

Benchmark 9

Determination of shear resistance given by the cross-section geometry and mechanics [EC2 clause 6.2]

Project file: **EN2_Benchmark9.esa**

Scia Engineer ver.: 10.1.348

Introduction

This benchmark concerns about *Example 6.4: Determination of shear resistance given by the cross-section geometry [EC2, clause 6.2] of Eurocode 2 - WORKED EXAMPLES, The European Concrete Platform ASBL, May 2008.*

Rectangular beam $b_w = 150$ mm, $h = 600$ mm, $d = 550$ mm
Vertical stirrups diameter 12 mm, 2 legs ($A_{sw} = 226$ mm²), $s = 150$ mm,
 $f_{yd} = 391$ MPa

This benchmark is divided into three parts according to the concrete class:

- a) $f_{ck} = 30$ MPa, $f_{cd} = 17$ MPa, $v = 0,616$ - marked as Benchmark 7
- b) $f_{ck} = 60$ MPa, $f_{cd} = 34$ MPa, $v = 0,532$ - marked as Benchmark 8
- c) **$f_{ck} = 90$ MPa, $f_{cd} = 51$ MPa, $v = 0,512$ - marked as Benchmark 9**

Reference Results

The reference gives following results:

- c) For the same section and reinforcement, with $f_{ck} = 90$ MPa, $f_{cd} = 51$ MPa; $v = 0.512$, proceeding as above it results:

$$\sin^2 \theta = \frac{226 \cdot 391}{150 \cdot 150 \cdot 0.512 \cdot 51} = 0.1504 \text{ hence } \cot \theta = 2.38$$

$$V_{Rd,s} = \frac{A_{sw}}{s} \cdot z \cdot f_{ywd} \cdot \cot \theta = \frac{226}{150} \cdot 500 \cdot 391 \cdot 2.38 \cdot 10^{-3} = 701 \text{ kN}$$

Scia Engineer Results

The results are evaluated in the service Check response for prestressed concrete (tree Concrete > 1D member > Member check - Check of non-prestressed concrete) for value V_{zu}

1. Check response EN 1992-1-1

Linear calculation, Extreme : Member
 Selection : All
 Load cases : LC1
 Check of shear for selected members

Member	$V_{Ed,c}$ [kN]	v [-]	θ [deg]	$V_{Ed,max,c}$ [kN]	V_{Ed} [kN]	$V_{Rd,max}$ [MPa]	d [mm]	z [mm]	$\sigma_{c,max,c}$ [MPa]	$f_{ct,max,c}$ [MPa]	α_{cc} [-]	V [-]	θ_{min} [deg]	θ_{max} [deg]
B1	56,03	0,51	22,79	699,95	702,75	0,87	556	500	0,36	2,33	1,00	0,51	21,80	45,00
B1	56,03	0,51	22,79	699,95	702,75	0,87	556	500	0,36	2,33	1,00	0,51	21,80	45,00

Comments

- In Scia Engineer, there is not material for reinforcement steel with $f_{yd} = 391\text{MPa}$. It is necessary to create new reinforcement steel B450B with $f_{yk} = 450\text{MPa}$.
- For correct calculation it is necessary to set angle theta in Setup – Concrete solver – ULS – Shear – set cotangent from reference (2,38).
- It is also necessary to set National annex on DIN (German). Activate checkbox for Show both the default EN and NA method. In EN 1992-1-1 – ULS set all combo-boxes on Standard EN except n_i – strength reduction factor and set correct factor according to the reference (0,616)
- In National annex – EN 1992-1-1 – General - set coefficient α_{cc} value to 0,85
- It is necessary to edit stirrups zone for set Distance to begin on 0,075 (real distance will be than 0,150 mm)
- It is necessary to edit stirrups cover for Edge 2 and 4 on 28 mm because Scia Engineer calculate z value as $z = 0,9*d \rightarrow$ This will set $d = 556\text{mm}$
- In Scia Engineer results column $V_{rd,max}$ is calculated according formula 6.9 from EN 1992-1-1 and column V_{rd} is calculated according formula 6.8 from EN 1992-1-1 – this is formula used in reference