Imperial College London

S1 – Roi Sanjurjo Fortes

STRUCTURAL PERFOMANCE OF HYBRID REINFORCED CONCRETE/STEEL FLOOR SYSTEMS

Roi Sanjurjo Fortes **Supervisor: Prof Ahmed Y. Elghazouli, Dr Dan V. Bompa**

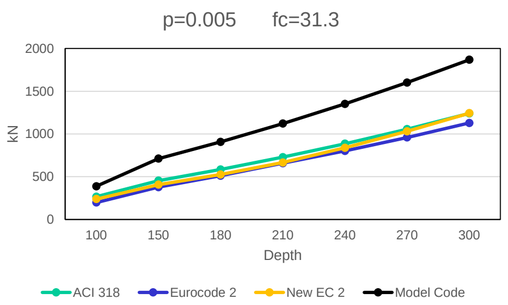
Department of Civil and Environmental Engineering

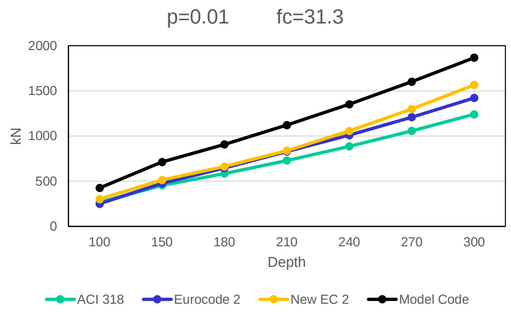
Imperial College London

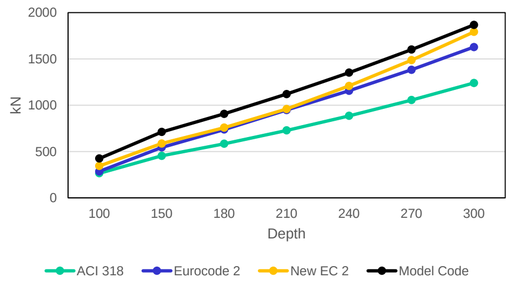
INTRODUCTION

The use of shearheads enhances the performance of reinforce concrete floors with steel columns. Since its application is not extended and the codes of practice such as the Eurocode 2 do not contemplate its use in buildings, a comparison in punching shear is made between the ACI 318, the Eurocode 2 and the Model Code 2010, which is strongly based on physical theories.

CODES OF PRACTICE COMPARISON







- Since the design formulae of ACI 318 are not dependent on the flexural reinforcement ratio, the values obtained are the same in all graphs.
- Although the results obtained from the Model Code 2010 increase with the reinforcement ratio, they are very similar in all the graphs because the most relevant parameters are the concrete strength, dimensions of the column and slab size.
- The values from Eurocode 2 increase with the flexural reinforcement. This is due to the proportionality between the punching capacity and this ratio.

CHANGE IN THE FORMULATION OF EUROCODE 2

Based on an assessment between the experimental results, accounting in the test of 11 slabs to punching shear failure, and the design values obtained from the codes a new formulation for the Eurocode 2 was proposed.

Punching shear capacity in Eurocode 2:

$$V_{Rd,c} = C_{Rd,c} * k * (100 * \rho_l * f_{ck})^{1/3} \quad (1)$$

Eurocode 2: $$k = 1 + \sqrt{\frac{200}{d}} \leq 2 \quad (2)$$

- Results obtained with the formulation provided were conservative (1)(2).
- As the effective depth increases the values for the parameter decrease.

Proposed parameter:

$$k = 1 + \sqrt{\frac{200}{d}} \quad (3)$$

$$2.15 \geq k \geq 2 \quad (4)$$

- The punching capacity for high heights of the slab were very low.
- The new boundary restraints of the parameter are meant to not lose accuracy in case of designing thin or fat slabs (4)(5).
- The upper bound given in the equation 5 takes into account the size effects theory.

$$150 \leq d \leq 450 \quad (5)$$

ACKNOWLEDGEMENTS

I would like to express a sincere feeling of gratefulness to Dr Dan V. Bompa and Prof Ahmed Y. Elghazouli for his advice, support, guidance and encouragement during the project.

PROPOSED FORMULATION FOR SHEARHEADS

The use of shearheads increase the punching shear capacity of reinforced concrete slabs. Therefore, a procedure is proposed to account the contribution of its use in punching shear design.

$$V_{Rd} = V_{Rd,c} + V_{SH}$$

V_{Rd}, is the nominal punching shear capacity.

$V_{Rd,c}$, is the concrete contribution to the punching shear capacity. Calculated with the codes of practice.

V_{SH}, is the shearhead contribution to the punching shear capacity.

$$V_{SH} = n * \frac{l_v}{c_s} * V_{Pl,Rd}$$

n, is the number of shearheads per side.

l_v, is the length of the shearhead.

c_s, the length of the column side.

$V_{Pl,Rd}$, is the plastic shear resistance from the Eurocode 3.

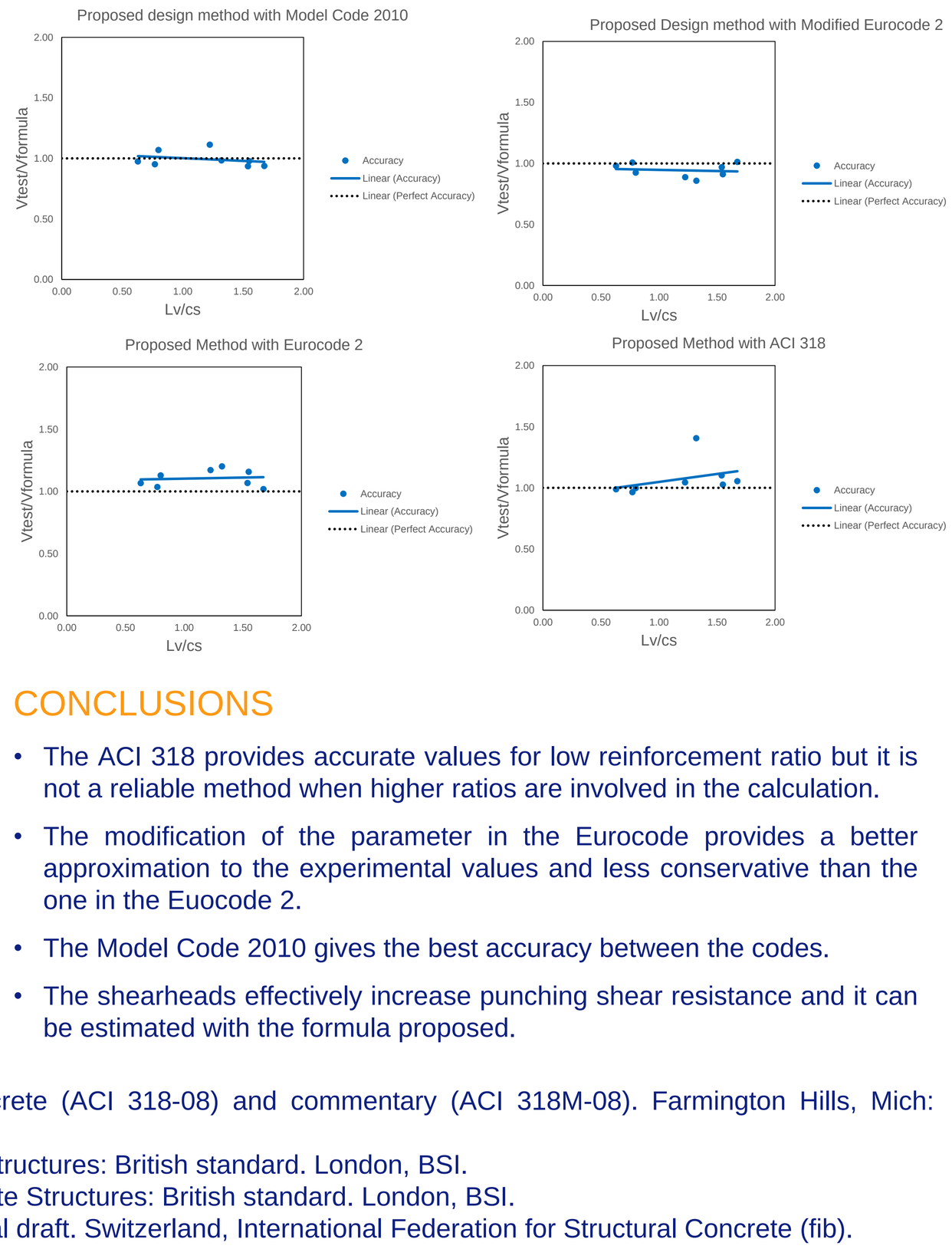
$$V_{Pl,Rd} = {A_v * f_y}/{(\sqrt{3} * \gamma_{M0})}$$

A_v, is the shear area.

f_y, is the yield strength.

γ_{M0}, is the partial factor for resistance of cross-sections whatever the class is.

PROPOSED PROCEDURE ACCURACY



CONCLUSIONS

- The ACI 318 provides accurate values for low reinforcement ratio but it is not a reliable method when higher ratios are involved in the calculation.
- The modification of the parameter in the Eurocode provides a better approximation to the experimental values and less conservative than the one in the Euocode 2.
- The Model Code 2010 gives the best accuracy between the codes.
- The shearheads effectively increase punching shear resistance and it can be estimated with the formula proposed.

REFERENCES

ACI Committee 318. 2008. Building code requirements for structural concrete (ACI 318-08) and commentary (ACI 318M-08). Farmington Hills, Mich: American Concrete Institute.

BRITISH STANDARDS INSTITUTION. (2005). Eurocode 3: Design of Steel Structures: British standard. London, BSI.

BRITISH STANDARDS INSTITUTION. (2008). Eurocode 2: Design of Concrete Structures: British standard. London, BSI.

FÉDÉRATION INTERNATIONALE DU BÉTON. (2012). Model code 2010: final draft. Switzerland, International Federation for Structural Concrete (fib).