Ironworker – Analyze of two ¾" Bolts

1. Bolt Clamping Force

¾" Bolt roughly equivalent metric M18 (Dia. 18mm)
170000psi equal grade 12.9
For M18 12.9 bolt clamping force 169kN (table data) - assembly torque ~ 400Nm

2. Bending moment

45000lbf ~ 22000kp ~ 220kN
Bending moment Mb = 220kN * 190mm = 41800kNmm = 41,800,000 Nmm

3. maximum tensile stress for one bolt

assumed axis of rotation h/4 –
h = 7,5" = 191mm, so h/4 = 48mm
distance axis to first bolt 191 – 48 – 100 = 43mm
distance axis to second bolt 191 - 48 – 50 = 93mm

$Mb = l_1 * F_1 + l_2 * F_2$, where $F_1/F_2 = l_1/l_2$ source: Roloff/Matek: Maschinenelemente
For two bolts, F is highest for bolt 2:
$Fmax = Mb / 2 * l_1 / (l_1^2 + l_2^2) = 86700$ N = 87 kN

4. remaining clamping force to withstand shear

2 * 169kN – 87 kN – 43.5 kN = 207 kN resulting clamping force from the two bolts

shear force is 220kN, even with a friction coefficient of 1, clamping force would not be high enough to avoid any movement of those 2 parts against each other

My summary is those bolts are too weak to withstand 45 tons force. All this calculations have been made for a static stress stituation, in reality it is a dynamic stress with each stroke of the ironworker. Calculating it for dynamic load would definitely resulting in those bolts undedimensioned. If the bolts don't brake during first 45 ton load, they will eventually under repeated high loads.

5. welded nuts

I have already given my opinion for those 2 nuts, welded to the 4" round bar. For weldings with standard mild steel a shear tension of 112N/mm² is tolerable (source: Roloff/matek). Given the force of 110kN per nut, You would need a welding crossection of nearly 1000mm². In addition, the welding conditions are extraordinary bad because of welding the nuts to a round shape. I am sure this design will break with lower than 45 tons of force