Step 1: Calculation of Hydraulic Water Power (WP)

Water power represents the theoretical energy transferred to the fluid per unit of time, disregarding any mechanical or volumetric losses within the pump casing itself. It is a direct function of the fluid's weight density (γ), the volumetric flow rate (Q), and the total dynamic head (TDH).

To maintain standard metric consistency, the flow rate is converted from liters per second to cubic meters per second (80 L/s = 0.08 m^3/s), while the specific weight of water is taken as γ = 9.81 kN/m^3:

$$WP = Q\gamma TDH$$

$$WP = \left(0.08\,\frac{m^3}{s}\right)\left(9.81\,\frac{kN}{m^3}\right)(35\,m) = 27.468\,kW$$

Step 2: Determination of Pump Shaft Brake Power (BP)

Brake power defines the real mechanical power required at the pump's input shaft to deliver the calculated fluid power. Because the pump is operating at an efficiency (η_P) of 80%, the mechanical input must be higher to compensate for internal friction, turbulence, and fluid slippage:

$$BP = \frac{WP}{\eta_P} = \frac{27.468\,kW}{0.80} = 34.335\,kW$$

Because power limits for chains are traditionally rated in English units, convert this value from kilowatts to horsepower (HP) using the standard conversion factor (1 HP = 0.746 kW):

$$BHP = (34.335\,kW)\left(\frac{1\,hp}{0.746\,kW}\right) = 46.025\,hp$$

Step 3: Applying the Service Factor to Determine Design Power (P_d)

This is where the provided handwritten solution failed. In machine design, components cannot be safely sized using the nominal operating power alone. A diesel engine introduces severe reciprocating torque fluctuations, and a fluid pump is subject to unexpected load surges. To safeguard the drive system, we apply the specified **Service Factor (SF = 1.4)** to compute the **Design Power (P_d)**:

$$P_d = (46.025\,hp)(1.4) = 64.435\,hp$$

Step 4: Computing the Exact Number of Strands (n)

With the total ruggedized design load established at 64.435 HP and the capacity per individual strand specified as 28 HP/strand, the required number of strands (n) is determined by simple division:

$$n = \frac{P_d}{HP\ per\ Strand} = \frac{64.435\ hp}{28\ hp/strand} = 2.301\ strands$$

In physical engineering practice, you cannot buy or run a fraction of a steel chain strand. Therefore, any fractional value must be rounded up to the nearest whole integer to preserve the design's safety parameters:

Number of strands = 3 strands

By splitting the 64.4 HP load across 3 narrower strands rather than one massive single strand, engineers can use a much smaller chain pitch. A smaller pitch minimizes sprocket diameters, lowers space requirements, reduces weight, and cuts down on noise and vibration caused by chordal action (the polygonal effect of chain links wrapping around a sprocket).