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Punching shear resistance of continuous RC slab compared to experimental specimens

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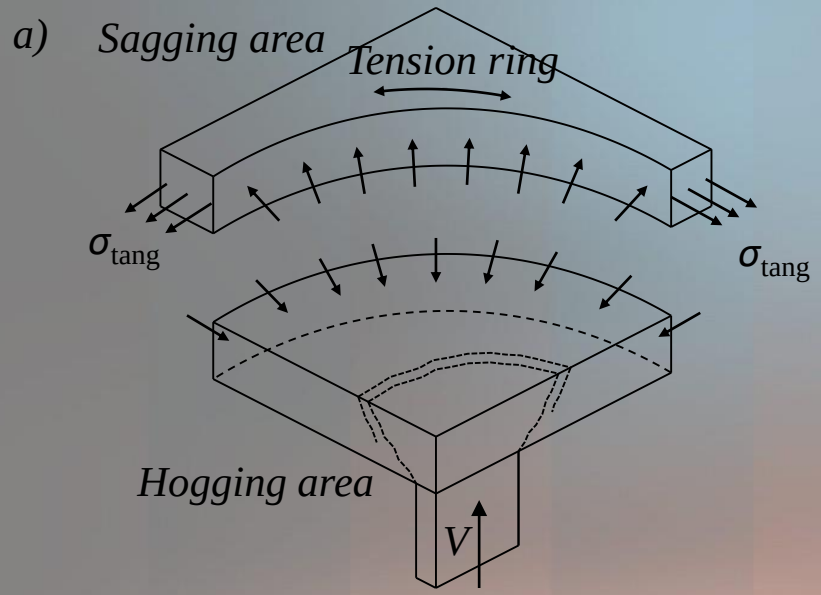
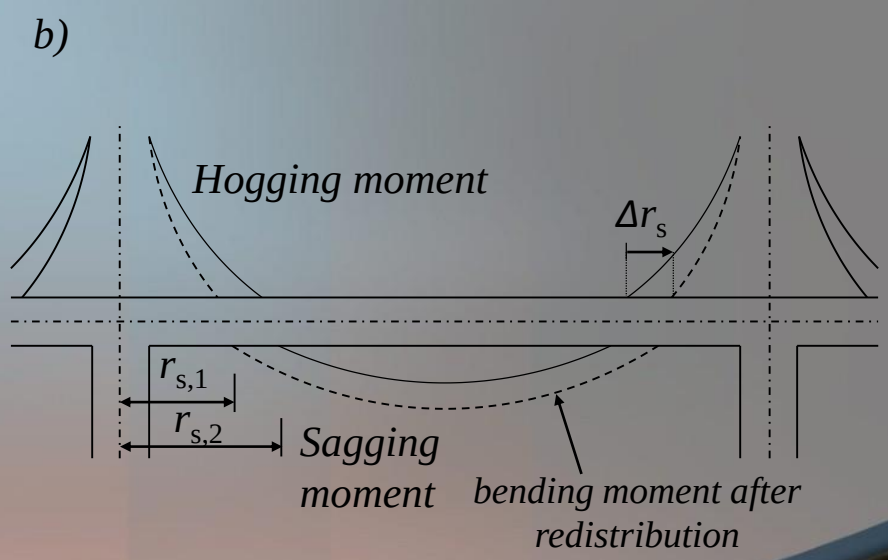
Introduction

- the experimental results on the basis of which the punching shear resistance of reinforced concrete flat slab were derived (Eurocode 2, Model Code 2010) were determined on isolated specimens,
- the effect of membrane actions and redistribution of bending moments can not be taken into account.





Eurocode 2

$$V_{Rd,c} = \frac{C_{Rk,c}}{\gamma_C} k (100 \rho_l f_{ck})^{1/3} u_1 d$$

where:

$C_{Rk,c}$ - empirical factor [MPa];

γ_C - partial safety factor, γ_C = 1.5 [-];

k - the size factor, $k = 1 + (200[\text{mm}]/d)^{0.5} \leq 2.0$ [-];

ρ_l - reinforcement ratio, $\rho = (\rho_x \rho_y)^{0.5}$ [-];

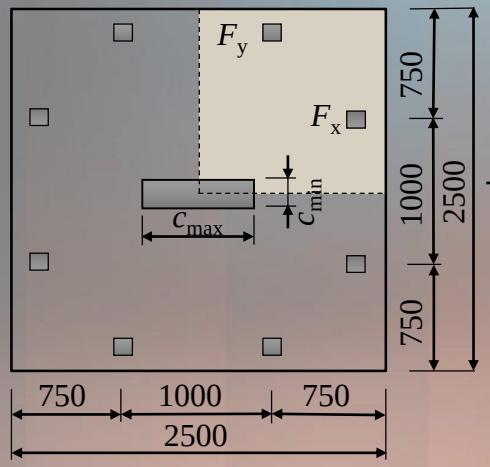
f_{ck} - characteristic concrete compressive cylinder strength [MPa];

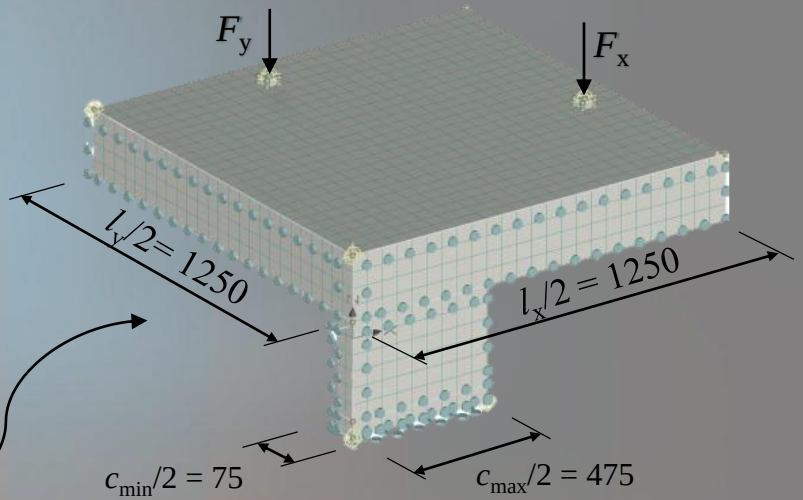
u_1 - shear-resisting basic control perimeter at distance of $2d$ from the face of a column [mm];

d - effective depth [mm].

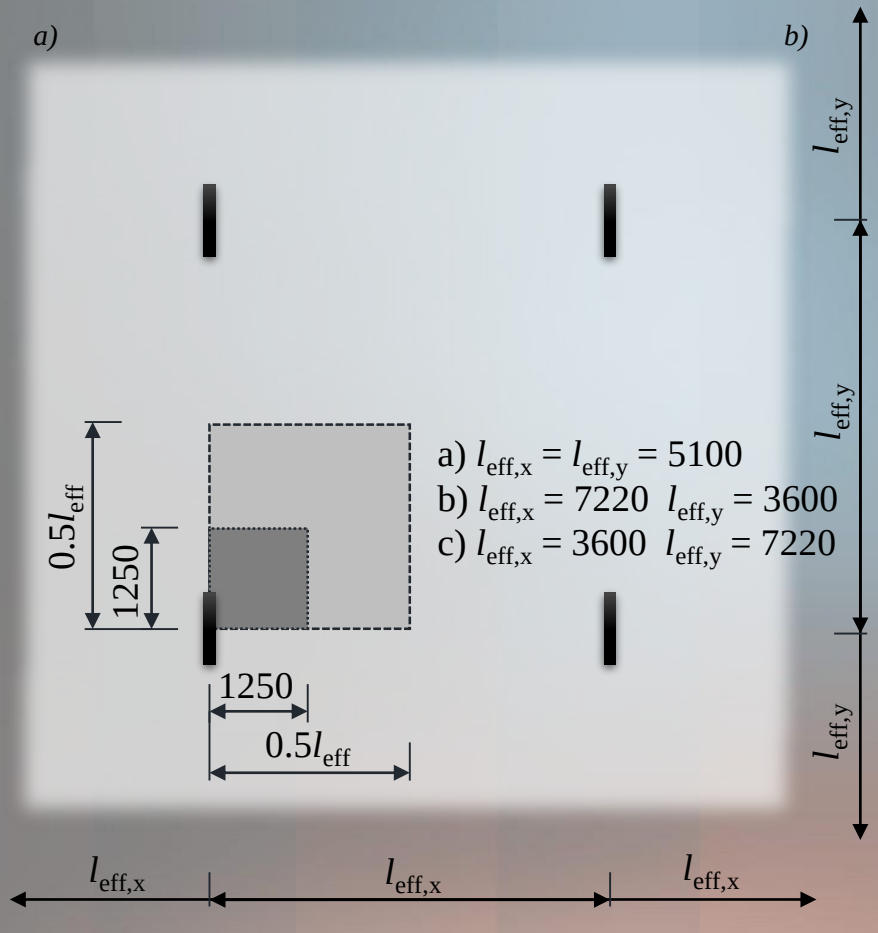
The non-linear analysis

- program Atena (only a quarter of the specimen was modeled)
- the first step - an appropriate finite element mesh and the necessary number of iterations
- two types of brick mesh – with side of 0.05 m and 0.04 m
- test specimens:
  - dimensions – 2.5 x 2.5 x 0.2 m
  - support – rectangular column 0.15 x 0.9 m
  - reinforcement – Ø16/100 (ρ_l = 1.26 %)
  - no transverse reinforcement
  - nominal effective depth (*d*) - 159 mm

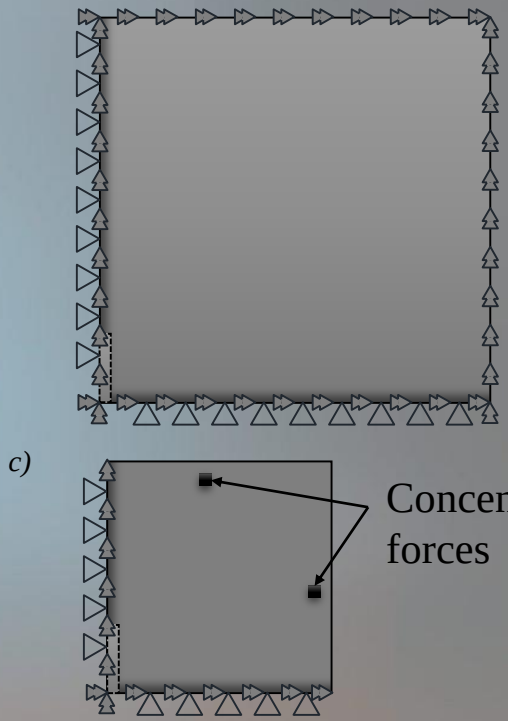




Boundary conditions



a) $l_{eff,x} = l_{eff,y} = 5100$
b) $l_{eff,x} = 7220$ $l_{eff,y} = 3600$
c) $l_{eff,x} = 3600$ $l_{eff,y} = 7220$



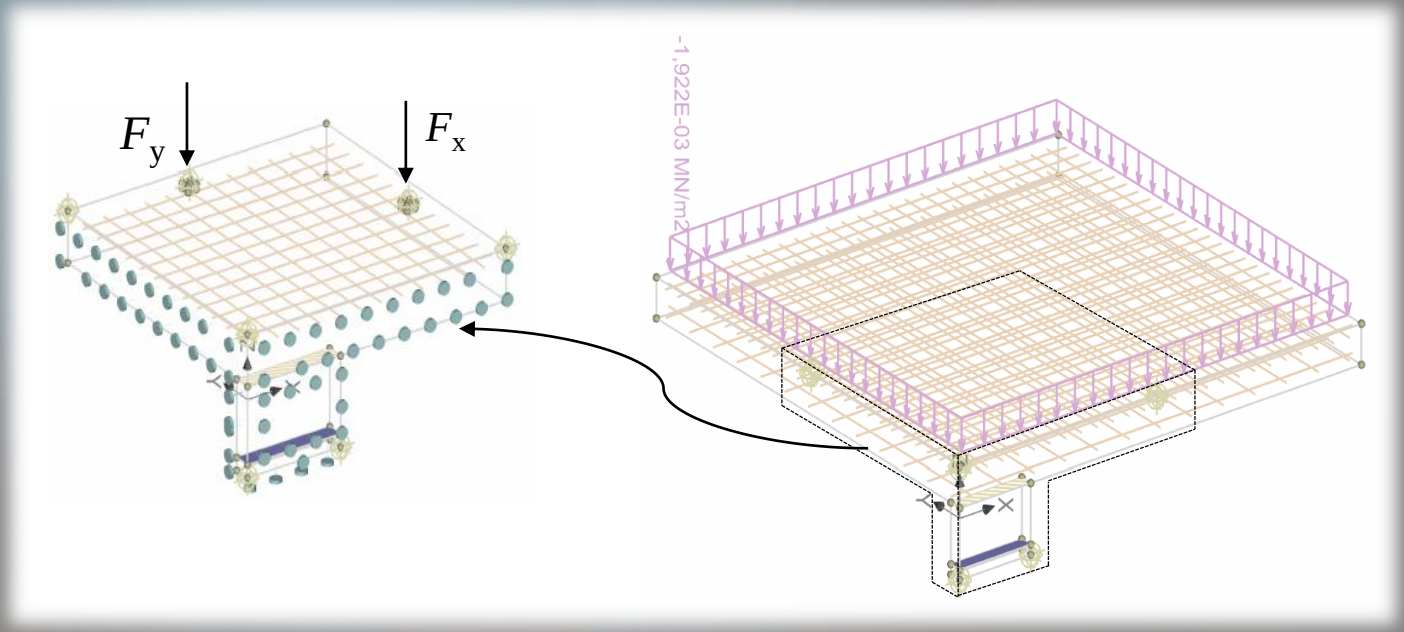
- rotation around *x*
- rotation around *y*
- translation on *x*
- translation on *y*

Loading conditions

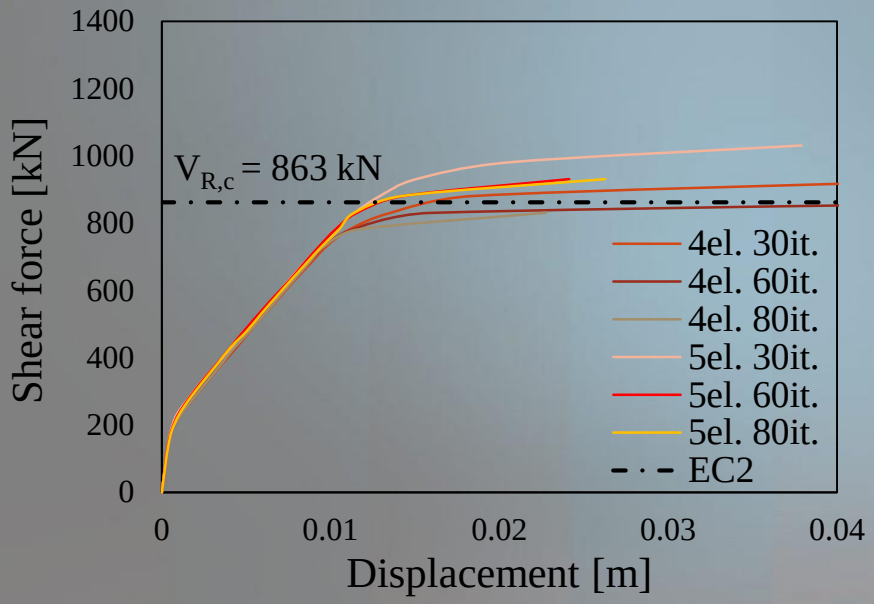
Loading XY
$F_x = F_y = 6.25$ kN

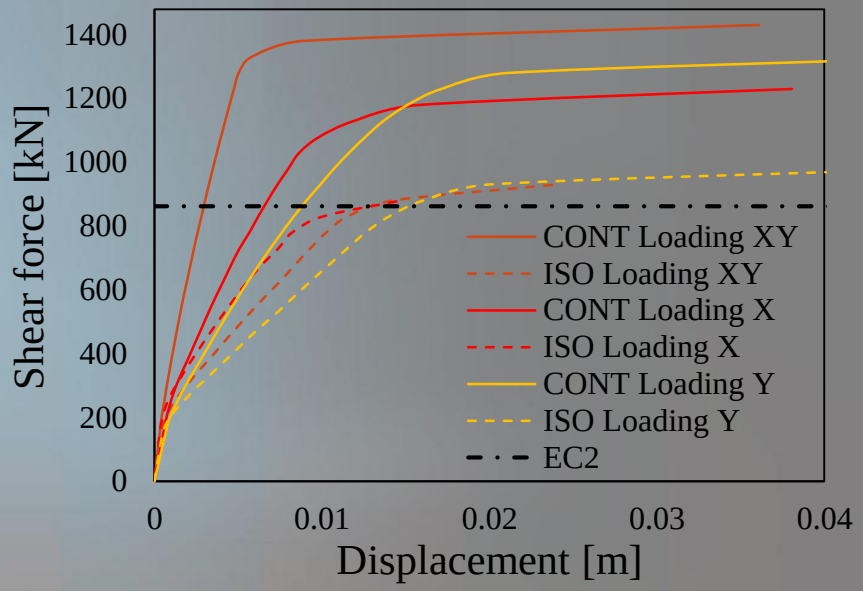
Loading X
$F_x = 8.33$ kN
$F_y = 4.17$ kN

Loading Y
$F_x = 4.17$ kN
$F_y = 8.33$ kN



Results


1400
1200
1000
800
600
400
200
0
Shear force [kN]
$V_{R,c}$ = 863 kN
0
0.01
0.02
0.03
0.04
Displacement [m]
4el. 30it.
4el. 60it.
4el. 80it.
5el. 30it.
5el. 60it.
5el. 80it.
EC2


1400
1200
1000
800
600
400
200
0
Shear force [kN]
0
0.01
0.02
0.03
0.04
Displacement [m]
CONT Loading XY
ISO Loading XY
CONT Loading X
ISO Loading X
CONT Loading Y
ISO Loading Y
EC2

Results

	$V_{R,c,EC}$ [kN]	$V_{R,ATENA}$ [kN]		$V_{R,c,CONT} / V_{R,c,ISO}$ [-]
		Isolated slab model $V_{R,c,ISO}$	Continuous flat slab $V_{R,c,CONT}$	
Loading XY	863	930	1380	1.48
Loading X		880	1180	1.34
Loading Y		930	1330*	1.43
Note: * bending failure occurred in continuous slab				

Conclusions:

1. The effect of membrane action was confirmed and it reaches up to 34 - 48 % beneficial influence.
2. The magnitude of influence of the membrane action could not be confirmed in Loading case Y, as the continuous slab led to bending failure.

Thank you for your attention