Thoughts on the effect of the fillet radius on stub axle strength, and a fact based answer to the "spacer or no-spacer" question.

STUB AXLE MODULUS STUDY
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Section Modulus:

In strength of materials, we use the section modulus to compare the relative strength of different shapes under the same loading conditions.
Let's compare the section modulus of the stub axle alone, against the "pipe" formed by the bearings and spacer assembly:

the section modulus of a solid bar is defined as:
(Z is in cubic inches)

$$Z = \frac{\pi D^3}{32}$$

D = diameter

and of a hollow pipe is defined as:

$$Z = \frac{\pi(OD^4 - ID^4)}{32\ (OD)}$$

OD = outer diameter
ID = inner diameter

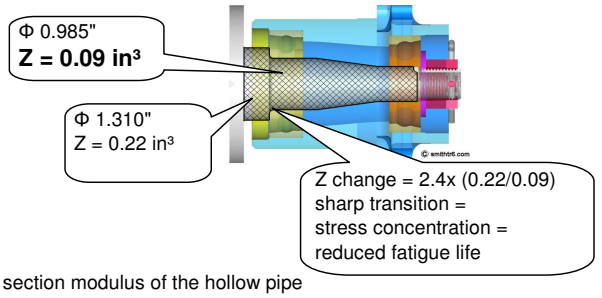
as you can see, for a bar or a pipe, the larger diameter will provide the larger section modulus.
Because the maxumum stress is located in the "outermost fibers", the goal is to achive the largest possible section modulus.
(the farther you can get those outermost fibers from the centroid of a section, the more the stress there is reduced)

Stress concentration:

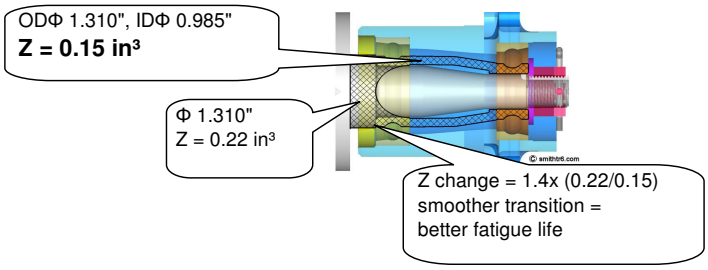
Another important consideration in strength of materials is the fatigue life. A part that is stressed within its elastic limit can experience the same load for millions of cycles, but if there is a notch, or "step" in the shape (a sudden change in section modulus), then stress will be concentrated there and the fatigue life will be reduced (the sharper the notch/step, the greater this effect), as a result, any transition in shape must be done as smoothly as possible.

Let's compare the two options:

1) no spacer, "let the stub axle flex". $0.985^3 * \pi / 32 = 0.09$ cubic inches



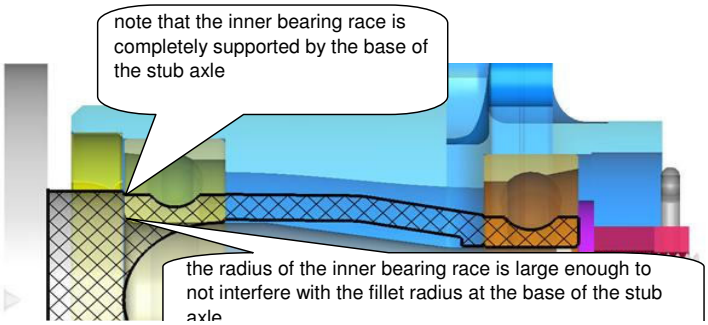
2) with spacer, section modulus of the hollow pipe
(spacer, plus the inner races of the inner and outer bearings) = 0.154 cu in.

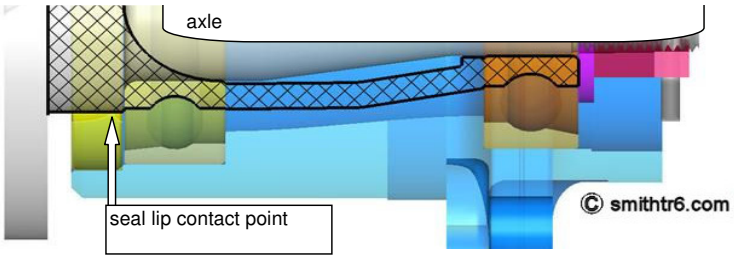


Using the spacer provides 1.7x the section modulus (0.154 vs. 0.09), compared to just the stub axle alone.
Also, it minimizes the section change, for better stub axle fatigue life.

That pesky fillet radius:

Original Bearing configuration.





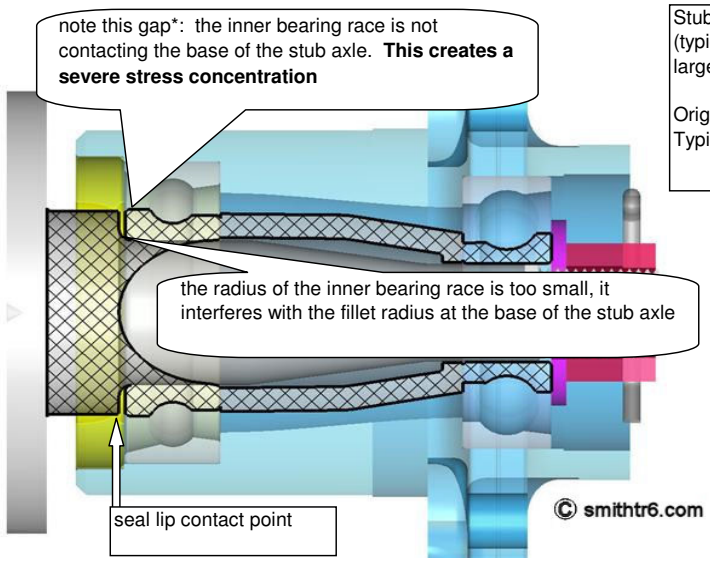
This first example is of the original bearing configuration. It includes the proper fitting bearing and the spacer between the bearings.

Note how the correct bearing radius allows the load to be transferred directly into the stub axle base.

Note also the seal contact position on the stub axle's seal surface.

And because the correct fitting bearing allows the hub in the proper position closer to the stub face it It also provides the best fit of the rotor in the brake caliper.

Improper bearing fit



This is an example of a bearing that does not fit correctly because it has a smaller radius than the stub axle's fillet radius.

Consider this; The lack of support behind the bearing causes a big stress concentration in that area.

That "notch" can cause fatigue failure even though the loading is well below the elastic limit of the stub axle material.

Also, notice that the position of the seal contact is moved outward. If it is moved too far, the seal will no longer be able to do its job.

Note that a shim could be used to fill this gap.
If a shim is used, care should be taken to confirm the seal lip position, and the rotor x brake caliper alignment.