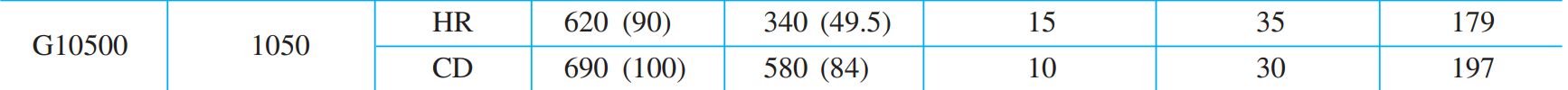
**Shaft Design L**

**Force Analysis:**

Choose the inexpensive steel, 1020CD steel, parameter is from Shigley’s book Table A-20:





Start with point C, where the bending moment is high and there is a stress concentration of the shoulder.

Forces at C:

Therefore,

Based on the inner radius of the gear (12 mm), let’s design the diameter d to be 12 mm.

Next, check for failure:

Choose diameter ratio for the shoulder: D/d = 1.5, thereby

Select standard value D = 18 mm.

Check if estimates were acceptable:

Choose fillet ratio for well-rounded shoulder, based on Shigley’s book [Table 7-1].

So the fillet radius is .

Choose the stress concentration factors from Shigley’s book

From the Shigley’s book equation 6-32:

Then the modifying factors:

**Surface factor** from the Shigley’s book Table 6-2, from cold draw.

From equation 6-18:

**Size factor** from the Shigley’s book equation 6-19, due to the ,

**Load factor** from the Shigley’s book equation 6-25, and since there is not fluctuating axial loading, and the loading factor for torsion is already taken into account when using Mises Stress.

**Temperature Factor** the endurance limit is available or being estimated based on the ultimate strength at the operating temperature.

**Reliability Factor**

Estimating the Endurance Limit from equation 6-10,

Finally, the endurance limit: From equation 6-17:

Use von Mises stresses from equation 7-4 and equation 7-5:

Then calculate the safety, using the Goodman Criterion from equation 6-41

And the yielding safety factor from equation 7-7:

**Shaft Design R**

**Force Analysis:**

Start with point D, where the bending moment is high and there is the keyway, just to the up of point D, and at the groove at point E.

Forces at E:

Therefore,

Based on the inner radius of the gear (12 mm), let’s design the diameter d to be 12 mm.

Next, check for failure:

Assume the radius at the bottom of the keyway will be the standard , thereby

Choose the stress concentration factors from Shigley’s book

From the Shigley’s book equation 6-32:

Then the modifying factors:

**Surface factor** from the Shigley’s book Table 6-2, from cold draw.

From equation 6-18:

**Size factor** from the Shigley’s book equation 6-19, due to the ,

**Load factor** from the Shigley’s book equation 6-25, and since there is not fluctuating axial loading, and the loading factor for torsion is already taken into account when using Mises Stress.

**Temperature Factor** the endurance limit is available or being estimated based on the ultimate strength at the operating temperature.

**Reliability Factor**

Estimating the Endurance Limit from equation 6-10,

Finally, the endurance limit: From equation 6-17:

Use von Mises stresses from equation 7-4 and equation 7-5:

Then calculate the safety, using the Goodman Criterion from equation 6-41

And the yielding safety factor:

And then check for point C, here the bending moment is high and there is a stress concentration of the shoulder.

Forces at C:

Therefore,

Based on the inner radius of the gear (12 mm), let’s design the diameter d to be 12 mm.

Next, check for failure:

Choose diameter ratio for the shoulder: D/d = 1.5, thereby

Select standard value D = 18 mm.

Check if estimates were acceptable:

Choose fillet ratio for well-rounded shoulder, based on Shigley’s book [Table 7-1].

So the fillet radius is .

Choose the stress concentration factors from Shigley’s book

From the Shigley’s book equation 6-32:

Then the modifying factors:

**Surface factor** from the Shigley’s book Table 6-2, from cold draw.

From equation 6-18:

**Size factor** from the Shigley’s book equation 6-19, due to the ,

**Load factor** from the Shigley’s book equation 6-25, and since there is not fluctuating axial loading, and the loading factor for torsion is already taken into account when using Mises Stress.

**Temperature Factor** the endurance limit is available or being estimated based on the ultimate strength at the operating temperature.

**Reliability Factor**

Estimating the Endurance Limit from equation 6-10,

Finally, the endurance limit: From equation 6-17:

Use von Mises stresses from equation 7-4 and equation 7-5:

Then calculate the safety, using the Goodman Criterion from equation 6-41

And the yielding safety factor from equation 7-7: