VDI 2230

‘Systematic Calculation of High Duty Bolted Joints’

Method developed by the German Society of Engineers that allows the determination of the diameter and strength of bolts to withstand the applied working loads without risk of premature failure

VDI 2230

- Many bolted joints are over-designed, and this can result in excess weight in the structure being assembled.
- History shows that some bolts are under-designed, resulting in service problems, sometimes disastrous.
- VDI 2230 is one of the common methods of design used for bolted joints, often in combination with FEM.

VDI 2230 Table A7

- Table A7 gives a rough estimate of the appropriate bolt size for a given bolted joint
- This is a good starting point for many joints, and may be useful as a check on whether a bolt is failing because of wrong selection of size and strength
- *It is a **rough guide** only, and forms the **starting point** for the VDI 2230 calculations*

VDI 2230 Table A7 - Estimate of diameter

1	2	3	4
LOAD	NOMINAL DIAMETER in mm		
in N	Strength grade		
	12.9	10.9	8.8
250			
400			
630			
1000	3	3	3
1600	3	3	3
2500	3	3	4
4000	4	4	5
6300	4	5	6
10000	5	6	8
16000	6	8	10
25000	8	10	12
40000	10	12	14
63000	12	14	16
100000	16	18	20
160000	20	22	24
250000	24	27	30
400000	30	33	36
630000	36	39	

VDI 2230 Table A7

- To start, you need to know the magnitude of the external applied load (**Step A**).
- You also need to know something about the type of external load, e.g. whether it is concentrically applied, whether it is an alternating load, etc. (**Step B**).
- *N.B. The determination of external loading does not form part of the VDI 2230 guideline.*

VDI 2230 Table A7

- Table A7 describes a hypothetical bolted joint as an example of how you make an estimate.
- It has an external axial load of 8500 N, it is eccentrically and dynamically loaded, and it is tightened with a torque wrench.
- In **step A**, the lowest load in column 1 of the table is selected that is higher than the working load.

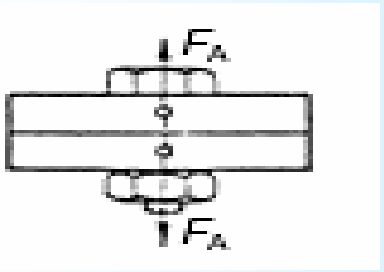
VDI 2230 Table A7 - Estimate of diameter

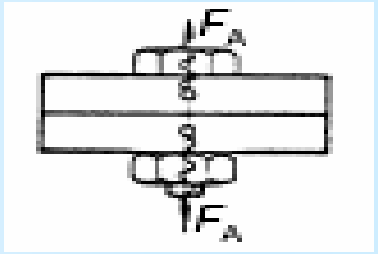
1	2	3	4
LOAD	NOMINAL DIAMETER in mm		
in N	Strength grade		
	12.9	10.9	8.8
250			
400			
630			
1000	3	3	3
1600	3	3	3
2500	3	3	4
4000	4	4	5
6300	4	5	6
10000	5	6	8
16000	6	8	10
25000	8	10	12
40000	10	12	14
63000	12	14	16
100000	16	18	20
160000	20	22	24
250000	24	27	30
400000	30	33	36
630000	36	39	

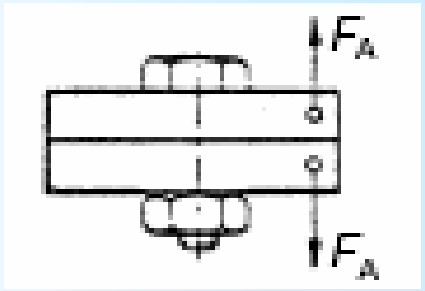
External axial load 8500 N

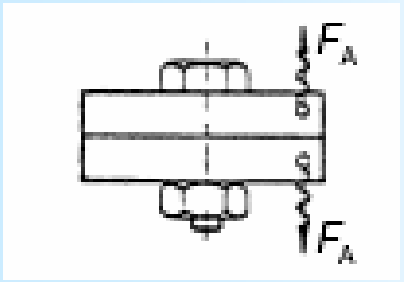
Next higher load in col 1 10000N

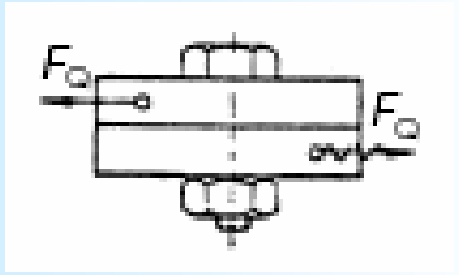
Types of joint loading, for step B







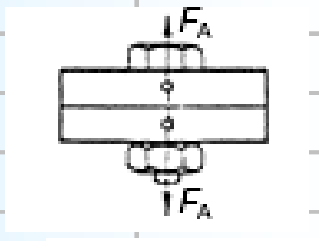


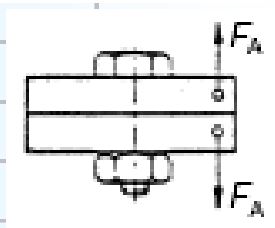


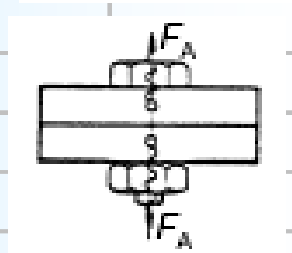
VDI 2230 Table A7 - Estimate of diameter

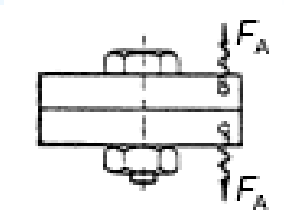
1	2	3	4
LOAD	**NOMINAL DIAMETER in mm**		
in N	**Strength grade**		
	12.9	**10.9**	**8.8**
250			
400			
630			
1000	**3**	**3**	**3**
1600	**3**	**3**	**3**
2500	**3**	**3**	**4**
4000	**4**	**4**	**5**
6300	**4**	**5**	**6**
10000	**5**	**6**	**8**
16000	**6**	**8**	**10**
25000	**8**	**10**	**12**
40000	**10**	**12**	**14**
63000	**12**	**14**	**16**
100000	**16**	**18**	**20**
160000	**20**	**22**	**24**
250000	**24**	**27**	**30**
400000	**30**	**33**	**36**
630000	**36**	**39**	

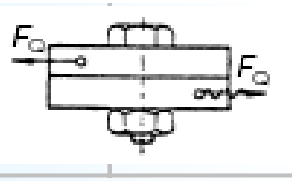
Ext load
8500 N
Next higher
10000N
concentric
static load
no steps up
eccentric
static
one step up
concentric
dynamic
one step up
eccentric
dynamic
two steps up
transverse
four steps up











VDI 2230 Table A7

- Next, you have to know how the bolt is tightened, because the accuracy of the clamp load produced will alter the size. This is **step C.**
- You use the load determined in step B as the minimum permissible.
- Preload scatter determines the maximum load the bolt may feel.
- Table A7 gives a simple rule for preload scatter.

VDI 2230 Table A7

- The reliability of the tightening method determines how much preload scatter there will be.
- Torque tightening by air driven tools gives torque scatter and friction scatter.
- Precision torque tools still have friction scatter.
- Yield or ultrasonic methods are the best.

VDI 2230 Table A7 - Estimate of diameter

1	2	3	4		
LOAD	**NOMINAL DIAMETER in mm**				
in N	**Strength grade**				
	12.9	**10.9**	**8.8**		Loading type,
250					eccentric
400					dynamic
630					from step B
1000	**3**	**3**	**3**		
1600	**3**	**3**	**3**		Yield or
2500	**3**	**3**	**4**		ultrasonic
4000	**4**	**4**	**5**		*no steps up*
6300	**4**	**5**	**6**		
10000	**5**	**6**	**8**		Precision
16000	**6**	**8**	**10**		torque tool
25000	**8**	**10**	**12**		*one step up*
40000	**10**	**12**	**14**		
63000	**12**	**14**	**16**		air driven
100000	**16**	**18**	**20**		torque tools
160000	**20**	**22**	**24**		*two steps up*
250000	**24**	**27**	**30**		
400000	**30**	**33**	**36**		
630000	**36**	**39**			

VDI 2230 Table A7

- So this rough estimate has identified a choice of three bolts: M10 size, 12.9 grade, M12 size 10.9 grade, or M14 size 8.8 grade.
- The choice of which one to use may influence the design of the components, or even the validity of the estimate (e.g. if the bigger bolt increases a reciprocating mass).

VDI 2230 Calculations

- The VDI guideline uses this rough estimate as the starting point for more detailed calculations which try to take account of the exact way the joint behaves.
- The calculations look at elastic effects, the point of application of applied load, embedding, friction scatter, alternating stresses, bearing face pressure, bolt and nut thread strengths, etc.

VDI 2230 Calculations

- Sometimes the calculations are done in conjunction with finite element methods in order to make them more reliable.

- But, once the calculation is completed, VDI 2230 says that if the bolt is critical, do not rely on the calculations – do some practical trials as well !