Working Strength / Load (W): 95 kN = 95,000 N
Working Stress (S_t): 85 MPa = 85 N/mm^2

Step 1: Establish the Empirical Mechanical Design Formula

When designing bolts to secure a tightly packed joint (such as a steam-tight flange or a high-pressure fluid seal), the bolt experiences an initial tightening stress in addition to the external working load. To account for this combined effect, standard machine design textbooks (such as Faires) utilize an empirical relationship established by ASME codes. This formula calculates the allowable working strength (W) in pounds (lbs) based on the allowable working stress ($\mathbf{S_t}$) in pounds per square inch (psi) and the nominal bolt diameter (D) in inches:

$$W = S_t\,(0.55D^2 - 0.25D)$$

Step 2: Convert SI Metric Units to US Customary Units

Because the empirical equation is strictly calibrated for English units (lbs, psi, and inches), we must convert our given metric values before substitution.

- **Convert Working Strength (W):** $W = (95,000\ N)\left(\frac{1\ lb}{4.44822\ N}\right) = 21,356.86\ lbs$
- **Convert Working Stress (S_t):**
  Using the standard conversion factor where 1 MPa = 145.038 psi:

$$S_t = (85\ MPa)\left(\frac{145.038\ psi}{1\ MPa}\right) = 12,328.23\ psi$$

Step 3: Substitute and solving for the meaningful root

Plugging the converted values into the correct empirical formula yields:

$$21,356.86\ lbs = 12,328.23\ psi(0.55D^2 - 0.25D)$$

$$D = 2\ inches$$

The empirical linear subtraction term (-0.25D) acts as a built-in safety penalty factor. It reflects a critical field reality: mechanics tightening joints manually with standard wrenches easily over-torque and shear smaller bolts. As bolt diameter decreases, the impact of this subtraction term grows significantly, forcing the formula to demand a larger nominal size to protect against human error during installation.