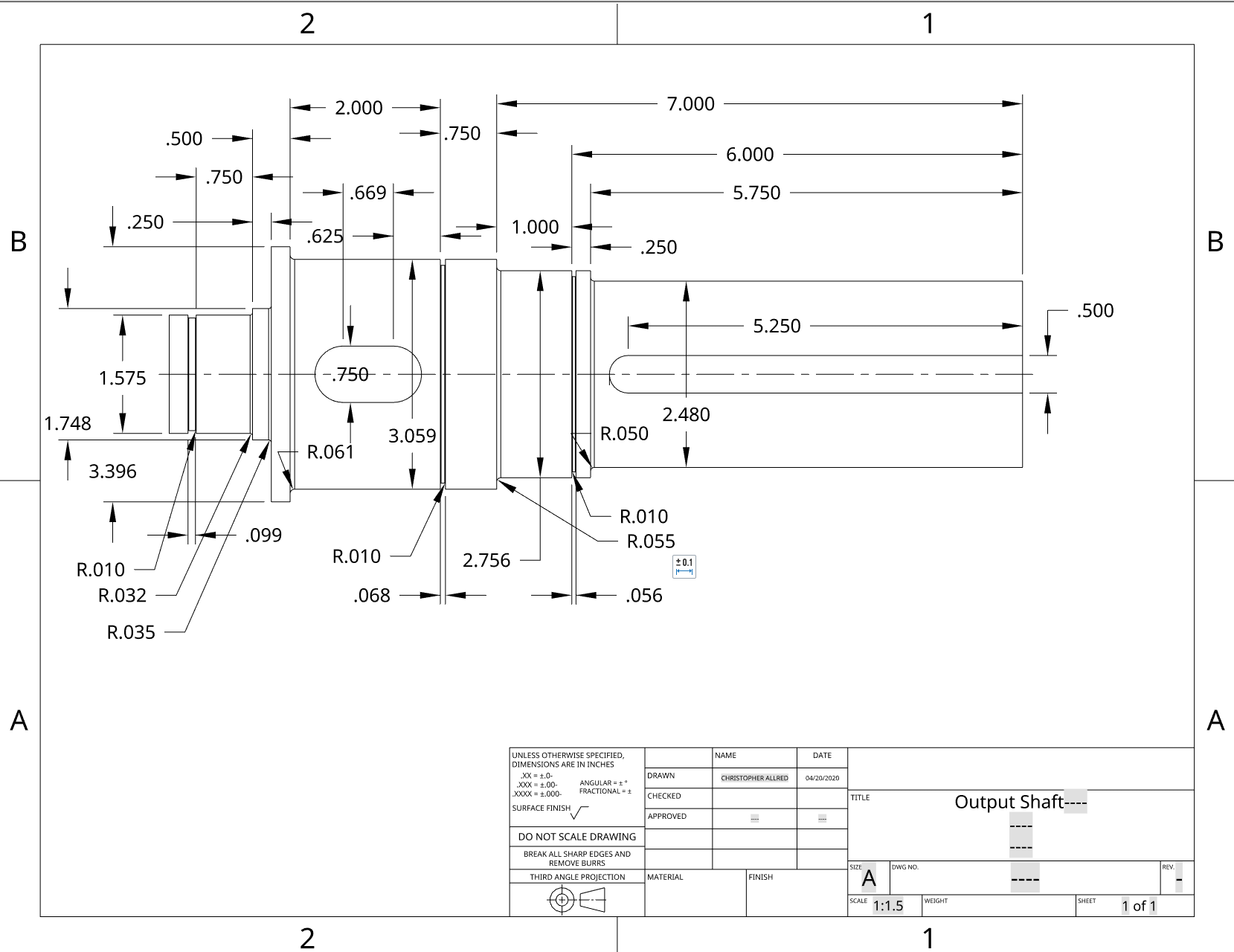
After finding the diameter, keys materials and dimensions must be determined as well as the dimensions for the key seat. It is inportant that the key has a lower yield strength then the host material as it needs to be designed to fail before causing damage to the shaft.

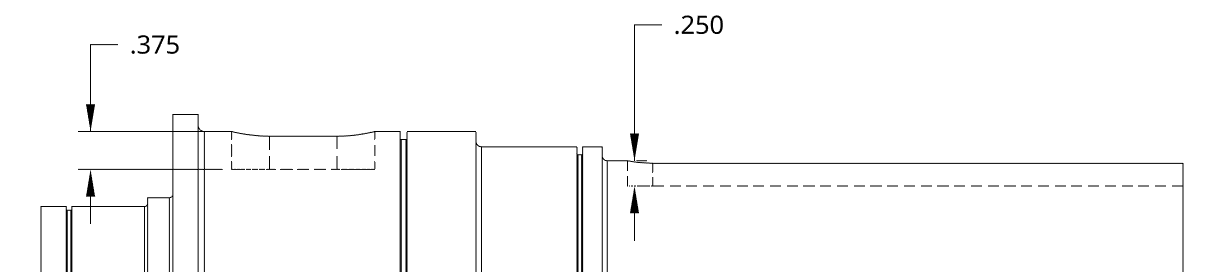
Finally, three retaining rings need to be specified to hold the bearings and gear in place. The retaining rings must be fitted to the portion of the shaft that it is designed for. The retaining rings that were chosen are as follows WS-318, WS-256, and WS-162.

Output Shaft Design



**Figure 1: 3D Isometric view of the shaft**

**Figure 2: 2D drawing of the shaft**



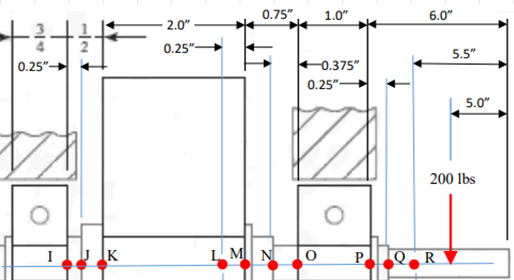
L

.R

🡪A🡨 Bearing locations 🡪B🡨

I . J. .K .G M . .N .O . P.Q

**Figure 3: A sketch of the shaft labeling analysis points**



**Figure 4: More detailed sketch of the shaft labeling analysis points**

**Table 1: Shaft properties of moments and torques at each point on the shaft**

|  |  |  |
| --- | --- | --- |
|  | Moment (in\* lbf) | Torque (in\*lbf) |
| I | 539.11 | 0 |
| J | 898.5243 | 0 |
| K | 1257.9341 | 0 |
| G | 2695.573 | 14586 |
| L | 1838.001 | 14586 |
| M | 1553.93 | 14586 |
| N | 1131.8152 | 14586 |
| O | 721.9903 | 14586 |
| P | 200 | 14586 |
| Q | 150 | 14586 |
| R | 100 | 14586 |

**Table 2: Stating Selected Diameters**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Selected Diameters (in) | | | | | | |
| D1 | D2 | D3 | D4 | D5 | D6 | D7 |
| 1.5748 | 1.748 | 3.3955 | 3.059 | 3.059 | 2.7559 | 2.48 |

**Table 2: Listing all the safety factors at points on the shaft**

|  |  |  |
| --- | --- | --- |
| Safety Factors | Against Fatigue | Against Yielding |
| I | 7.8 | 11.162 |
| J | 8.98 | 13.001 |
| K | 21.01 | 32.99 |
| L | 17.48 | 27.448 |
| M | 2.635 | 3.85 |
| N | 7.03 | 4.519 |
| O | 4.24 | 2.597 |
| P | 3.85 | 2.196 |
| Q | 3.55 | 2.002 |
| R | 2.76 | 1.54 |

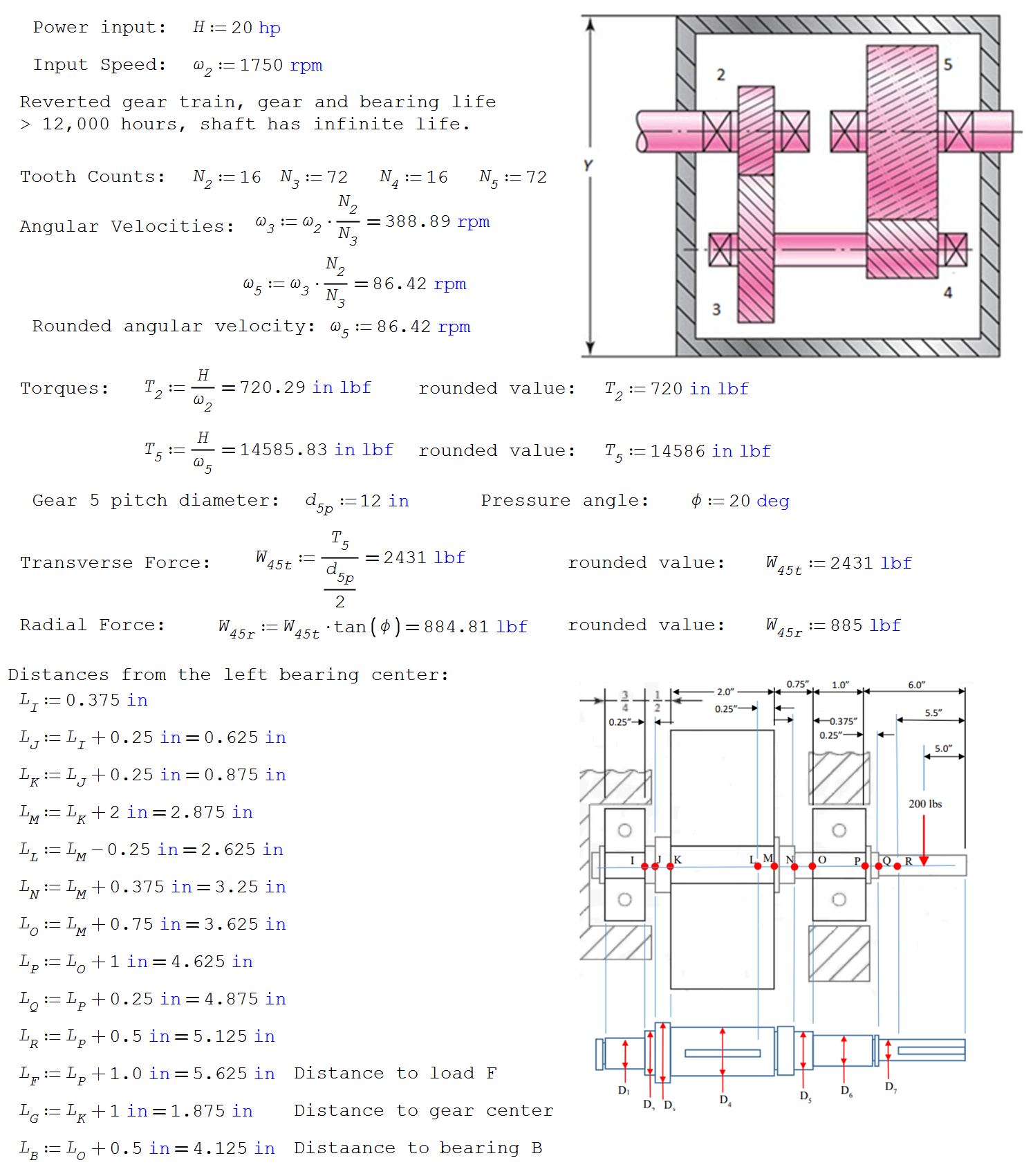
**Table 3: Computed; bearing, reaction forces, C10 loads, and bearing type**

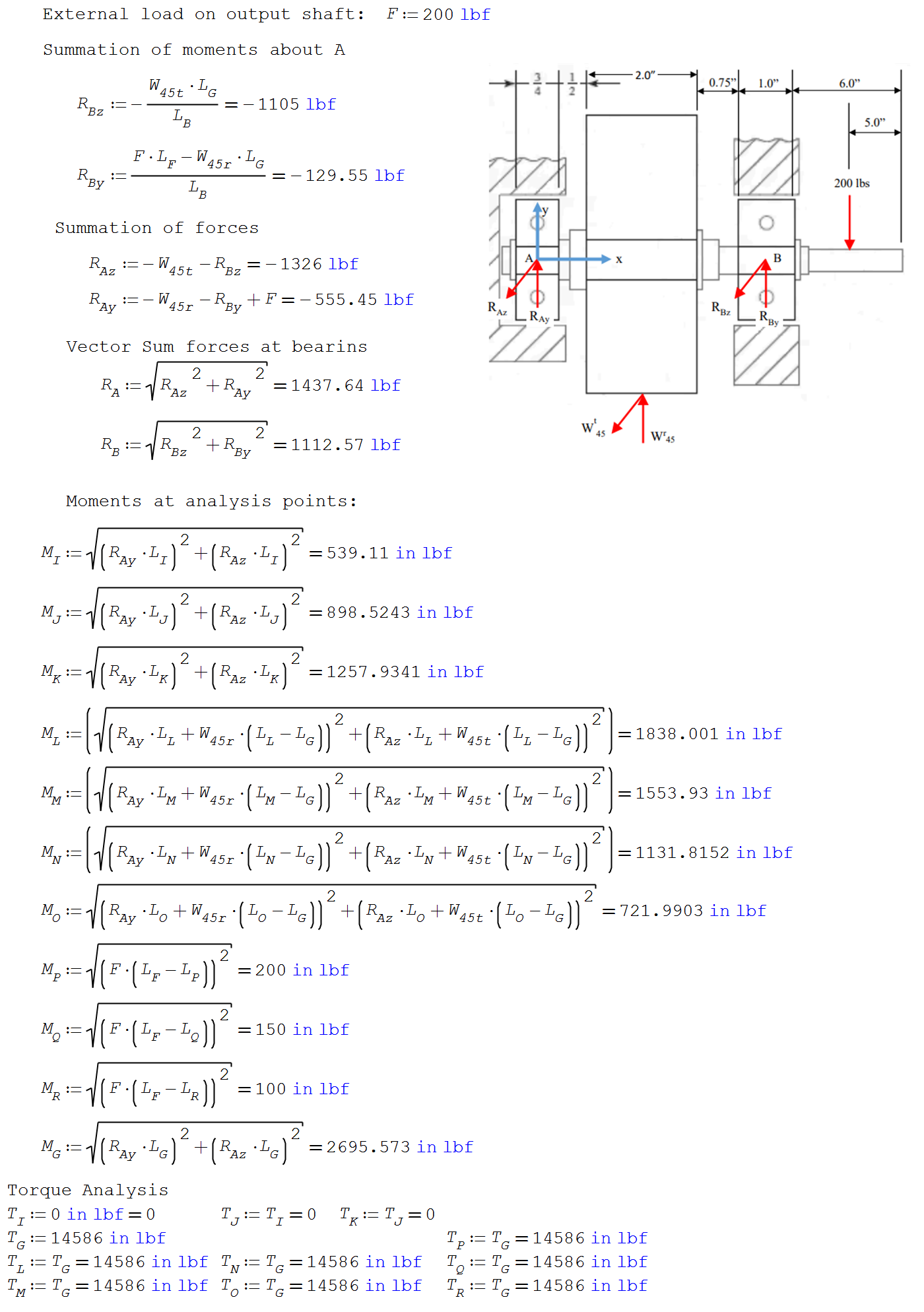
|  |  |  |  |
| --- | --- | --- | --- |
| Location | Reaction Forces (lbf) | C10 (lbf) | Bearing Type: |
| A | 1437.639 | 7822.5859 | Cylindrical Roller Bearing |
| B | 1112.5678 | 6053.7848 | Cylindrical Roller Bearing |

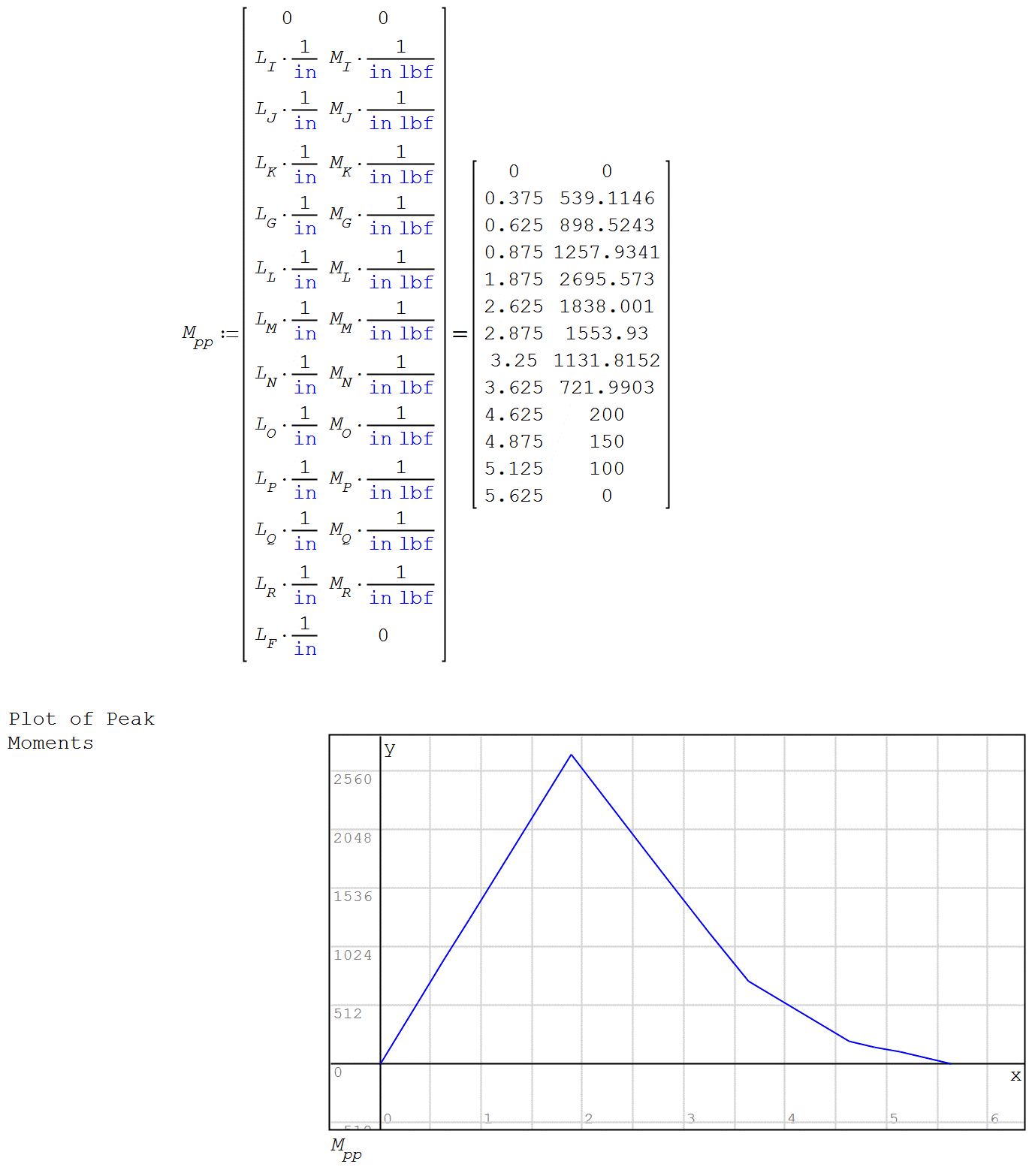
**Table 4: Gear, Shaft key material, and dimensions**

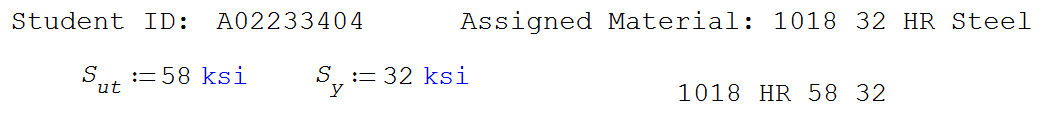
|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Feature | Material Name | Yield Strength (ksi) | Hight (in) | Width (in) | Length (in) | Death (in) |
| Key 1 | 1020 CD | 57 | ¾ | ¾ | 0.6692 | 3/8 |
| Key 2 | 1015 HR | 27.5 | 5/8 | 5/8 | 2.0806 | 5/16 |
| Gear | Not required by | contracted rubric | \*\*\* | \*\*\* | \*\*\* | \*\*\* |

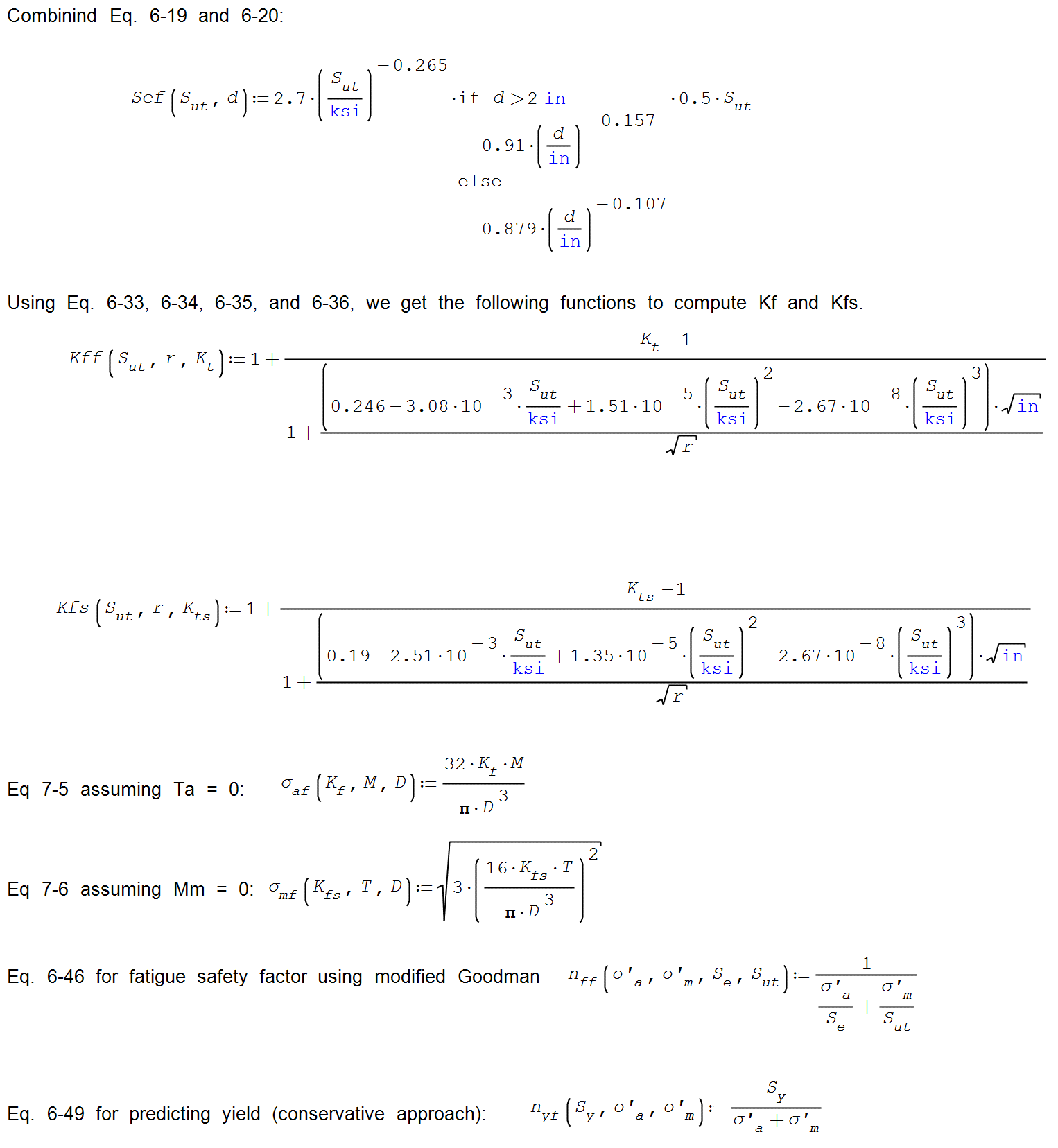
Calculations



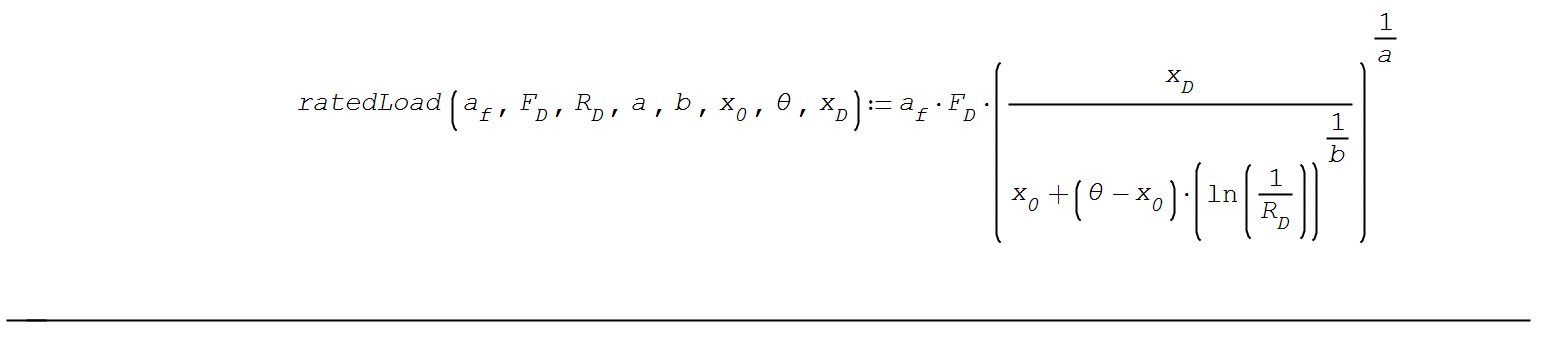










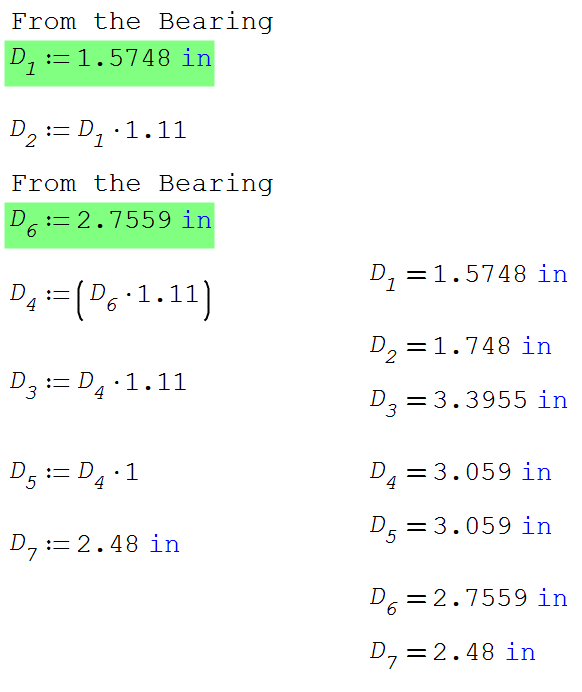


Point Calculations

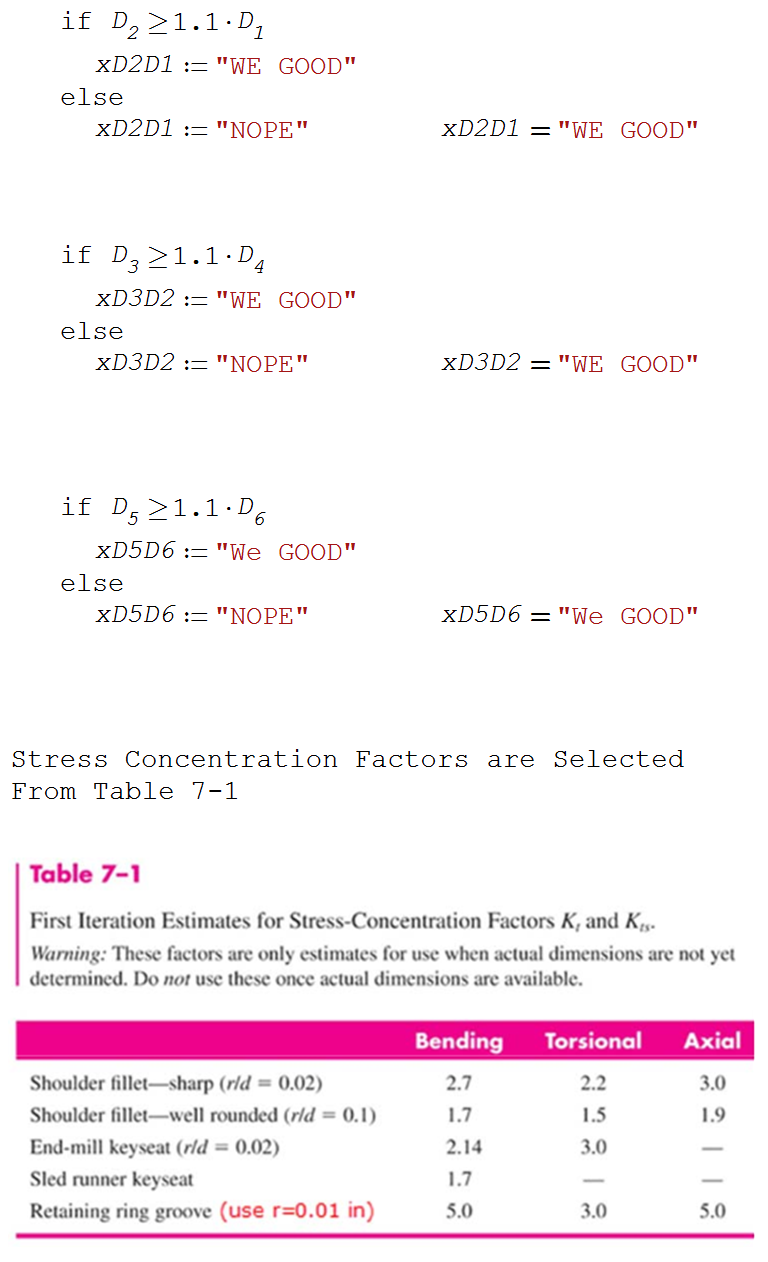
The diameter for bearing 1 at D1 is 1.5748 in

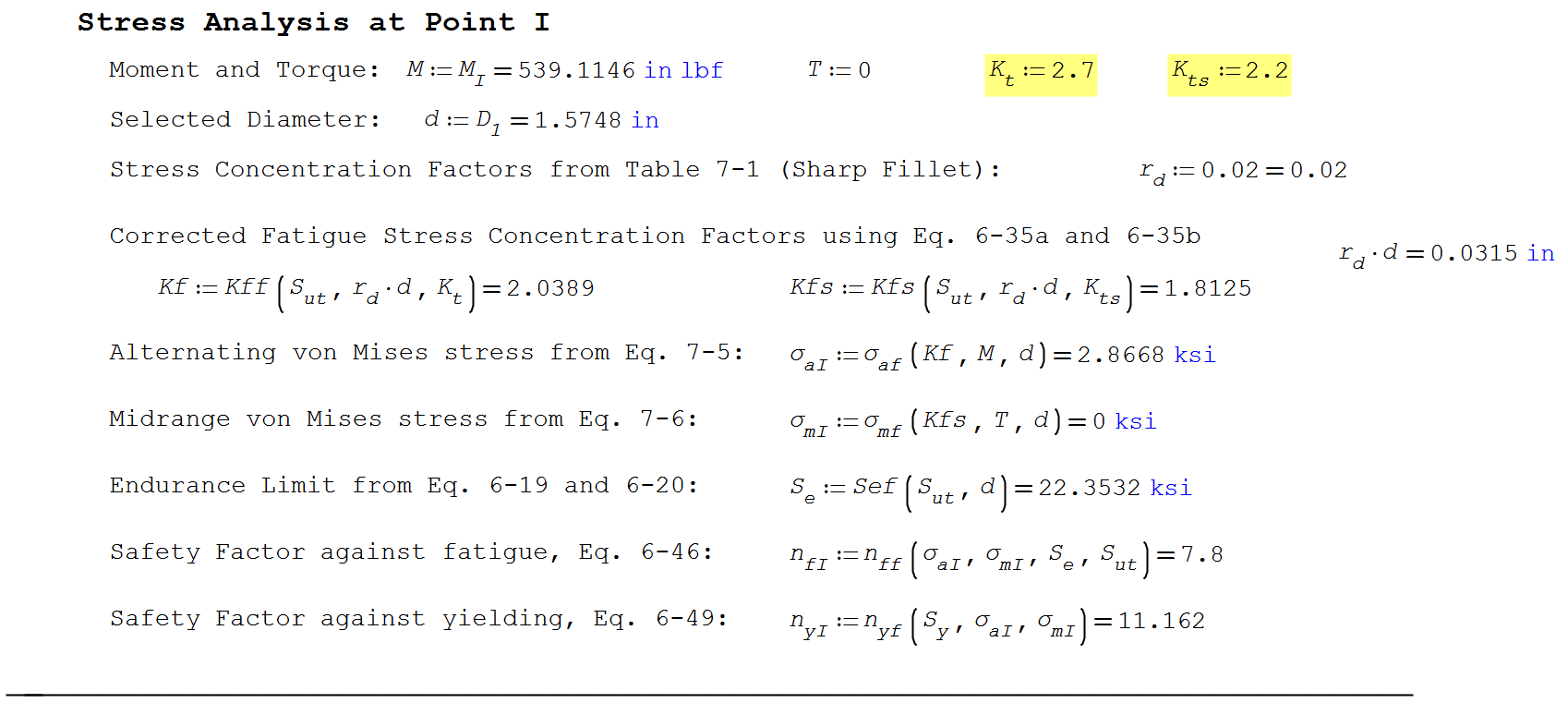
The diameter for bearing 2 at D6 is 2.7559 in

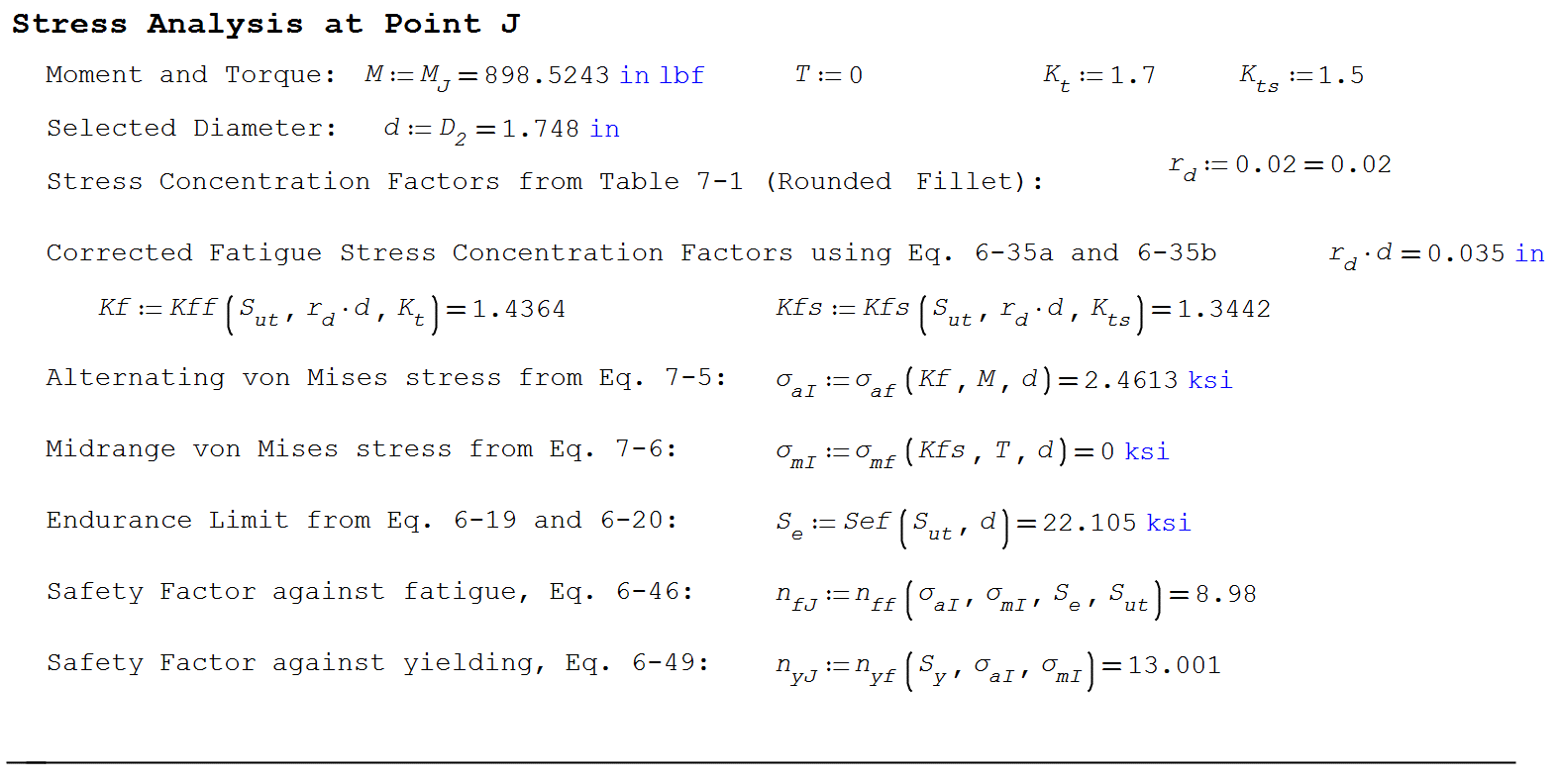
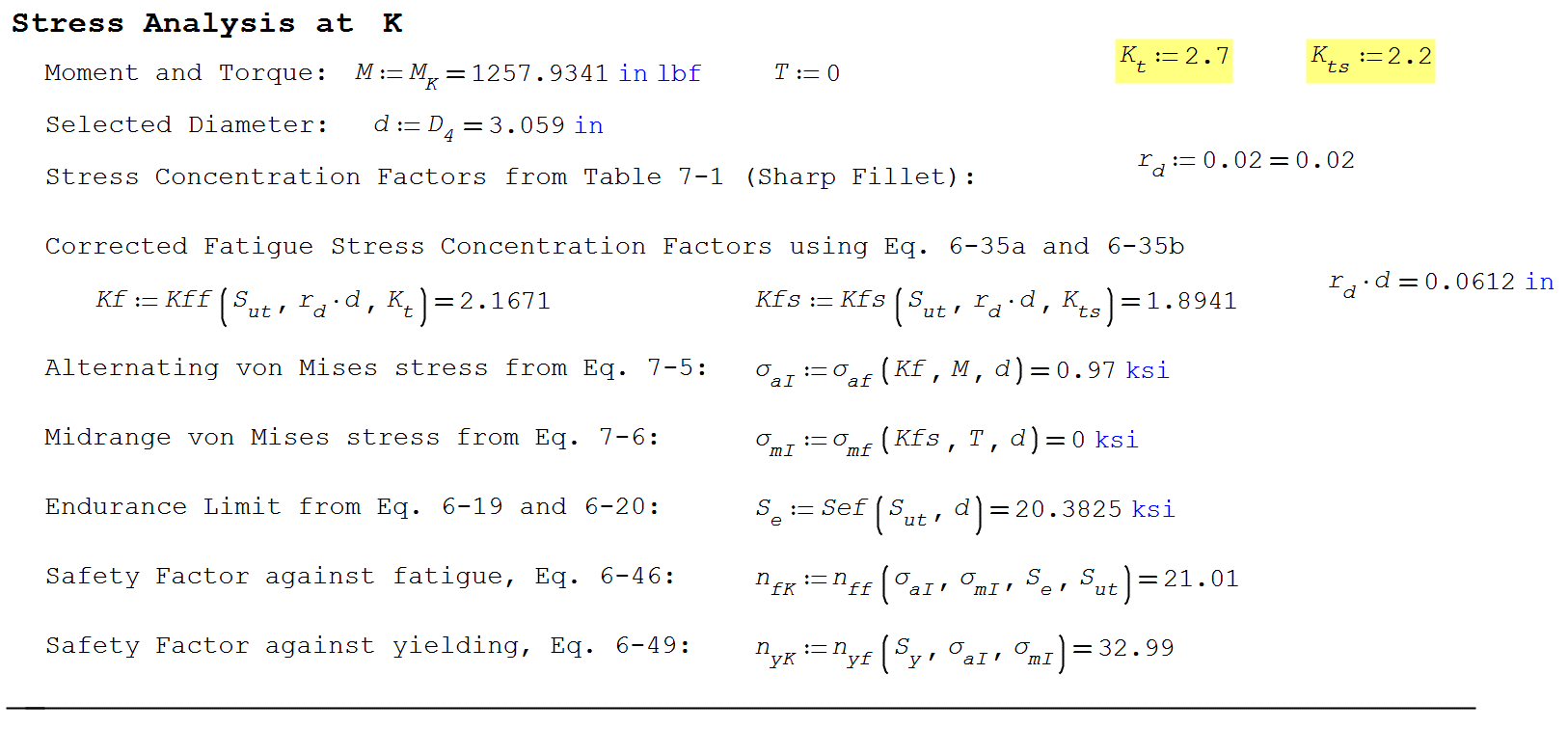
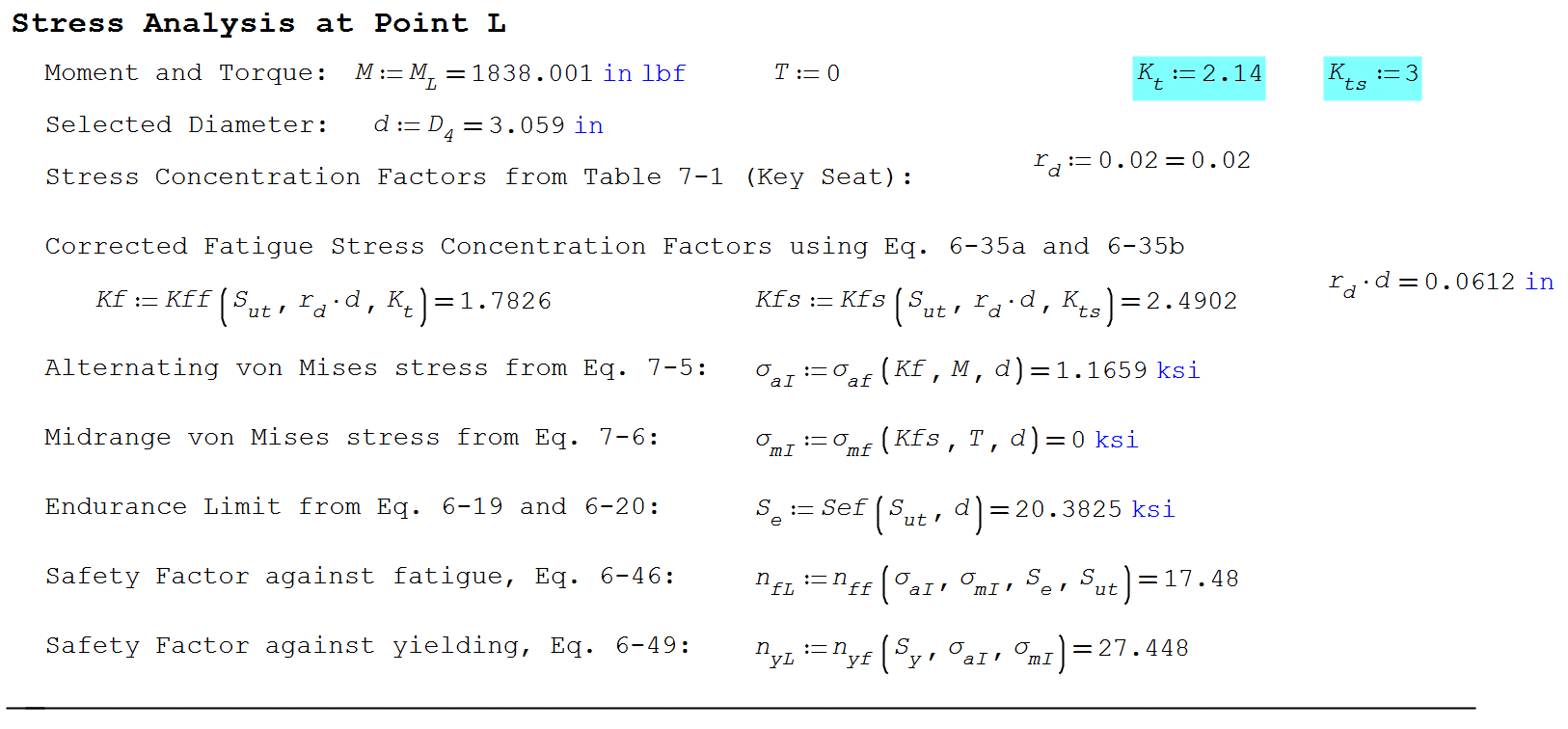
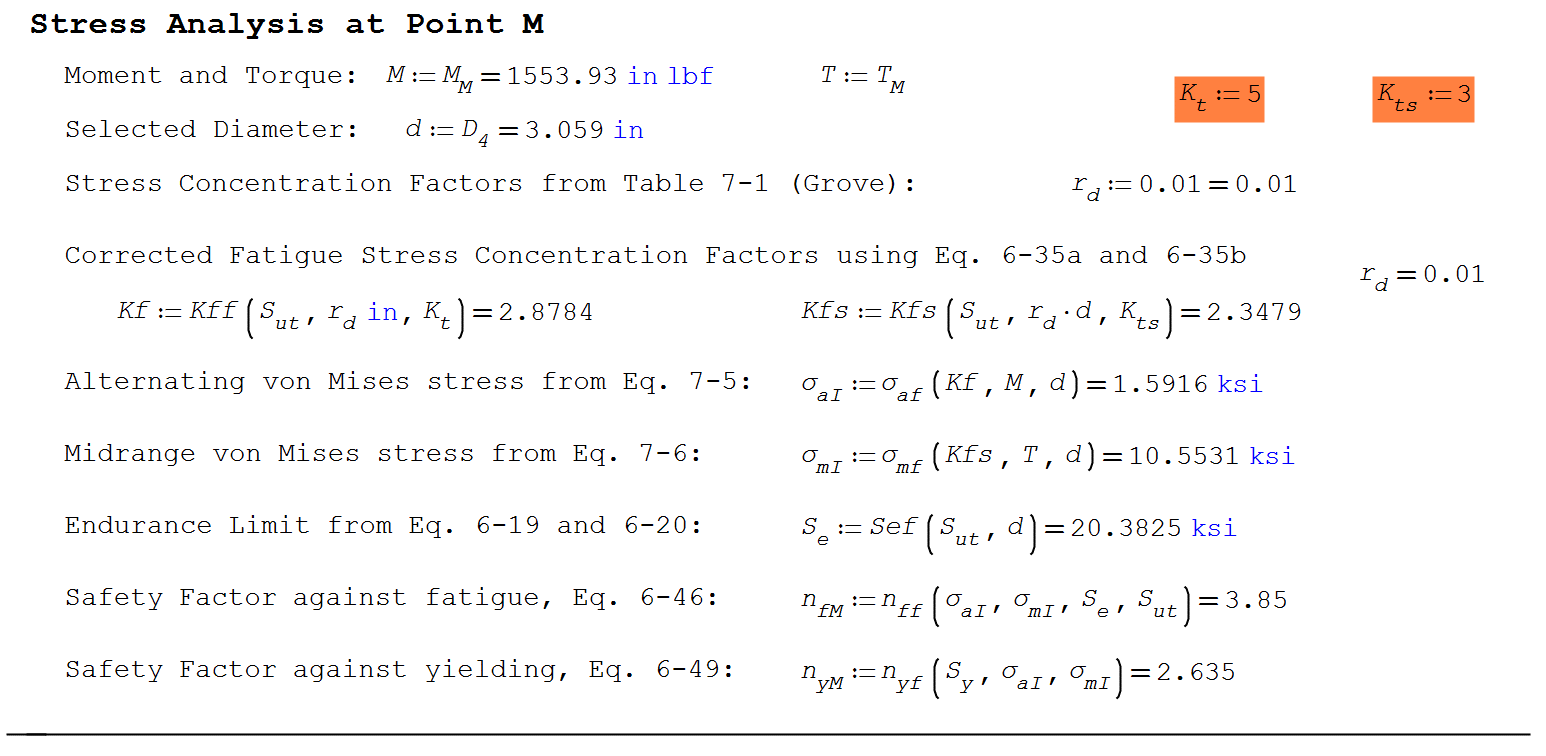
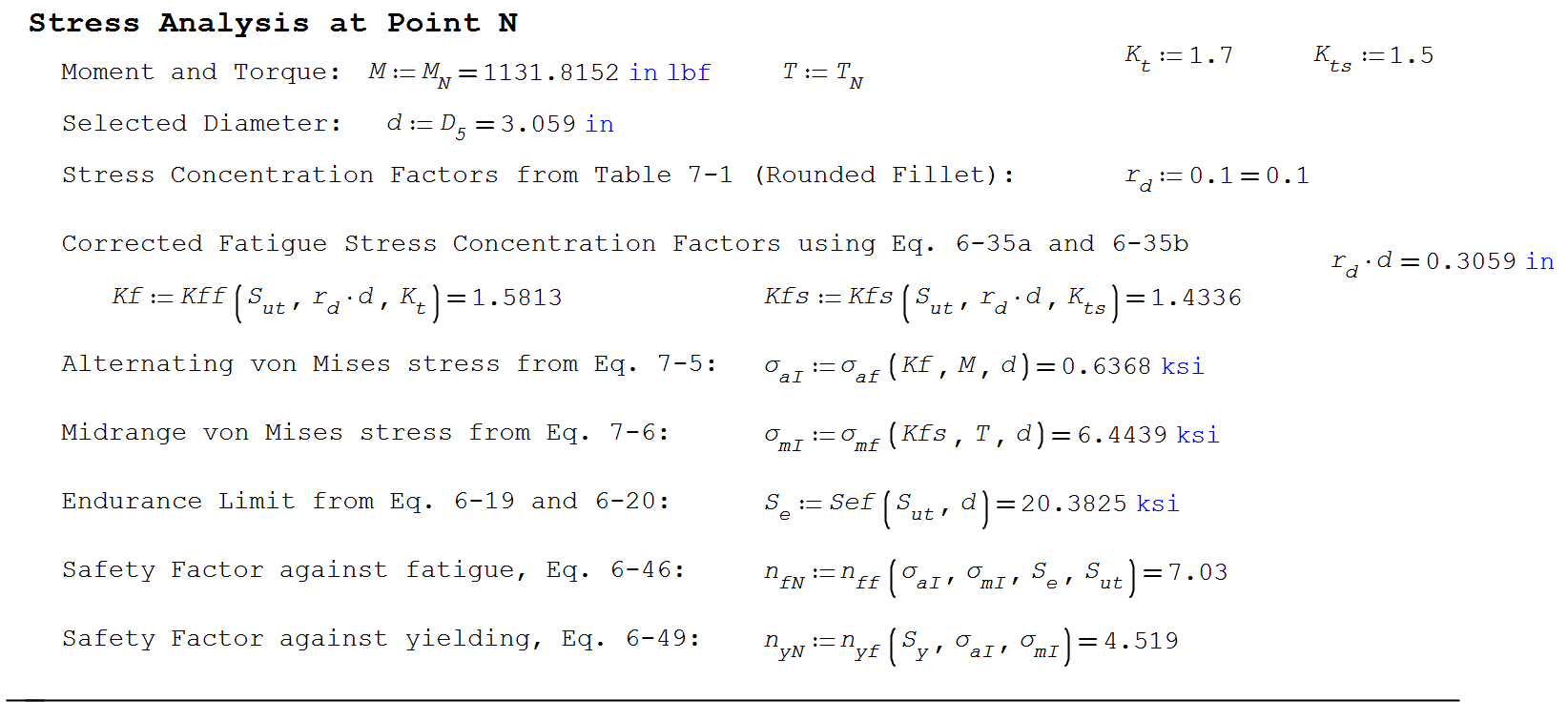
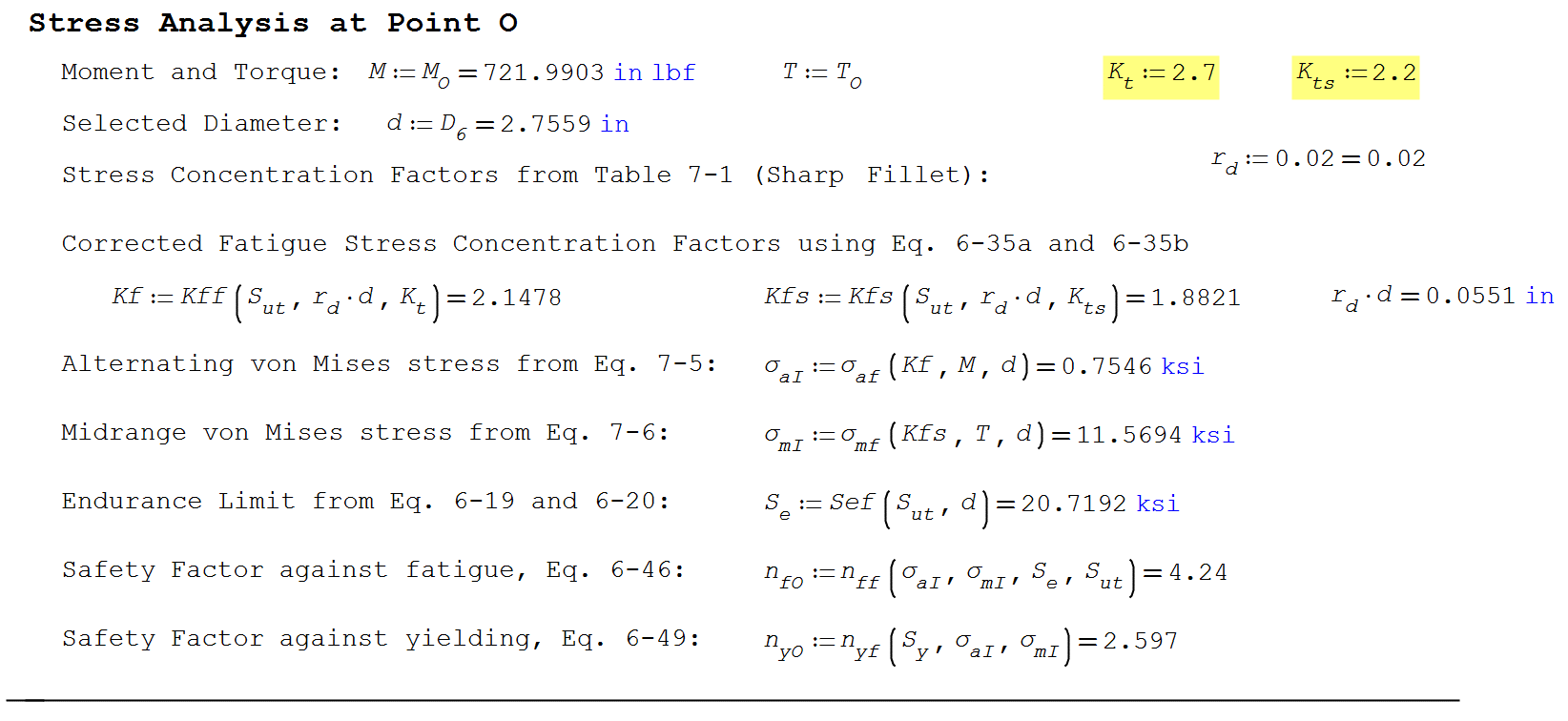
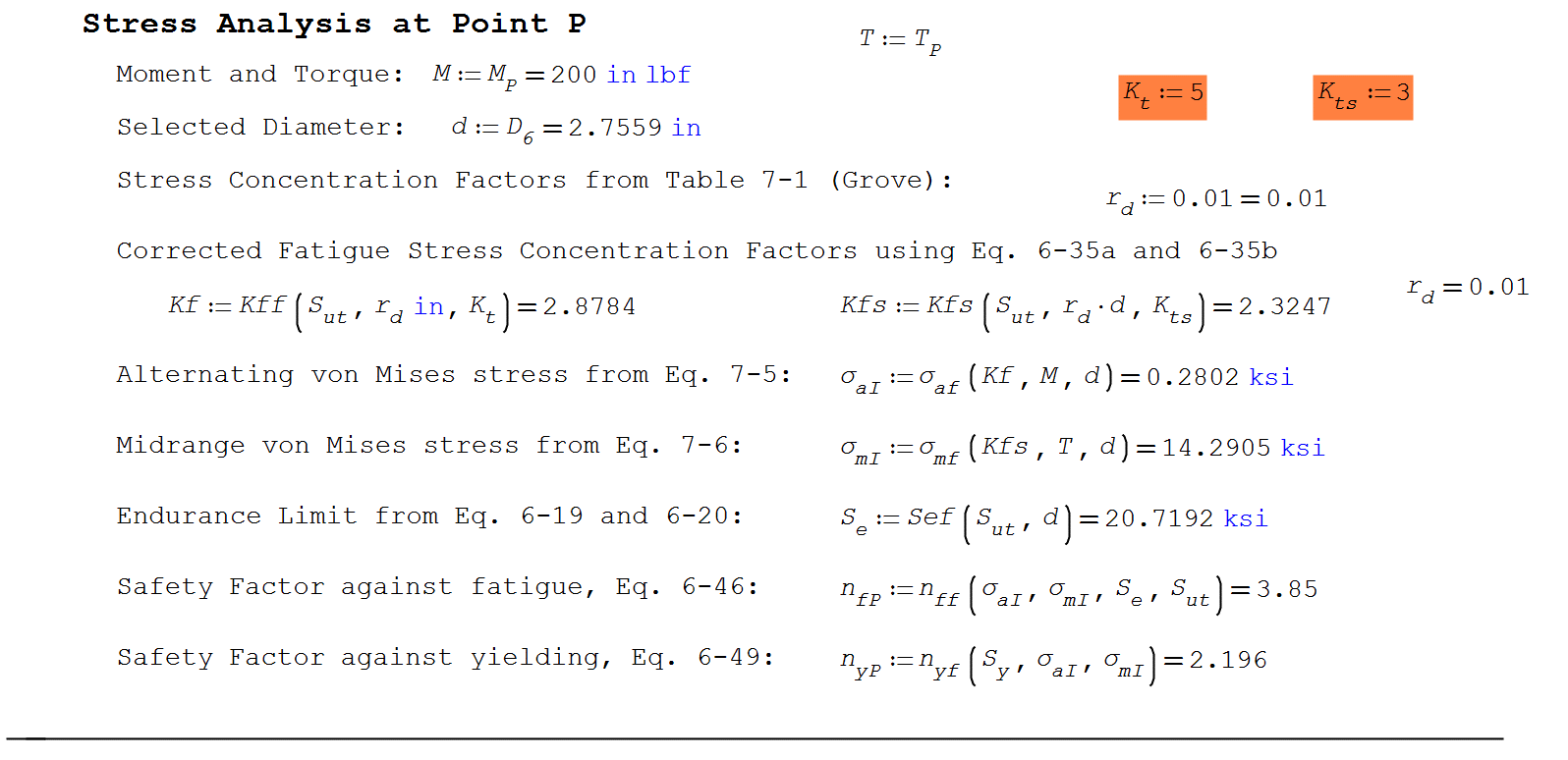
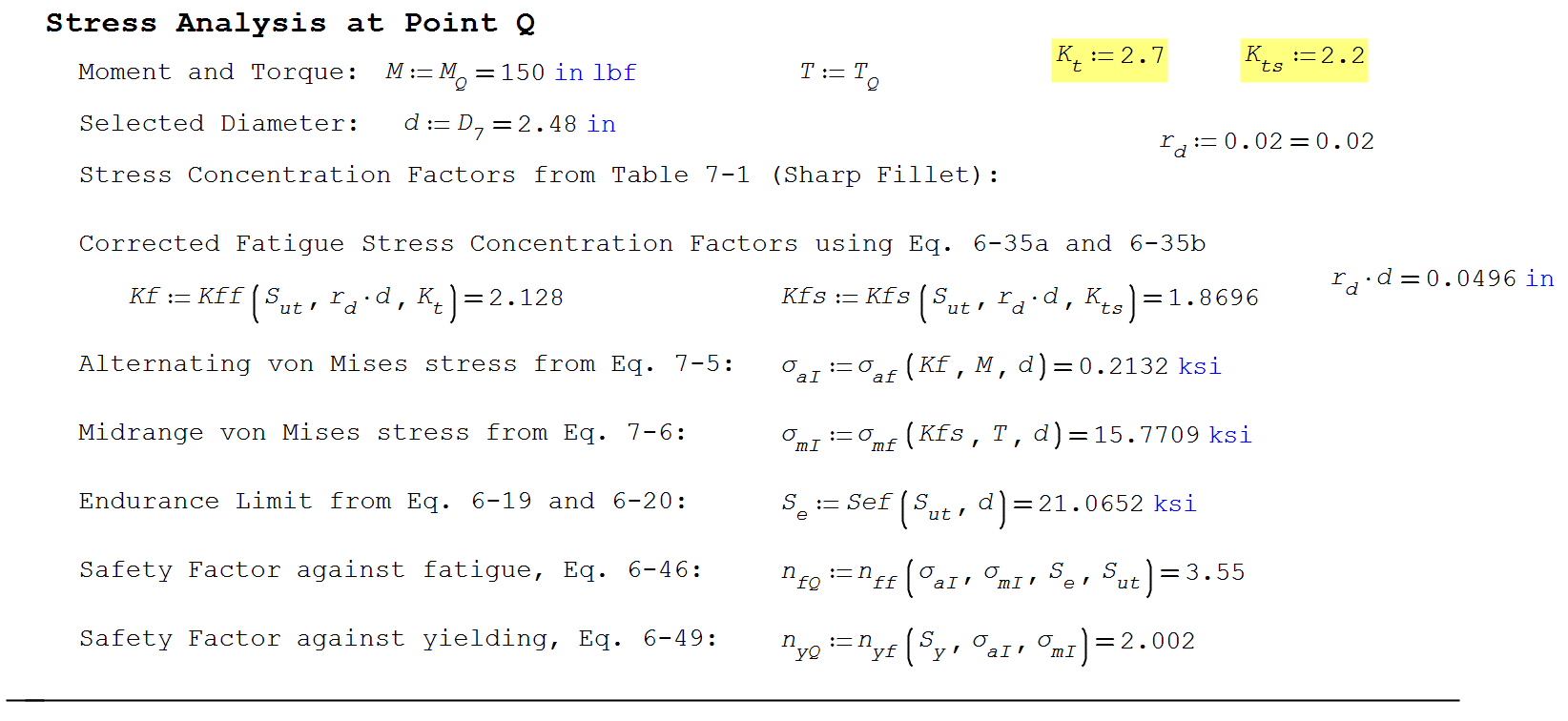
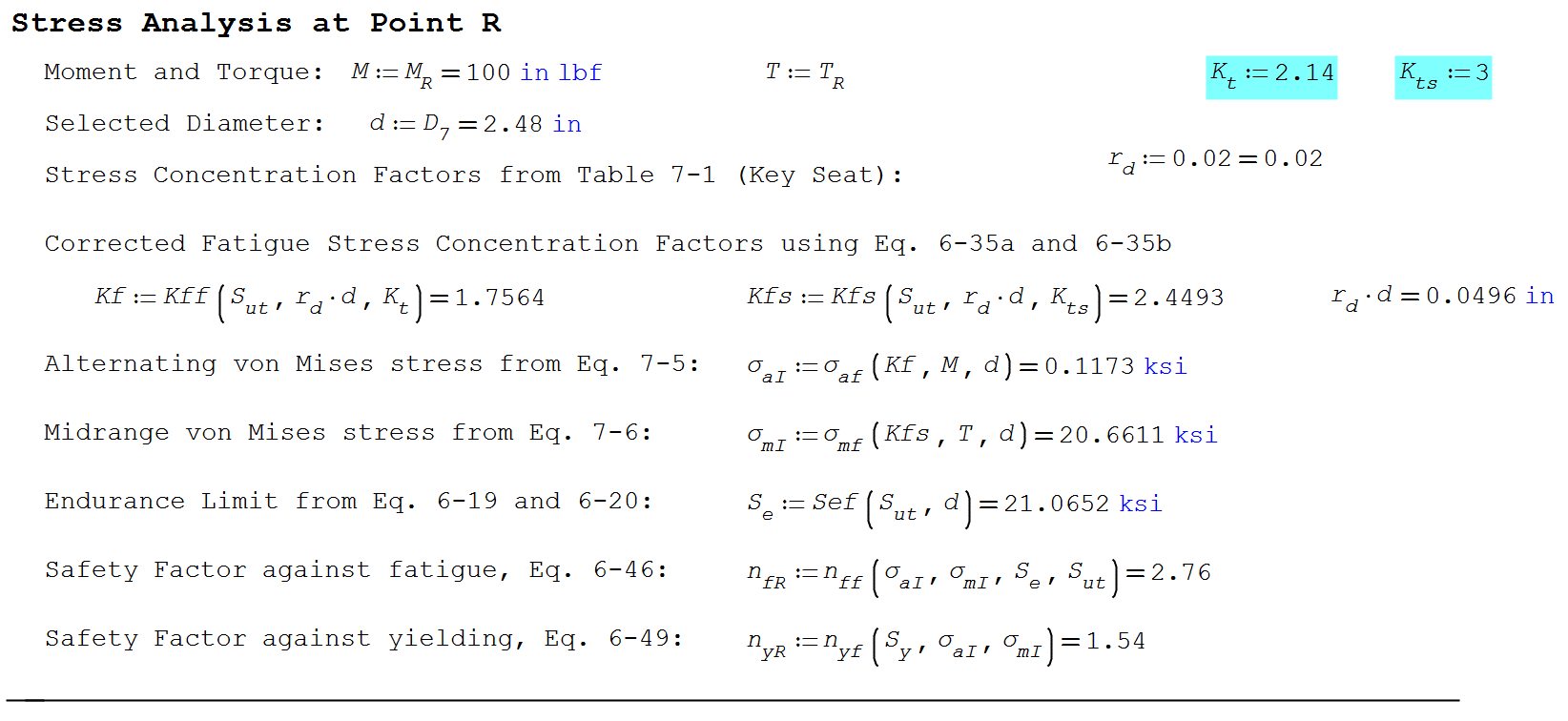
The rest of the bearings are calculated by guess and check

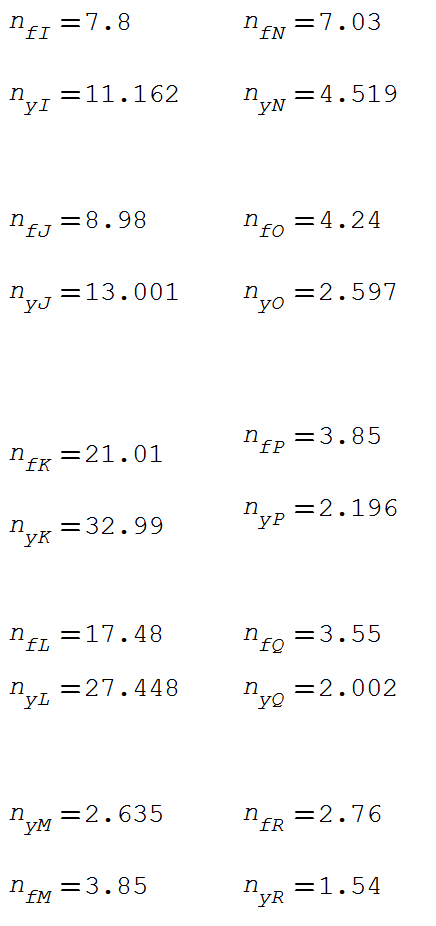
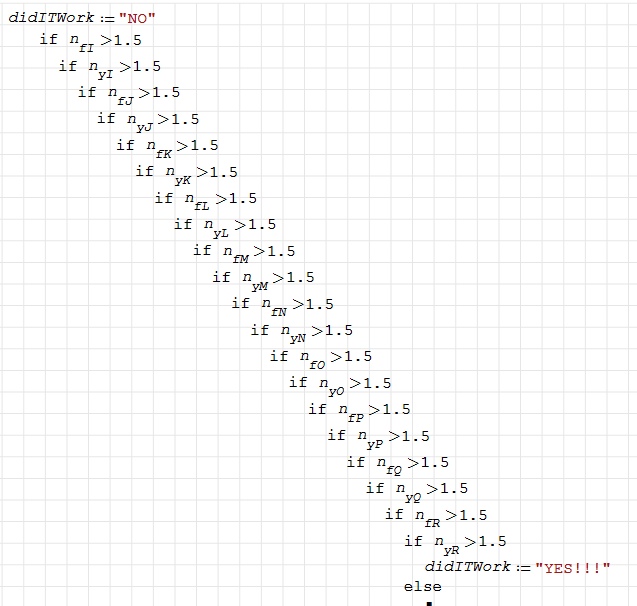


This is the Logic code to help:



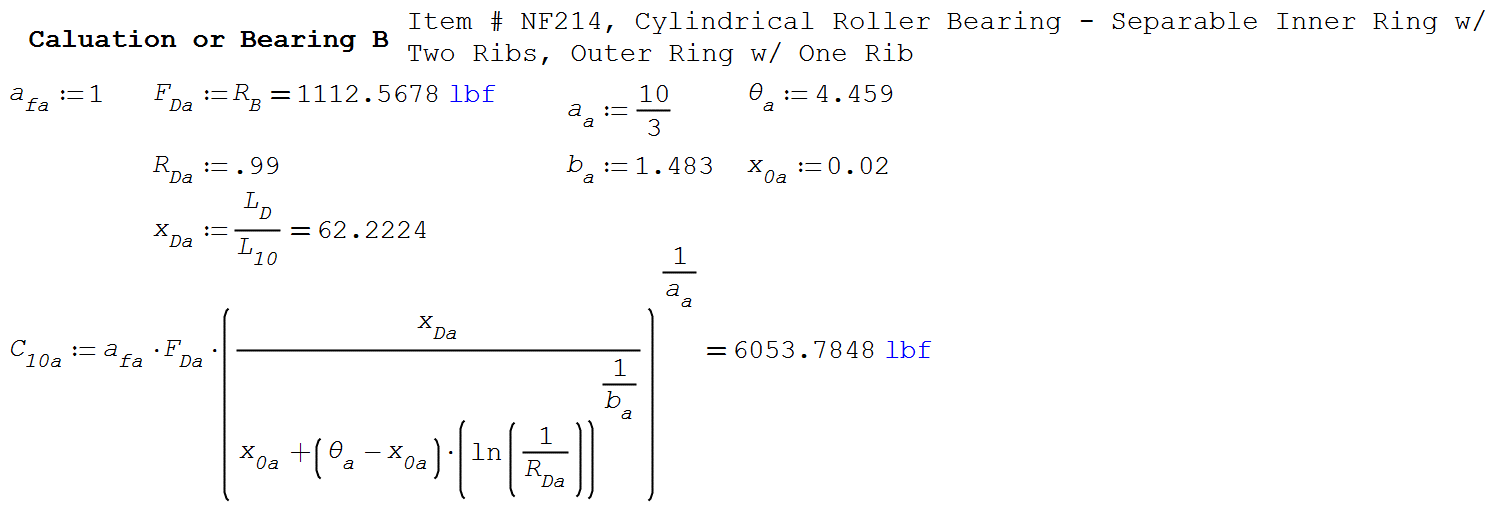
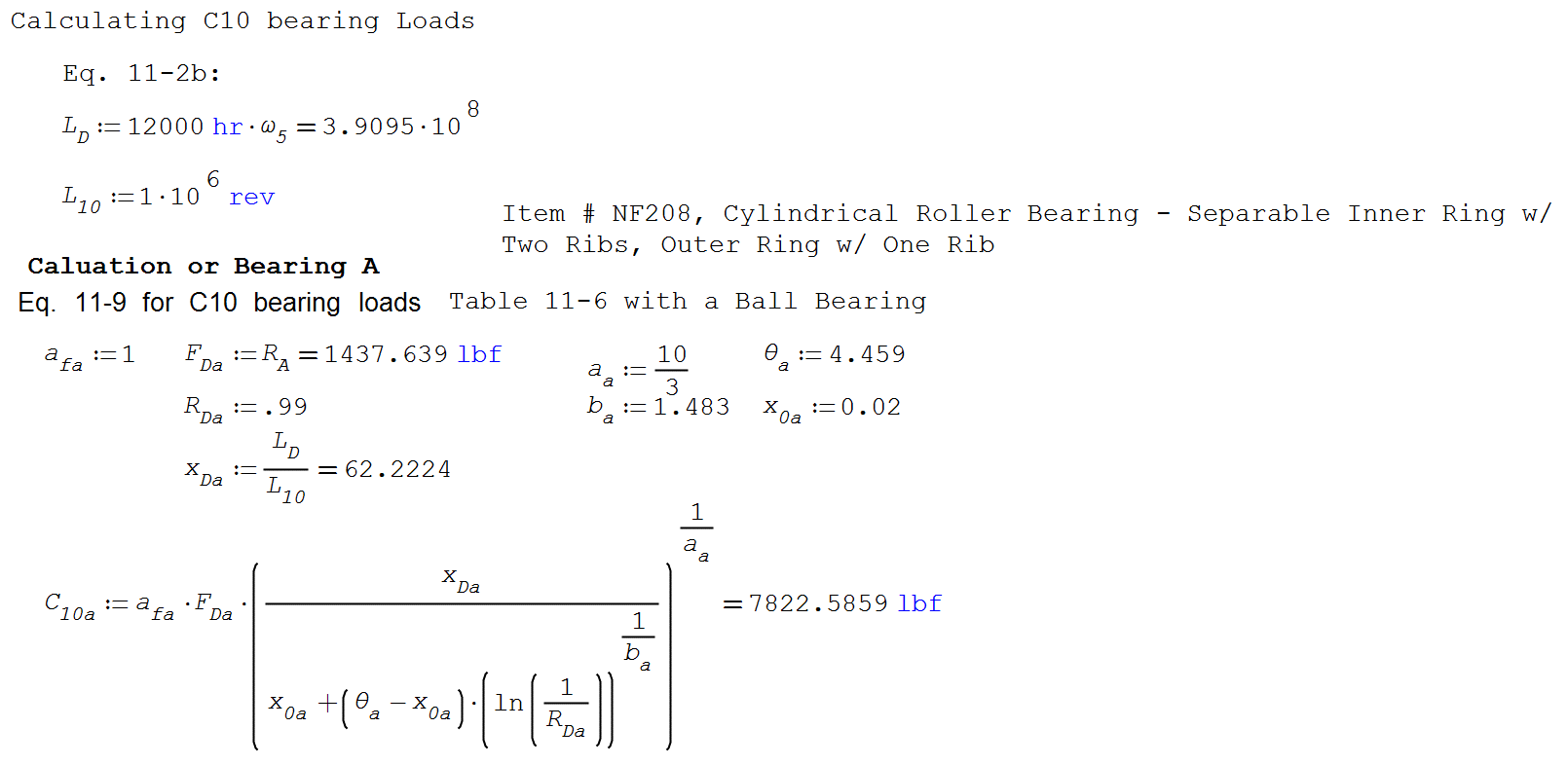


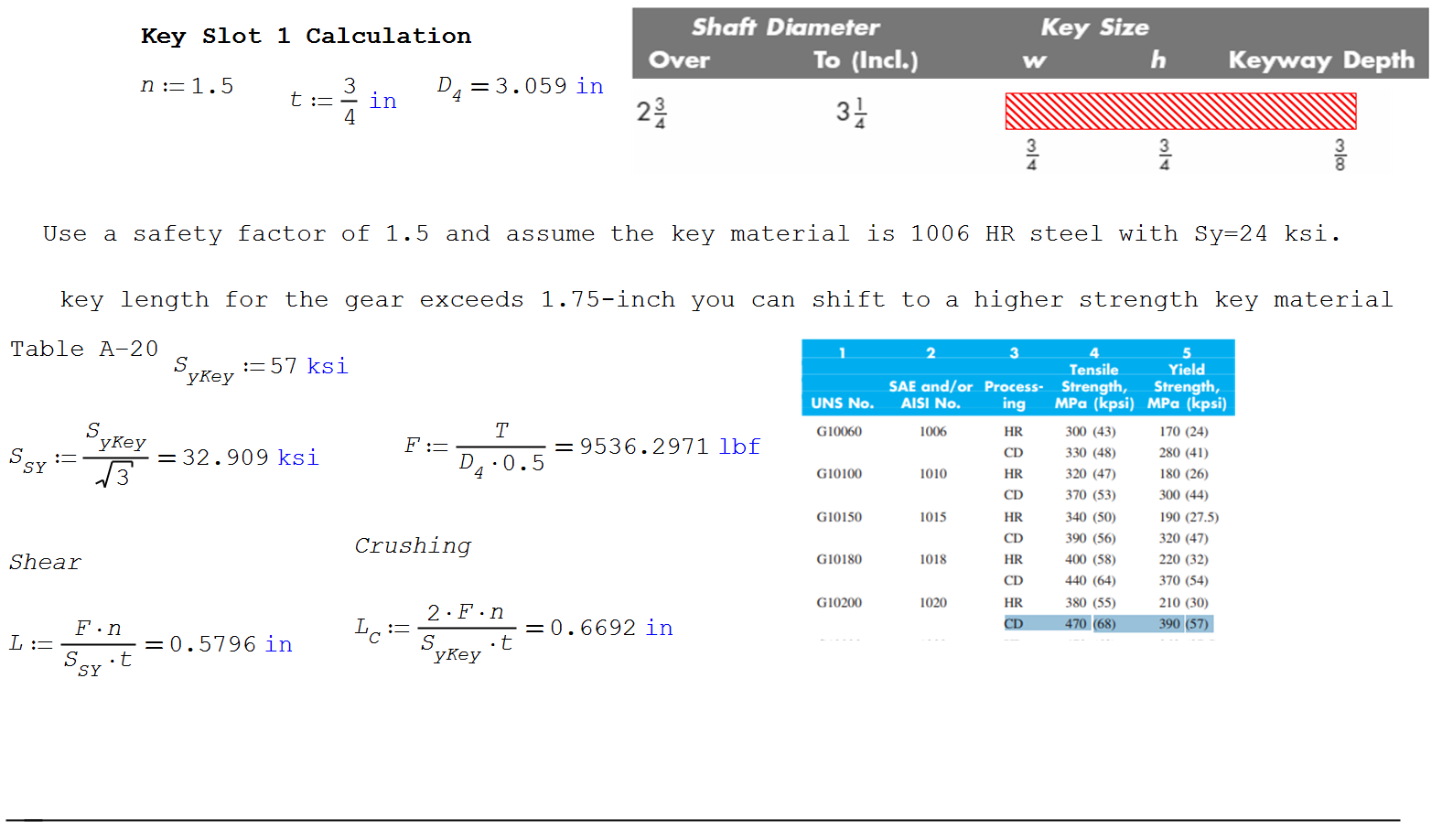
 

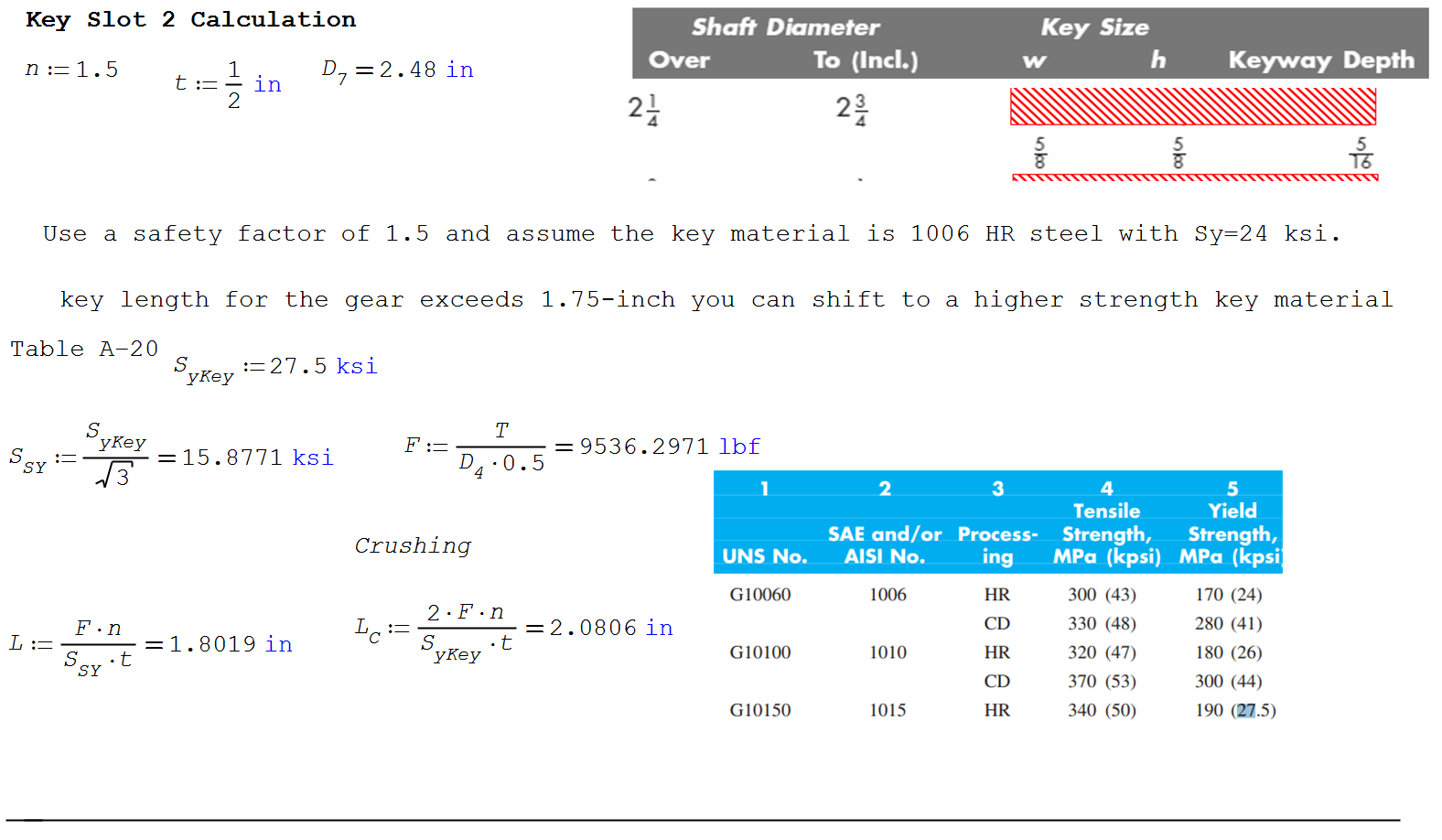


Bearing Calculations



Key Length Calculations



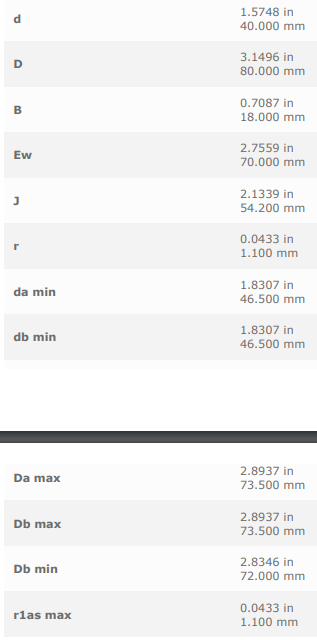
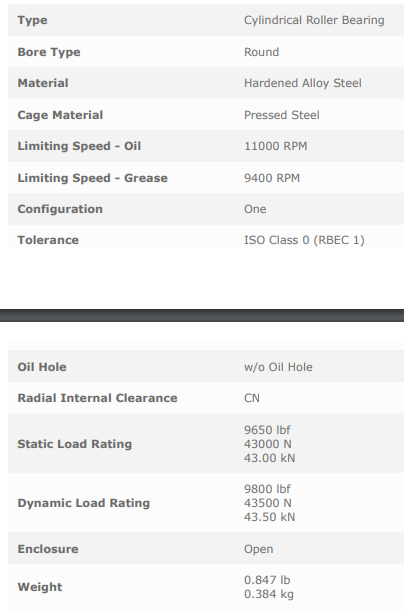


Appendix

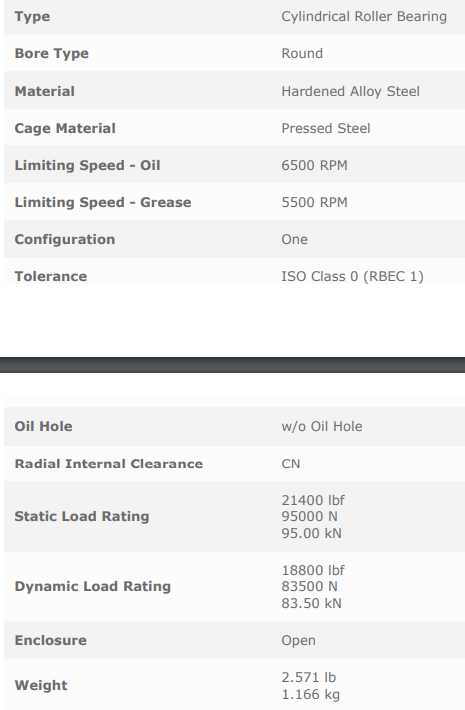
Selected bearings

Bearing One for D1

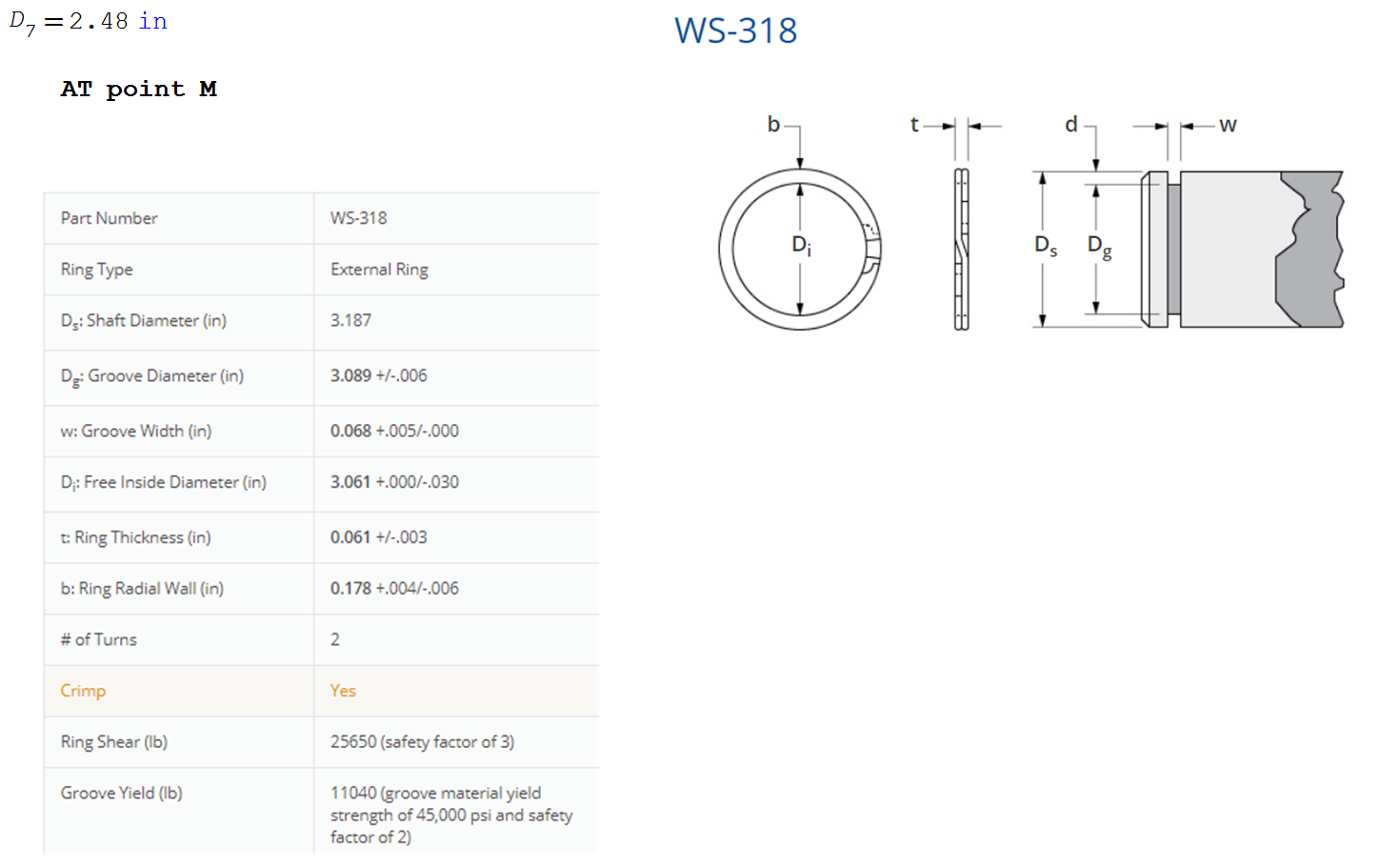


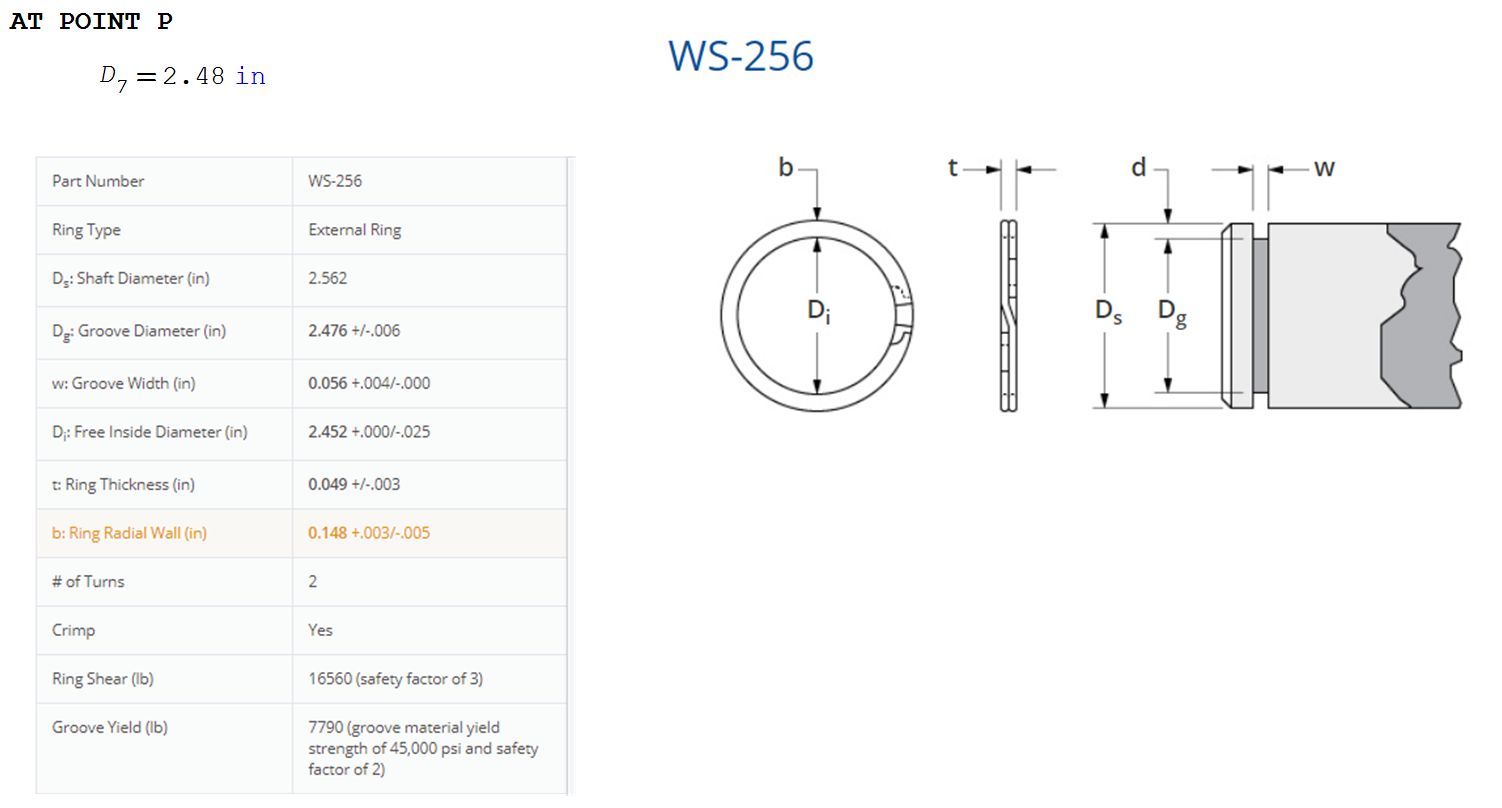
 

Bearing Two for D6

Selected Retaining Clips





WS-162

