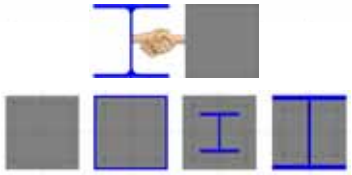
"St. CIRIL and METHODIUS" UNIVERSITY
FACULTY OF CIVIL ENGINEERING
SKOPJE - MACEDONIA



JOVANOSKA MILICA, CVETKOVSKA MERI

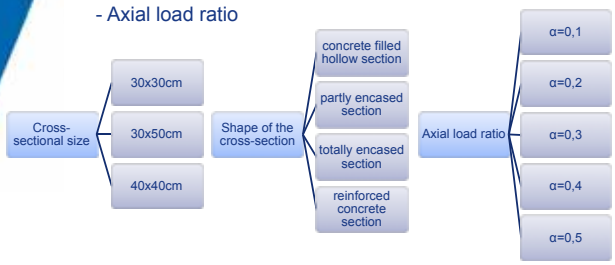
THE INFLUENCE OF CROSS-SECTION SHAPE ON FIRE RESISTANCE OF COMPOSITE CONCRETE-STEEL COLUMNS

STUDY CASE. INPUT PARAMETERS

- Column length: L=3m
- Suport condition: pinned-fixed
- Load case: centrically loaded
- Concrete compressive strength fc(20°C)=30Mpa
- Steel profile yielding strength fy=400Mpa
- Reinforcement yielding strengthh fy=400Mpa
- All sides exposed to fire

VARIABLES CONSIDERED IN THE STUDY

- Shape of the cross section
- Cross sectional size
- Axial load ratio



COMPUTER PROGRAM FIRE

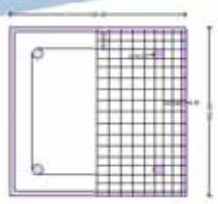
Module FIRE-T: Nonlinear transient heat flow

Module FIRE-S: Nonlinear stress-strain response associated with fire

-Thermal expansion
-Shrinkage
-Creep
-Cracking, crushing
-Temperature dependent material properties are considered
-The spalling is not taken into account

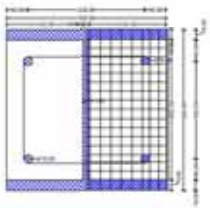
-Two dimensional heat transfer is assumed
-Fire is modeled by a single valued gas temperature history, according to ISO 834
-No contact resistance to heat transmission at the interface between the steel and concrete occurs
-The easier heat penetration because of cracks and crush, is neglected
- Buckling and geometrical imperfections are not taken into account

CONCRETE FILLED HOLLOW SECTION CFH30



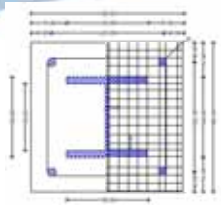
Rectangular Hollow Section 300.300.8
Reinforcement 4ϕ18
Nu=6533kN

PARTLY ENCASED SECTION PE30



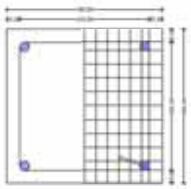
HE300B
(b=300, h=300, d=19, t=11mm)
Reinforcement 4ϕ16
Nu=8276kN

TOTALLY ENCASED SECTION TE30



HE160
(b=160, h=160, d=8, t=13mm)
Reinforcement 4ϕ16
Nu=5931kN

REINFORCED CONCRETE SECTION RC30



Cross sectional size 30x30cm
Reinforcement 4ϕ18
Nu=3077kN

COMPUTER PROGRAM FIRE

Isotherms in the cross section

t=0,5h

RC30 PE30 CFH30 TE30

t=1h

COMPUTER PROGRAM FIRE

Isotherms in the cross section

t=2h

RC30 PE30 CFH30 TE30

t=3h

COMPUTER PROGRAM FIRE

Isobars in the cross section -cracked concrete

α =0.1
t=1h

RC30 PE30 CFH30 TE30

α=0.1
t=2h

COMPUTER PROGRAM FIRE

Isobars in the cross section -cracked concrete

α=0.2
t=1h

RC30 PE30 CFH30 TE30

α=0.2
t=1,5h

COMPUTER PROGRAM FIRE

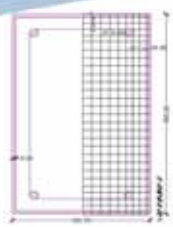
Isobars in the cross section -cracked concrete

α=0.3
t=0,5h

RC30 PE30 CFH30 TE30

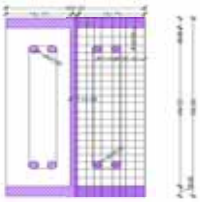
α=0.3
t=1h

CONCRETE FILLED HOLLOW SECTION CFH50



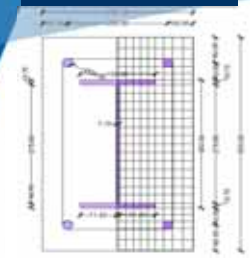
Rectangular Hollow Section 300.500.8
Reinforcement 4ϕ18
Nu=9517kN

PARTLY ENCASED SECTION PE50



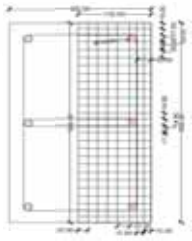
HE500B
(b=300, h=500, d=28, t=14.5mm)
Reinforcement 8ϕ20
Nu=14027kN

TOTALLY ENCASED SECTION TE50



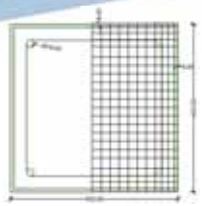
IPE160
(b=150, h=300, d=10.7, t=7.1mm)
Reinforcement 4ϕ20
Nu=6883kN

REINFORCED CONCRETE SECTION RC50



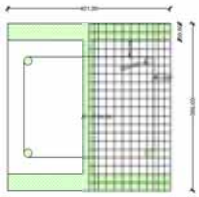
Cross sectional size 30x50cm
Reinforcement 6ϕ18
Nu=5066kN

CONCRETE FILLED HOLLOW SECTION CFH40



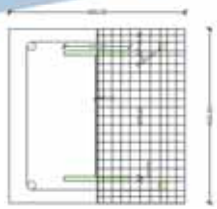
Rectangular Hollow Section 400.400.8
Reinforcement 4ϕ18
Nu=9817kN

PARTLY ENCASED SECTION PE40



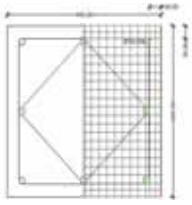
HD400x314
(b=401, h=399, d=39,6, t=24,9mm)
Reinforcement 4ϕ20
Nu=19963kN

TOTALLY ENCASED SECTION TE30



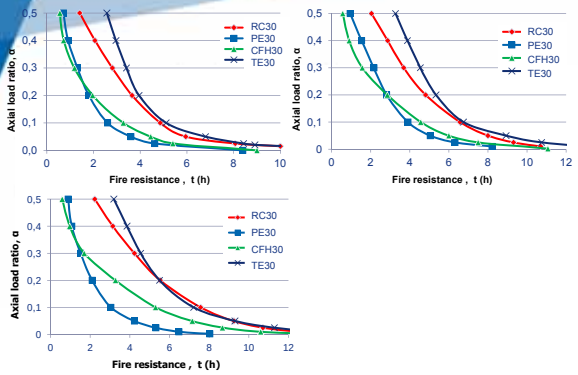
I30
(b=150, h=300, d=10,7, t=7,1mm)
Reinforcement 4ϕ20
Nu=7183kN

REINFORCED CONCRETE SECTION RC30

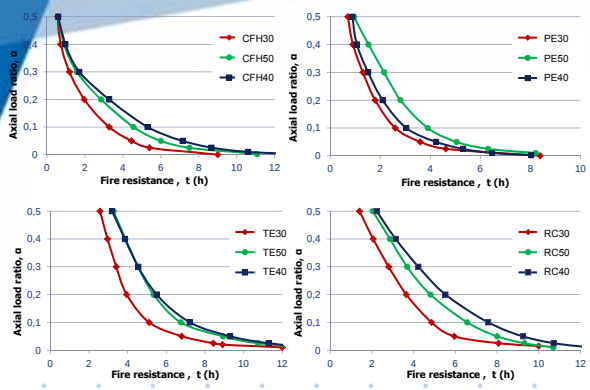


Cross sectional size 40x40cm
Reinforcement 8ϕ16
Nu=5392kN

COMPARATIVE ANALYSIS



COMPARATIVE ANALYSIS



COMPARATIVE ANALYSIS

-For a load coefficient from 0.1 to 0.3, which is a very common case in practice, the fire resistance of PE and CFH is approximately 35-50% of the fire resistance of TE section

*The steel profiles significantly increase the initial bearing capacity. Because of the peripheral position of the steel it is heated to high temperatures. Reduction of the mechanical propertiese of steel is caused, which results in lower fire resistance

-The bigger the dimensions are, the slowly the section is heated, achieving higher fire resistance

*There is an exception for the partly encased section - in the section with 40x40cm, the steel profile participates with 25,6%, while in the section with 30x50cm only 17%

THANK YOU !!!