Fatigue design of threaded tension rods

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Motivation & Problem

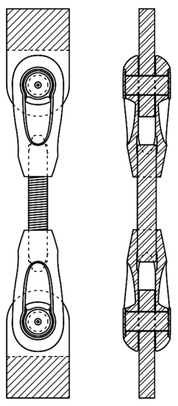
Tab. 1: Current standardization for the proof of fatigue strength of a tension rod

	DIN EN 1993-1-9	DIN EN 1993-1-11
Detail category	50	105
Size effect	from 30 mm	✗
Manufacturing process	no distinction	no distinction
Hot-dip galvanization	no distinction	no distinction

Threads are either rolled or cut. Cold deformation during thread rolling induces residual stresses which have a positive effect on fatigue strength. The question is: How large are the influences of the manufacturing process and the subsequent surface treatment on the fatigue strength?

Methods

Fatigue tests



Tab. 2: Number of tests

	cut thread		rolled thread	
	blank	HDG[1]	blank	HDG[1]
M16	36	24	12	12
M48	24	24	12	12
M68	9	9	-	-
M100	9	9	-	-

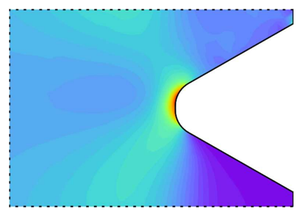
[1] HDG = hot-dip galvanized

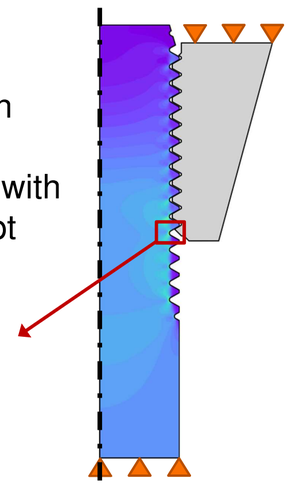
Material tests

Metallography & fractography

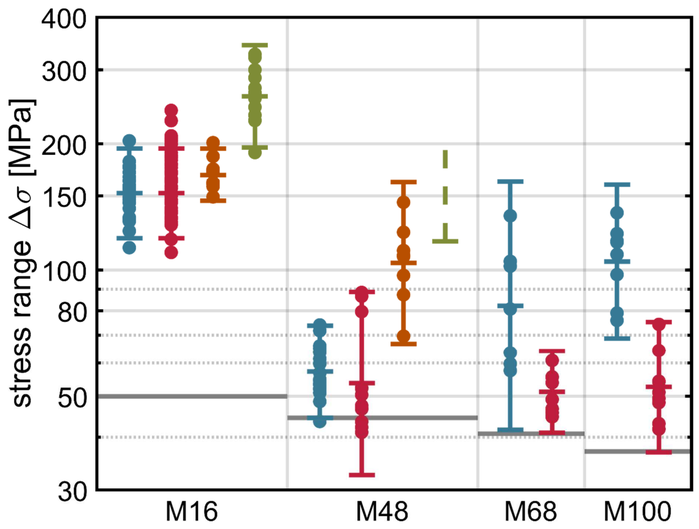
Numerical investigations

Parameter study on manufacturing and assembly tolerances on the rotationally symmetrical 2D model with the notch strain concept





Results of previous fatigue tests



Legend		
cut thread	blank	
	hot-dip galvanized	
rolled thread	blank	
	hot-dip galvanized	
•	Test data standardized to 2 million load cycles	
⊥	Bilateral 90% prediction quantile	
—	$\Delta\sigma_k$ according to detail 14 of DIN EN 1993-1-9	

Conclusions

- Tension rods with rolled thread have a considerably higher fatigue strength than tension rods with cut thread.
- The results of tension rods with a cut thread from a diameter of 68 mm fit the detail 14 (detail category 50) of DIN EN 1993-1-9.
- A negative effect of hot-dip galvanizing on the fatigue strength of cut tension rods could not be observed.
- In the case of rolled tension rods, subsequent hot-dip galvanizing in the thread area leads to a significant reduction in fatigue strength

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