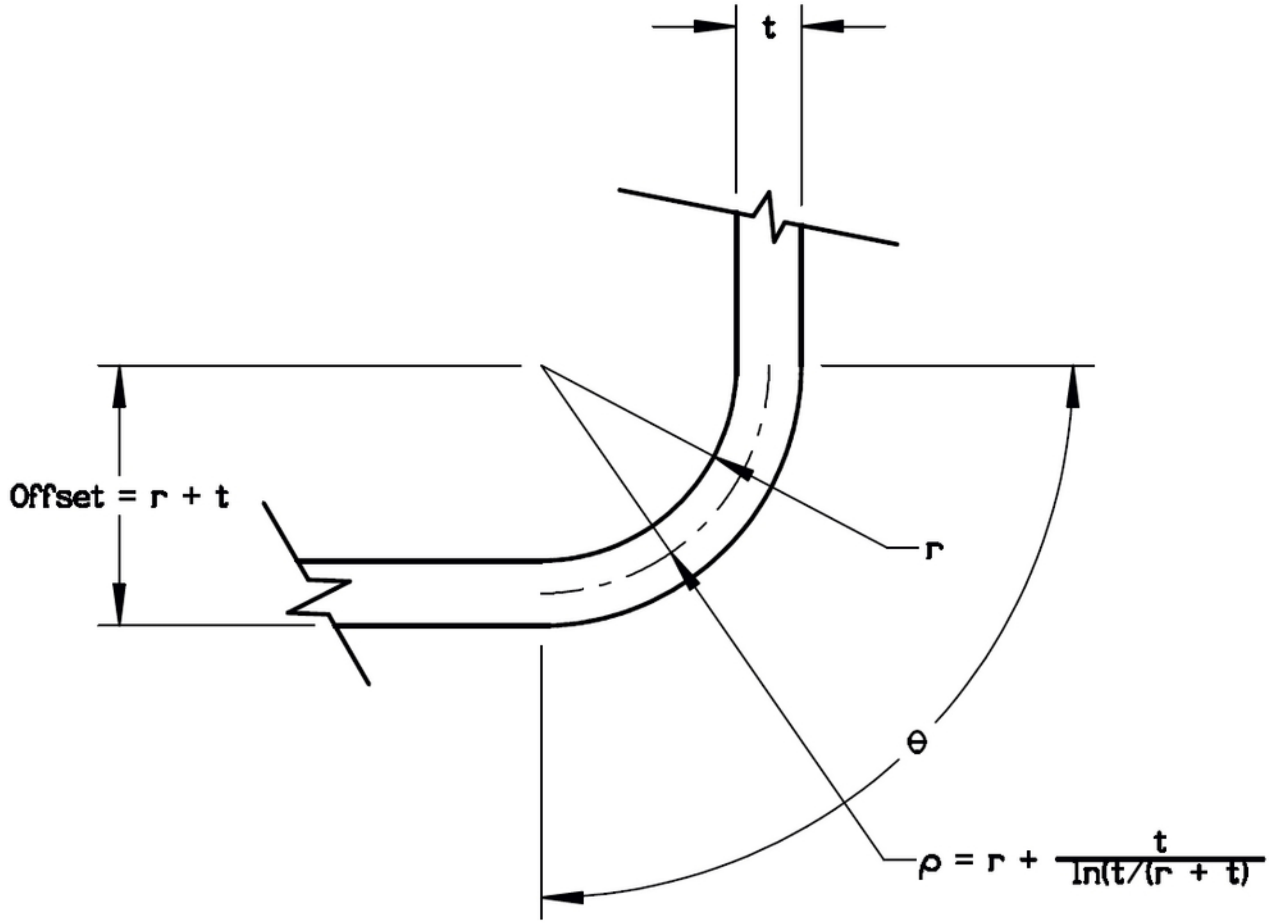
Non-Rectangular Shape Neutral Axis & K-Factor:

Prologue:

Whereas determining *Neutral Axis* and *Lockheed K Factor* values for rectangular sections is fairly straightforward ($\rho = r + t/\ln(t/r+t)$), round and hollow round sections are more challenging. I will state firmly that the "standard text" (*Rourke's Formulas for Stress & Strain*) is, in my opinion, a waste of time, effort, and paper. **My** 40 year old copy of Alexander Blake's *Practical Stress Analysis in Engineering Design* gets used many times more often and more successfully. I recommend it to anyone working the mechanical design side of the street!

Rectangular Section Neutral Axis Values:



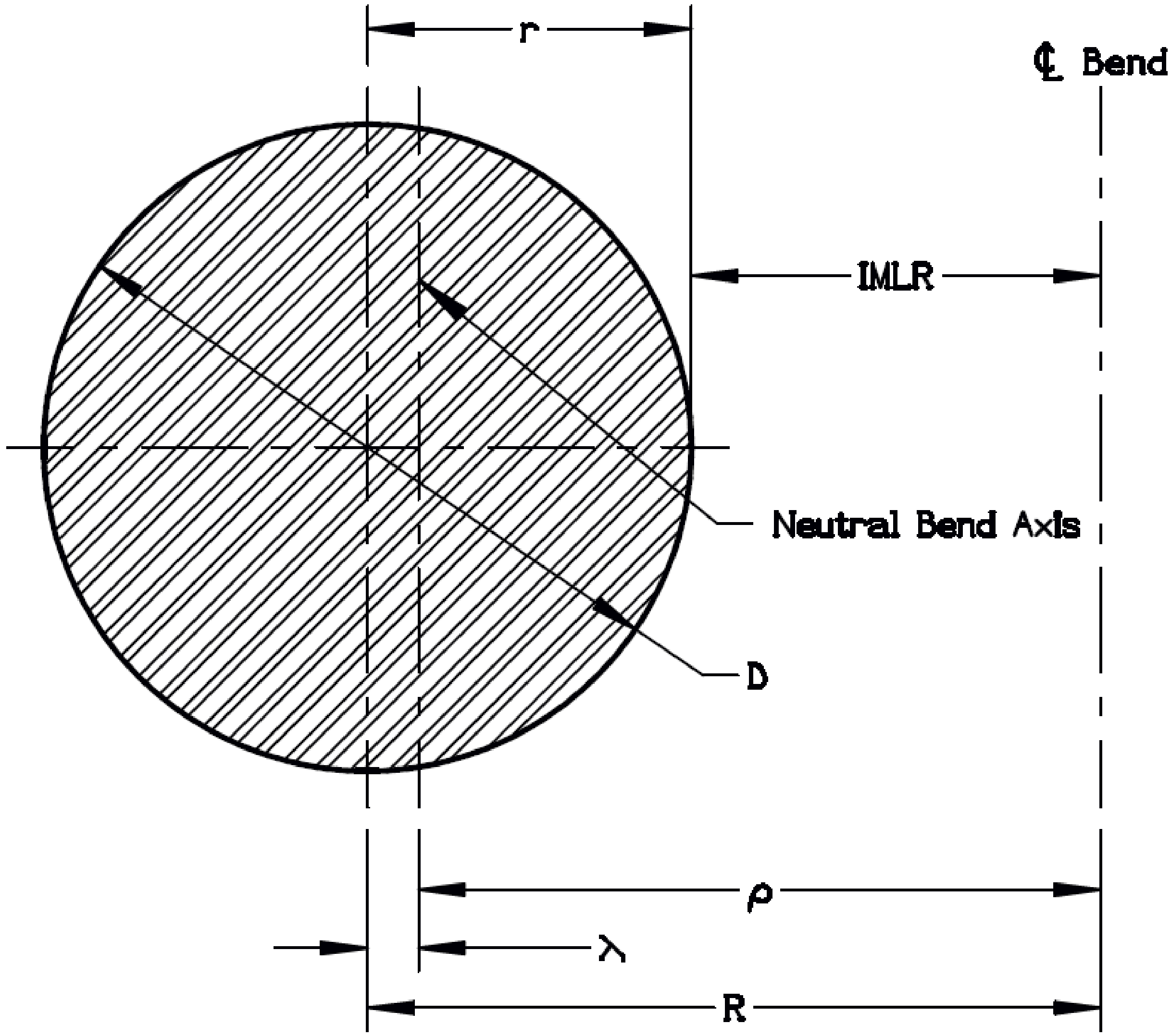
Neutral Axis and Bend Allowance Figure

The figure above shows the *Neutral Axis* (ρ) calculation for a rectangular section. [This is nigh unto impossible to locate in *Rourke's* whilst it nearly leaps into one's lap in *Blake's*.]

Circular Section Neutral Axis Values:

The only two *Circular Section* value generally of interest in mechanical design are: *circular bars* and *circular tubes*. This section is limited accordingly (though *Blake's* carries it much further). The basis (*Circular Bars*) may be demonstrated as:

Round Bar Neutrtal Axis Values:



$$\lambda = 2*(R/r)^2 - 2 * \sqrt{(R/r)} * \sqrt{(R/r)^2}$$

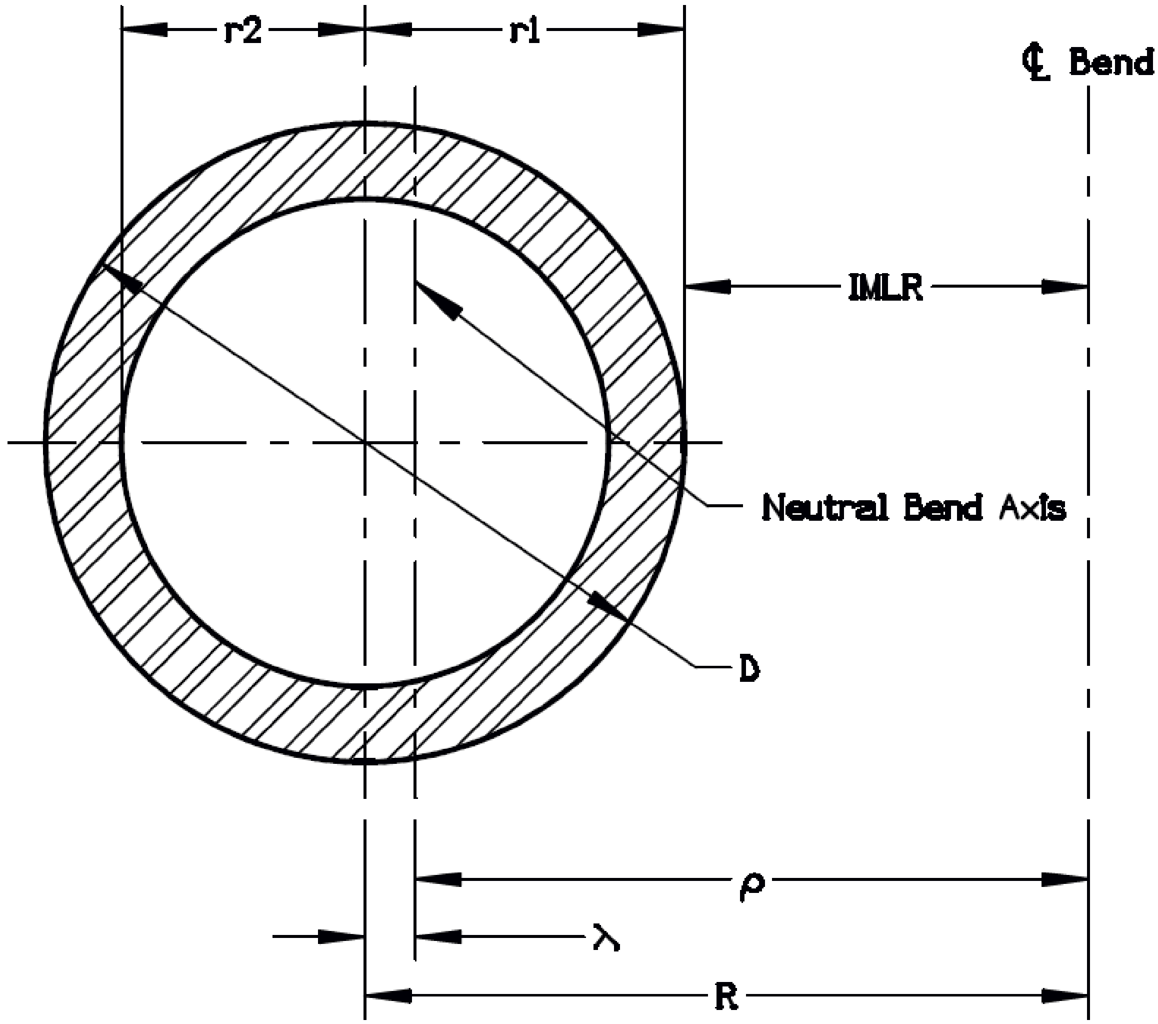
$$\rho = R - \lambda$$

$$IMLR = R - r$$

The figure above shows the important considerations for a *Round Bar* of *Diameter* "*D*" and a *central radius* of "*R*." "*λ*" is the *offset* from the *central radius* ("*R*") and the *Neutral Axis Radius* "*ρ*." *The calculations for this ought to be fairly clear*. The *IMLR* is the *Inside Mold Line Radius* and is the minimum radius about which the *Bar* is formed.

Circular Tube Section Neutral Axis Values:

The assumption is that *Tubing* has a consistent wall thickness. This is *generally* if not *always* true and the differences may generally be ignored. Arguments about the "truth" of that statement are best left to *QA* types.



$$\lambda = 2R/(r1^2 - r2^2) * [\sqrt{R^2 - r1^2} - \sqrt{R^2 - r2^2} - 1$$

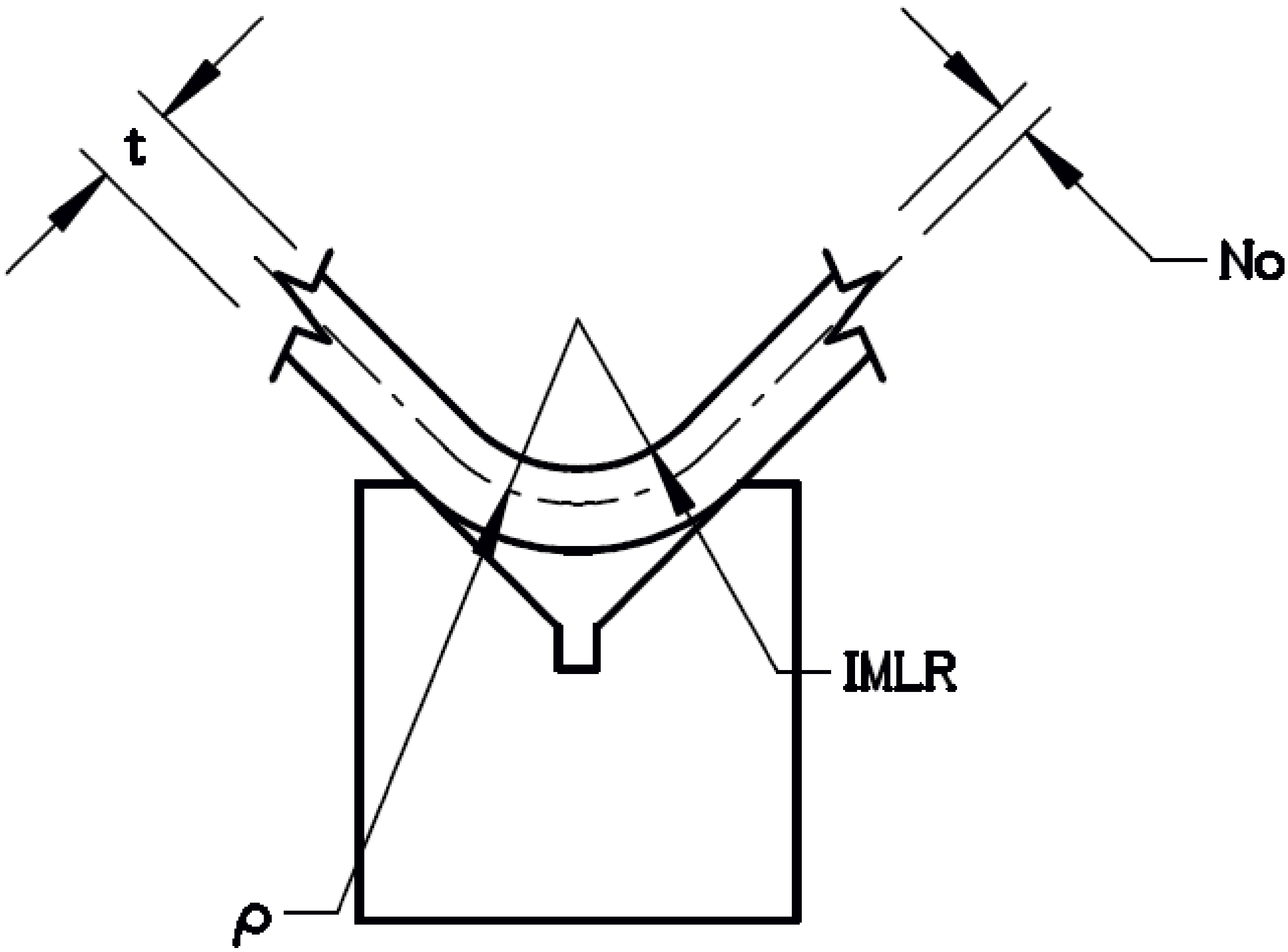
$$\rho = R - \lambda$$

$$IMLR = R - r1$$

The figure above shows the *values* and *equations* that apply to a *Tube* of outer diameter "*D*" and wall thickness given by "*R1 – R2*." As above this figure, "*IMLR*" stands for "*Inside Mold Line Radius*" and is the minimum radius about which the *Tube* is formed.

Converting *Neutral Axis Radius* Values to *Lockheed K Factor* Values:

The *Lockheed K Factor* is a somewhat mythical value. It derives from the "offset" between the *Inside Mold Line* face of the component being bent and the location of the *Neutral Axis* (symbolized here by the Greek character *Rho*). The following figure should make this clear.



$$K = No/t$$

$$No = \text{Neutral Axis Offset}$$

$$\rho - IMLR = No$$

This applies to **all** *Neutral axis* calculations.

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