

## *Re-assessment of Rivet size by Empirical way for Theoretically Calculating Tensile Strength under IS code 800-1984.*

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### **Abstract**

*Steel structure are used in the form of steel column base, steel roof truss, steel beam girders, and plate girders and these are fixed with either riveting or welding. While riveting in steel structure when the tensile load comes on the member, the rivet hole is deducted from the cross sectional area of member either it may be IS angle, tea section, channel section or I-Section, while assessing rivet diameter through Unwinds formula, the tensile strength usually comes less. Hence by theoretically and on empirical way the author has calculated the rivet diameter assessment through the new revised formula  $\phi = 5.6\sqrt{t}$  than the existing formula previously in vogue by  $\phi = 6.5\sqrt{t}$  and find more tensile strength theoretically.*

*Hence the author of this technical paper promotes the use of  $\phi = 5.6\sqrt{t}$  in place of  $\phi = 6.5\sqrt{t}$  while designed of tensile steel member.*

**Keywords:** *Steel plates, Rivet value, Tensile Strength, IS code 800-1984*

### **INTRODUCTION**

Steel plates are joined with lap or butt joint and fixed with either by Riveting or welding or both. While riveting the efficiency is measured for joint by

dividing joint strength to strength of solid plate.

The joint strength is usually dependent on rivet diameter, thickness of plate and

number of rivet. The tearing strength of plate remains less if more dia rivets are being used and also their numbers. The rivet strength is governed with rivet value and number of rivets. Rivet value is dependent on rivet dia and thickness of plate.

Rivet value is the failure strength of rivet either in shearing or in bearing whichever is less. Shearing will be either single or double. Single shear exists when joint is lap or butt with single cover plate. Double shear will be when joint is butt with double cover plate.

Hence  $F_{s1} = \frac{\pi}{4} x d^2 x f_s$  (for single shear exists in butt joint with single cover plate or lap joint)

$F_{s2} = 2 x \frac{\pi}{4} x d^2 x f_s$  (for double shear exists in double cover plate butt joint)

$F_b =$  Bearing strength of rivet  
 $= f_b x d x t$

The rivet may fail either in shearing or bearing. Lesser the value of  $F_s$  and  $F_b$  will be the rivet value usually measured for single rivet.

Rivet strength = No. Of rivet x rivet value

The plate after Riveting may fail in tearing.

The tearing strength  $F_t = (B - n x d) x t x F_t$

Where

$B =$  Plate width,  $n =$  no. Of rivet in a rivet line,  $t =$  thickness of plate

Lesser the value of rivet strength or plate tearing strength will be the joint strength. The plate joint strength and rivet size with respect to plate thickness has been always an important aspect for joint efficiency point of view.

The Unwins formula has been in vogue hitherto for assessing the rivet shank dia ( $\phi$ ) on the basis of plate the thickness ( $t$ ).

Formula in vogue

$$\phi = 6.05\sqrt{t}$$

For example,

if  $t = 10\text{mm}$  then  $\phi = 6.05\sqrt{10} = 19.13\text{mm} = 20\text{mm}$

When the steel members are joined by riveting then rivet area is deducted from steel sections when the members are being treated as tension member. More rivet sectional area wills less, the strength of joint. Hence it becomes necessary to clause and select the  $\phi$  judiciously. In compression member no change will occur while choosing diameter of rivet either more or less.

*Assessed formula-*As the author has set an example and on this basis, it has been revealed that assessing of  $\phi$  by unwins prevailing formula represents higher dia of rivet shank which reduces the tearing strength of plate as well as increasing bearing strength of rivet cum shearing also. So to get the efficiency more for joint, it is required to get assess, again the  $\phi$  by revising the existing formula.

$$\phi_{mkv} = 5.6\sqrt{10} = 17.69 = 18\text{mm}$$

If we use 18mm  $\phi$  rivet in place of 20 mm, we find that there will be little change in finding the number of rivets and strength of joint as well as efficiency which will be then higher theoretically A tabulated comparative study for setting an example will demonstrate the theme of this technical paper.

The author confines the new formulas

$$\phi_{mkv} = 5.6\sqrt{t}$$

If  $t=10\text{mm}$ ,

*Illustration-* suppose plate size is 100mmx10mm joined with lap joint providing 4 rivets in 2 rivet line. Take  $F_t=150 \text{ N/mm}^2$ ,  $F_b=300 \text{ N/mm}^2$  and  $F_s=100 \text{ N/mm}^2$

**Table: 1**

Joint efficiency by unwins formula	Joint efficiency by author
$\phi = 6.05\sqrt{10} = 20\text{mm}$	$\phi_{mkv} = 5.6\sqrt{10} = 18\text{mm}$
Rivet hole dia. $d=20+1.5=21.5\text{mm}$	Rivet hole dia. $D = 18+1.5=19.5\text{mm}$
Strength of solid plate $F_t = B \times t \times f_t = 100 \times 10 \times 150 = 150000 \text{ N}$	Strength of solid plate $F_t = B \times t \times f_t = 100 \times 10 \times 15 = 15000 \text{ N}$
For rivet value $F_{s1} = \frac{\pi}{4} \times d^2 \times f_s$ $= 0.785 \times 21.5 \times 21.5 \times 100 = 36286.625\text{N}$ $F_b = f_b \times d \times t = 300 \times 21.5 \times 10 = 64500\text{N}$ Rivet value = 36286.625N	For rivet value $F_{s1} = \frac{\pi}{4} \times d^2 \times f_s$ $= 0.785 \times 19.5 \times 19.5 \times 100 = 29849.625\text{N}$ $F_b = f_b \times d \times t = 300 \times 19.5 \times 10 = 58500\text{N}$ Rivet value = 29849.625N
Tearing strength of plate $F_t = (B-d) \times t \times f_t$ $= (100-21.5) \times 10 \times 150 = 117750\text{N}$	Tearing strength of plate $F_t = (B-d) \times t \times f_t$ $= (100-19.5) \times 10 \times 150 = 122250\text{N}$



No. of rivet= $\frac{117750}{36286.625}=3.24=4$	No. of rivet= $\frac{122250}{29849.625}=4.09=4$
Arrange 4 Rivets in 2 rivet lines. Each rivet line contains 2 rivets. $Ft1=(B-2d) \times t \times ft = (100-43) \times 10 \times 150=85500N$	Arrange 4 Rivets in 2 rivet lines. Each rivet line contains 2 rivets. $Ft1=(B-2d) \times t \times ft = (100-39) \times 10 \times 150=91500N$
Rivet strength (RS) =No. of rivet x Rivet value =4x36286.625N=145146.5N	Rivet strength (RS) =No. of rivet x Rivet value =4x29849.625=119398.5N
Joint strength=Least of Rs & Ft=85500N	Joint strength=Least of RS & Ft=91500N
Efficiency= $\frac{85500}{150000} \times 100=57\%$	Efficiency= $\frac{91500}{150000} \times 100=61\%$
	Efficiency increased= $(61-57)/57 \times 100=7\%$

### CONCLUSION

The above study reveals that using of 18mm  $\phi$  rivets in place of 20 mm, the efficiency of the joint increased by 7% theoretically. Hence the rivet diameter assessed by the author for steel as tension member by the author  $\phi_{mkv} = 5.6\sqrt{t}$  is more feasible than Unwins formula  $\phi=6.05\sqrt{t}$ .

So the assessed formula by the author for determining the rivet diameter as  $\phi_{mkv}=5.6\sqrt{t}$  is more relevant and authentic than  $\phi=6.05\sqrt{t}$  formula. Hence the re-assessed formula  $\phi_{mkv}=5.6\sqrt{t}$  must be in vogue and should be promoted for designers for designing of steel structures.

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