Laboratory test of loadbearing structural materials

03- March 2020

STEEL

8 mm diameter reinforcing bars A=0,5 cm2 loaded by axial compression force

test no.	specimen length l (cm)	ultimate force F_u (kN)	ultimate strength f_u kN/cm2	remark
1	25,5 cm	4,8	9,6	too slender specimen, early buckling
2	51	1,3	2,6	extraordinary slender specimen, very early buckling
3	15,5	22,5	45	slender specimen buckled before reaching material strength
4	5	?	?	unfortunately no test was made with this specimen length

TIMBER

1,5x1,5 cm cross-section soft timber specimens loaded by axial compression force parallel - to grains

test no.	specimen length l (cm)	ultimate force F_u (kN)	ultimate strength f_u kN/cm2	remark
1	15 cm	5,0	2,22	these are realistic values
2	15	5,1	2,27	
3	15	5,3	2,35	
4	15	6,1	2,71	
5	15	4,5	2,00	
6	5	5,1	2,27	For this smaller length the ultimate strength values should
7	5	5,4	2,4	be somewhat higher, due to smaller slenderness ratio and
8	5	6,0	2,67	imperfectness conditions
9	5x2,5x2,5 specimen loaded by compression perpendicular to grains f_u=2,4 kN/(5x1,5)= 0,3 kN/cm2			cca 14 % of the strength parallel to grains (1/7th)

CONCRETE

4x4 cm cross-section short column loaded by axial compression force

1	15,5	22,5	1,4	This is a realistic value for a not very high concrete quality

Interesting was the way of failure: compressed members are subjected to tension in perpendicular direction (about to 10 to 20% of the compression). If the tensile strength is law, tension failure occurs

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in this direction: cracks of the column develop parallel to axis of the column. This leads to sudden failure of the column.

Final conclusions

Observe the magnitude and the ratio of the above compression strengths!

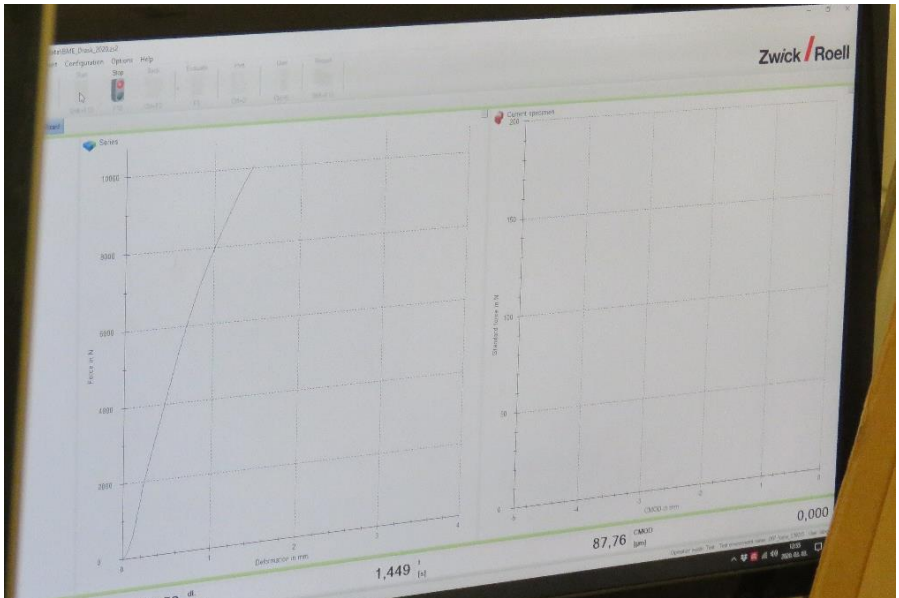
Timber and concrete are having not very different compression strengths (high strength concrete may have greater than the double of timber). Steel is having much higher strength, more than an order of magnitude higher!

In case of higher slenderness ratio (length of the member devided by a cross-sectional dimension) the resistance of the member is reducing because of the danger of buckling. Buckling: because of the increasing eccentricity of the – initially theoretically axial - compression force, axial compression goes over to eccentric compression with step-by-step increasing eccentricity and finally loss of stability due to buckling.

Compressed columns of materials having small tensile strength like concrete and brick, fail due to the development of cracks in direction parallel to compression. Thus decomposition of the column occurs into more slender columns, which then explode under compression.

Hydraulic jack
Compressing the 8 mm diameter reinforcing steel test specimen

The load-deformation diagram shown on the tv monitor during testing of one of the specimens



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Failure mode of the 4x4 cm cross-section concrete test specimen under compression.
Due to transverse tension and low tensile strength of the concrete, cracks parallel to the axis of the concrete column develope , and cause compression failure of the reduced cross.sevtion