Prestressing in steel fibre reinforced concrete

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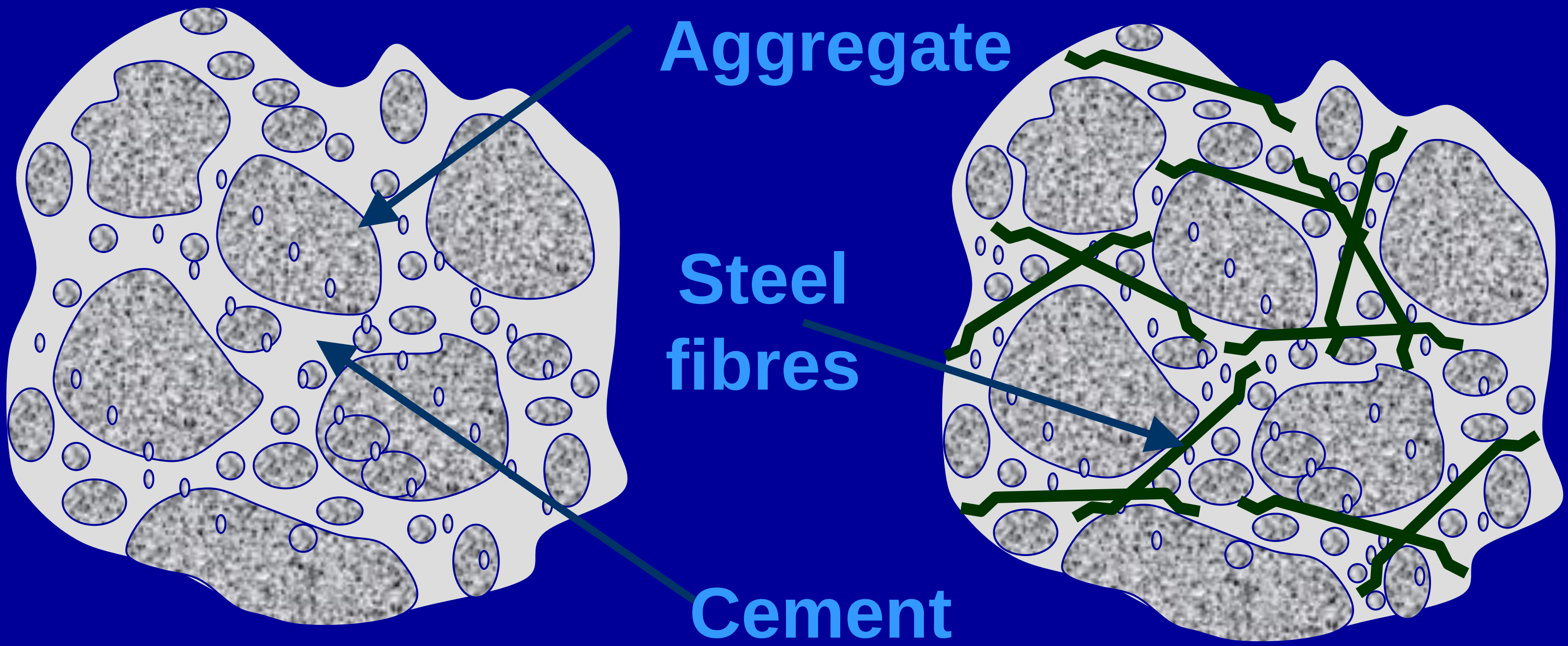
Steel fibre reinforced concrete

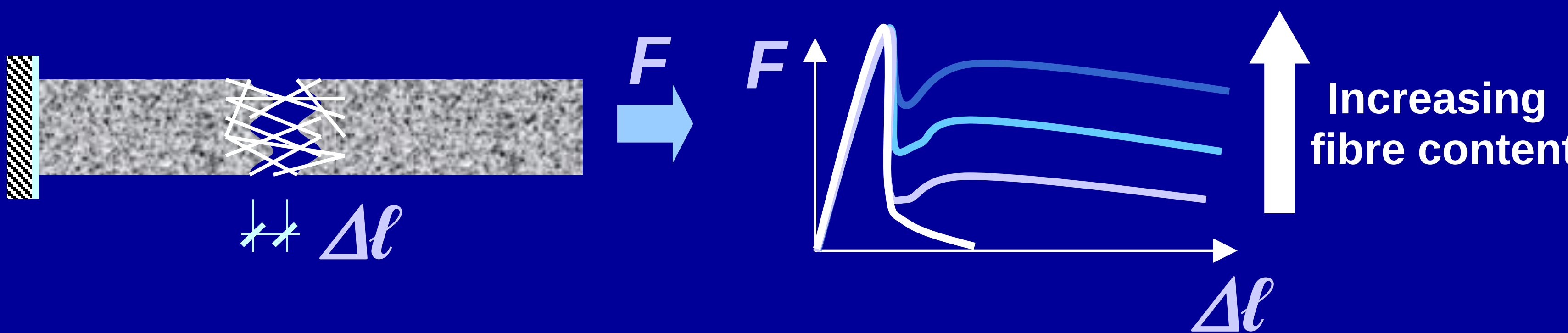


Plain concrete

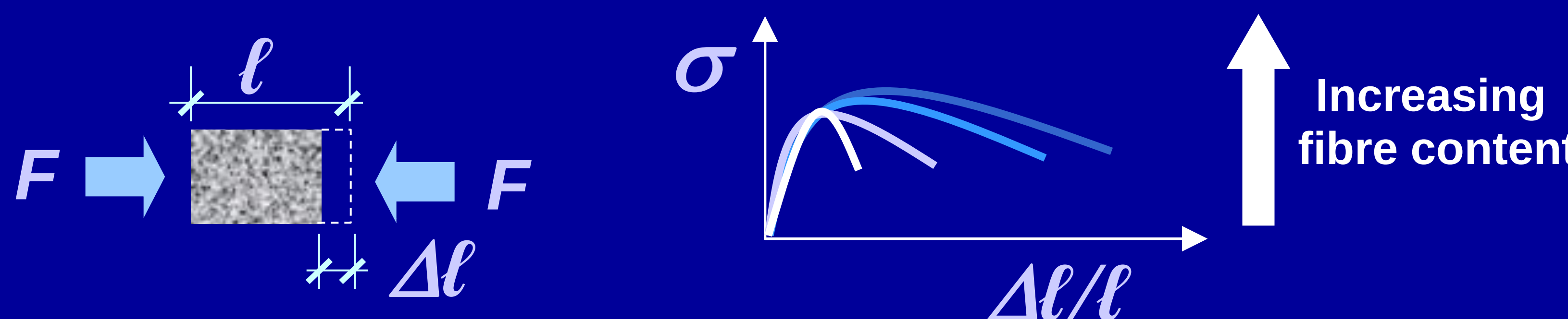
Steel fibre reinforced concrete

Behaviour of SFRC

Tension *(Balaguru & Shah, Naaman & Reinhardt, Rossi)*

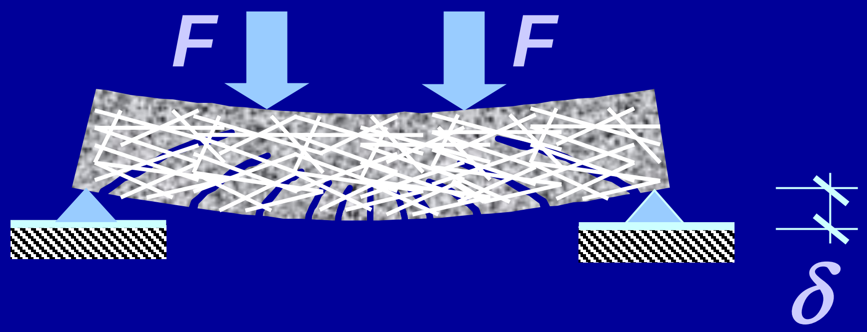


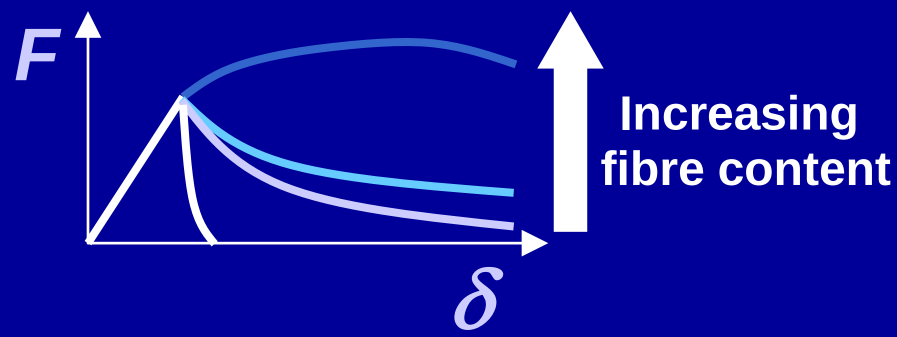
Compression *(Balaguru & Shah, Naaman & Reinhardt, Balázs L.)*



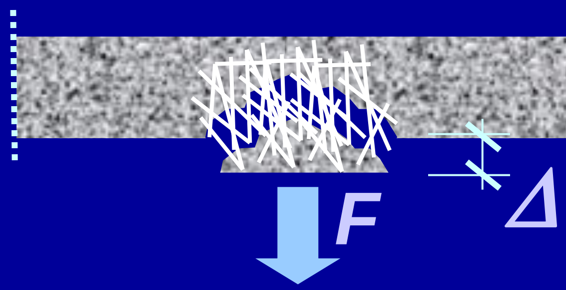
Behaviour of SFRC

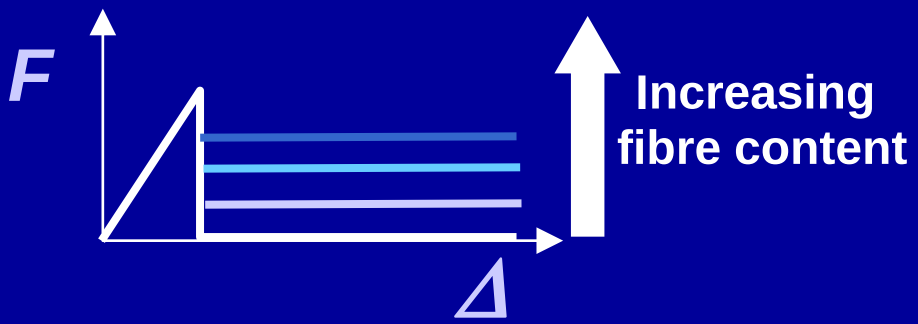
Bending *(Balaguru & Shah, Erdélyi, Magyari, Falkner, Kovács)*





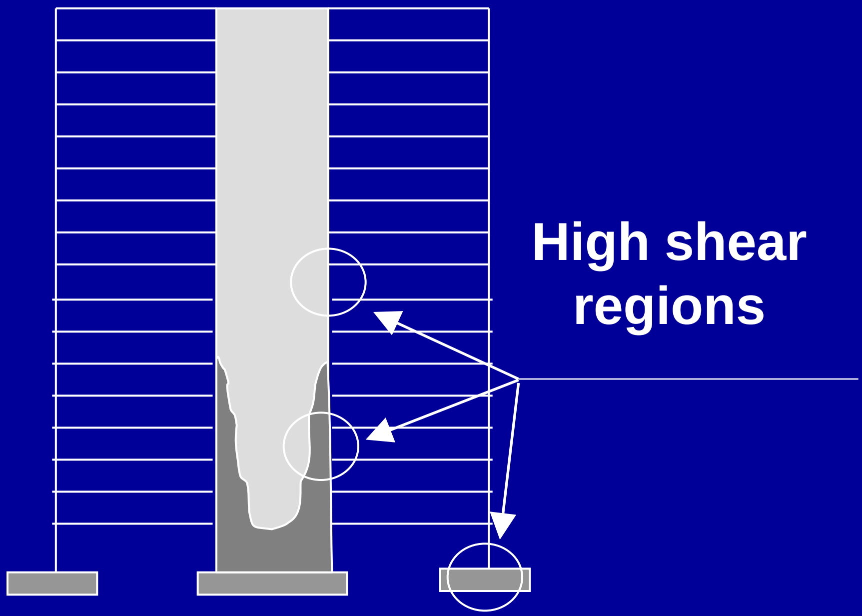
Effect of local force *(Falkner)*

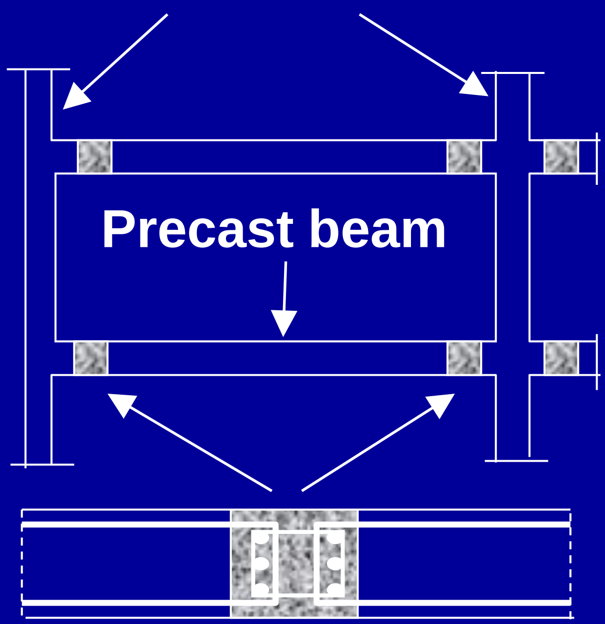




Structural application of SFRC

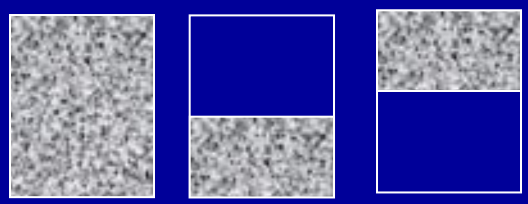
Examples of different use of steel fibre reinforcement in seismic resistance and pre cast structures after Naaman & Reinhardt





Use of SFRC in cross section

Steel fibre reinforcement in concrete members



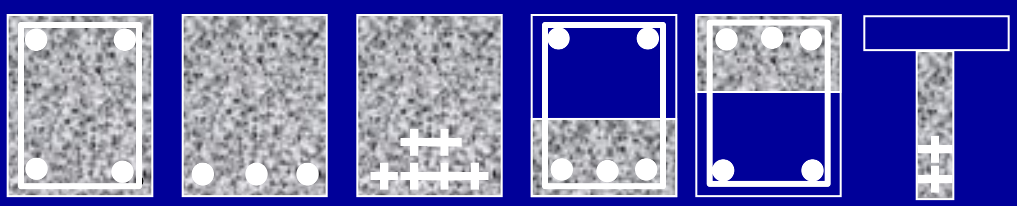
Concrete

Fibre reinforced concrete

Reinforcing bar

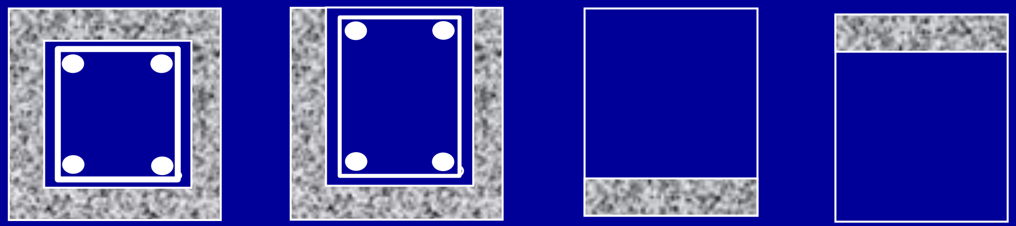
+ Prestressing

Steel fibre reinforcement in reinforced concrete and prestressed concrete members

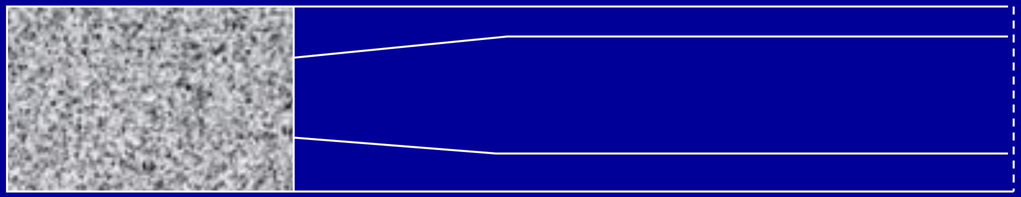


Use of SFRC in cross section

Steel fibre reinforcement in repair and strengthening of concrete members



Steel fibre reinforcement in the end block region of prestressed member



PC beams

0 V% Dramix® ZC 30/.5 hooked-end fibres

PC-G1

0.5 V% Dramix® ZC 30/.5 hooked-end fibres

PC-G2

1.0 V% Dramix® ZC 30/.5 hooked-end fibres

PC-G3

0 V% Dramix® ZC 30/.5 hooked-end fibres

PC-S1

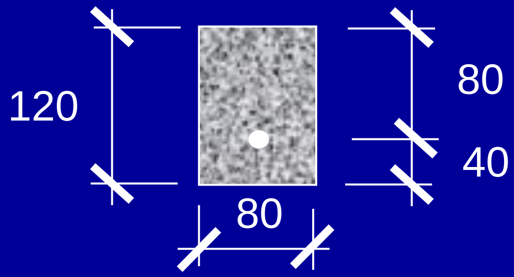
0.5 V% Dramix® ZC 30/.5 hooked-end fibres

PC-S2

1.0 V% Dramix® ZC 30/.5 hooked-end fibres

PC-S3

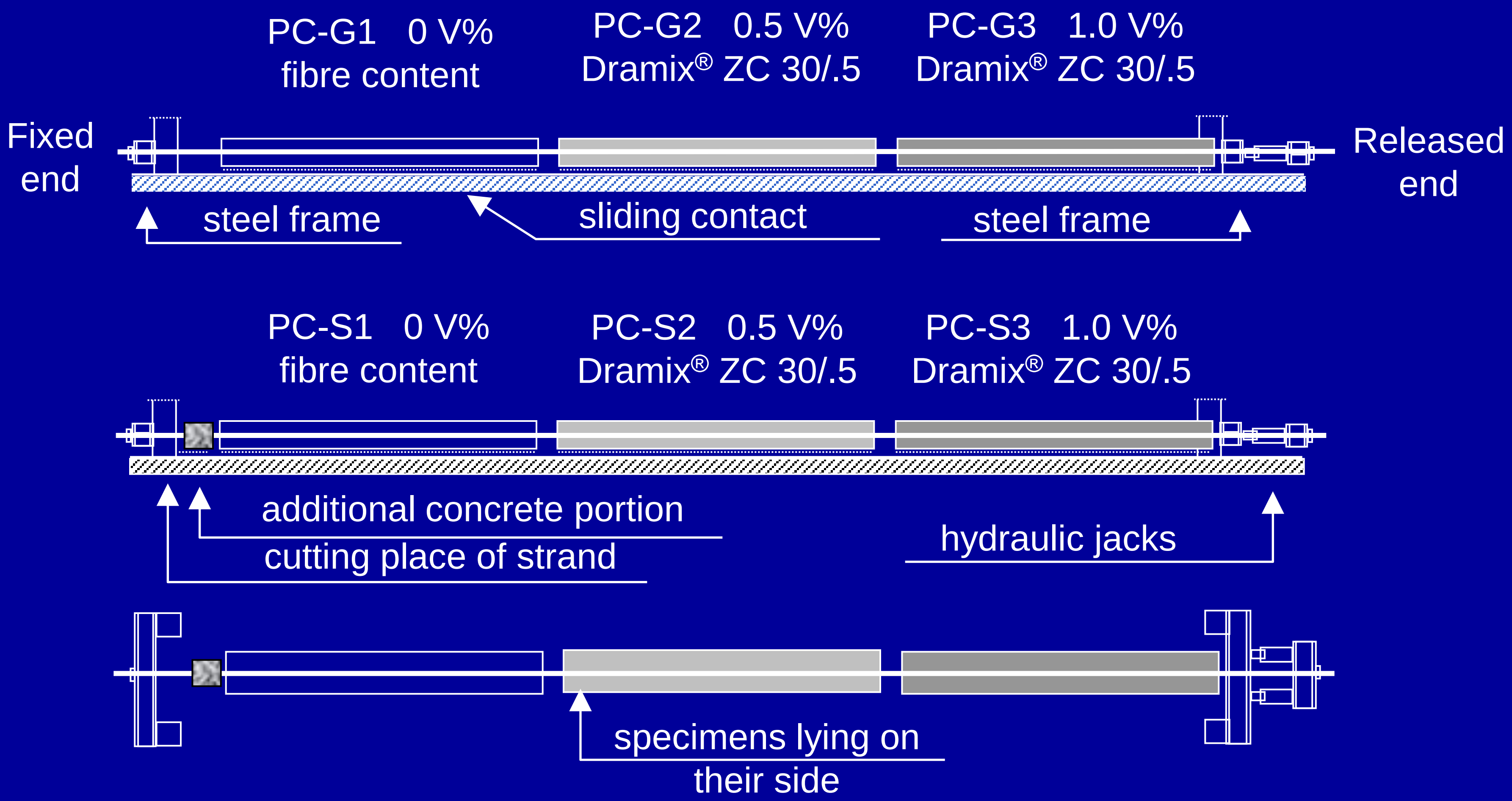
Seven-wire strand
Ø12.7 mm
A_p = 100 mm^2
f_{ptk} = 1770 MPa
$f_{pt,0.1}$ = 1770 MPa
E_p = 193700 MPa



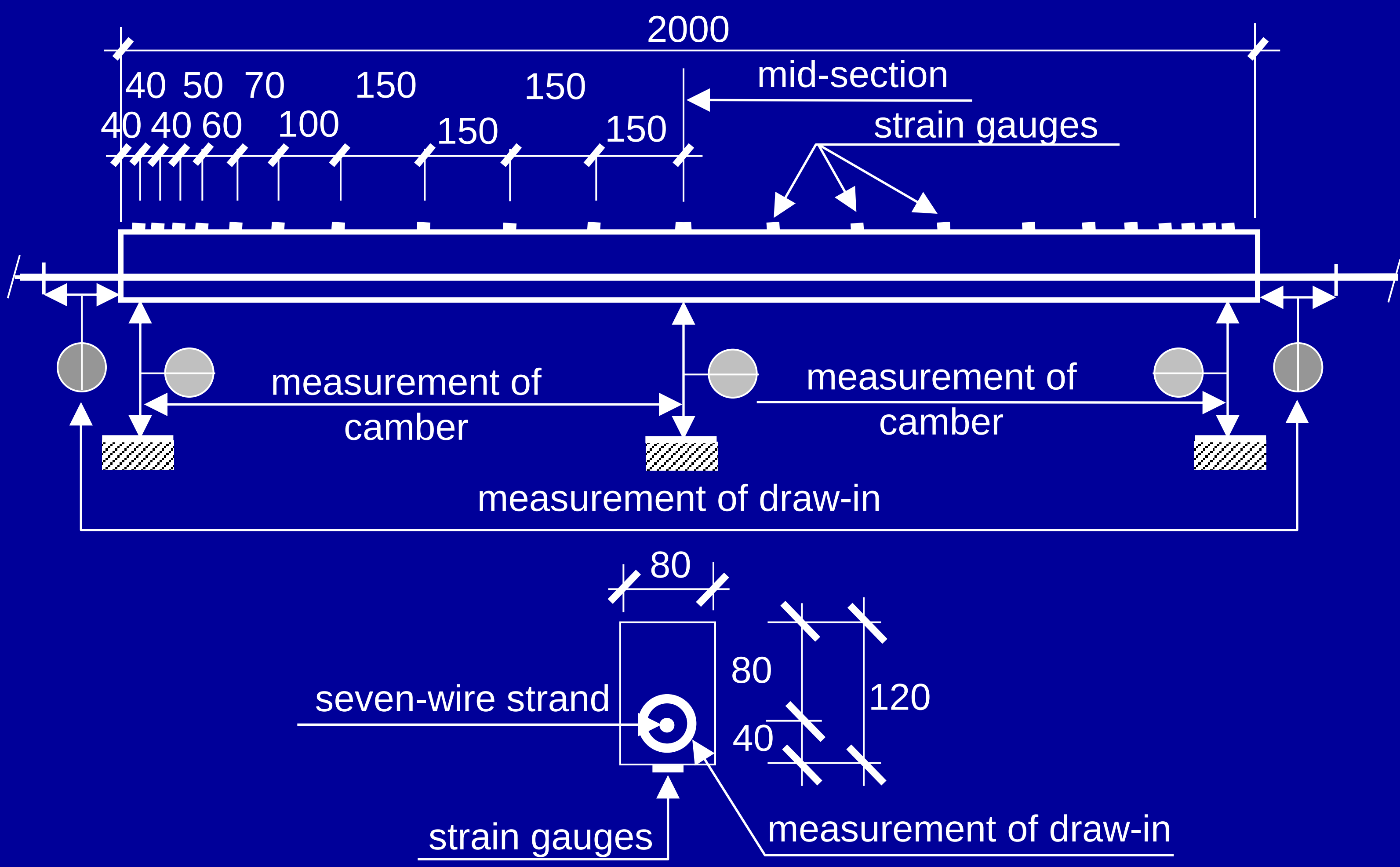
G: gradual release

S: sudden release

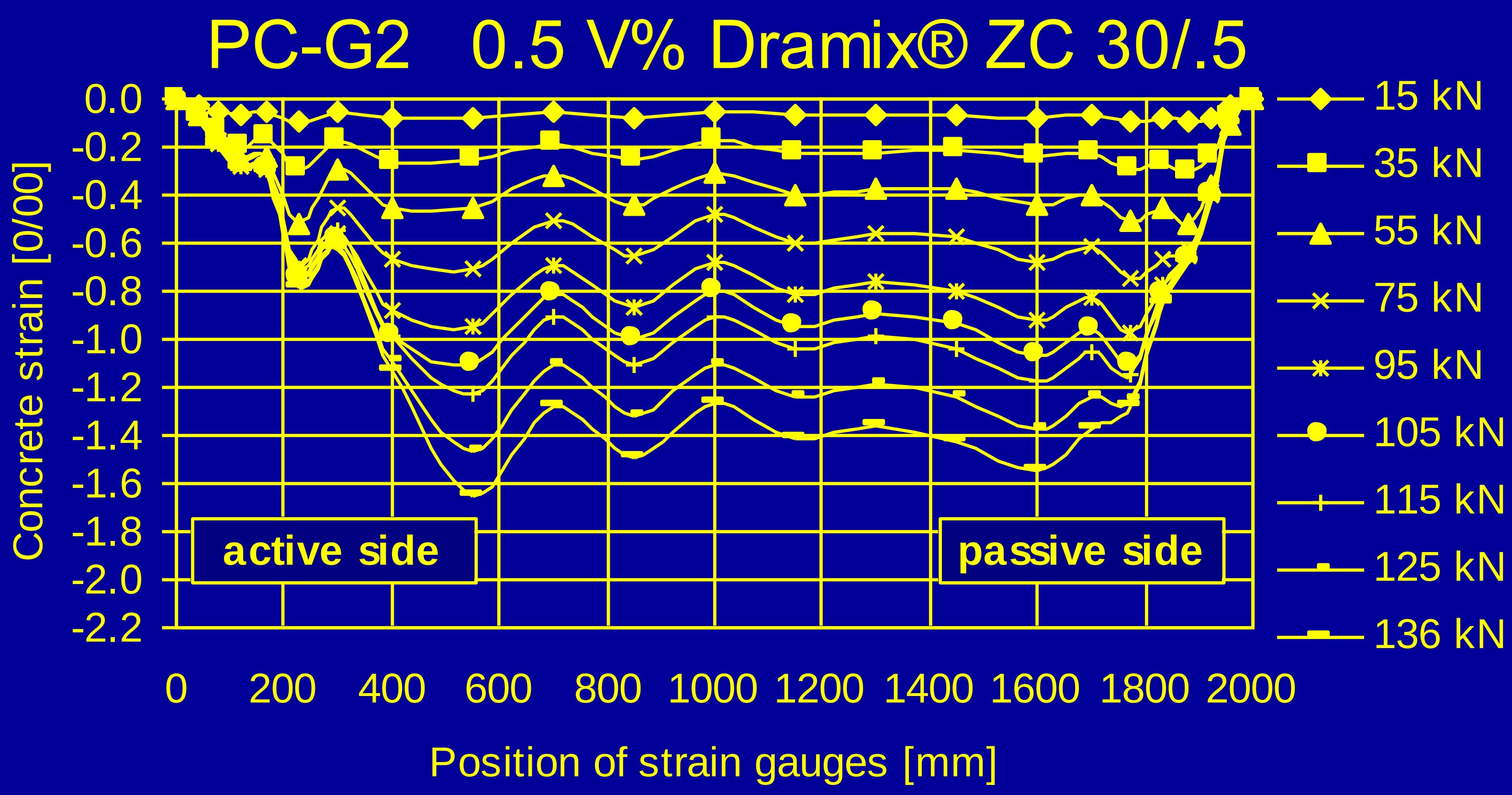
Specimens under tension release



Measuring systems on PC beams

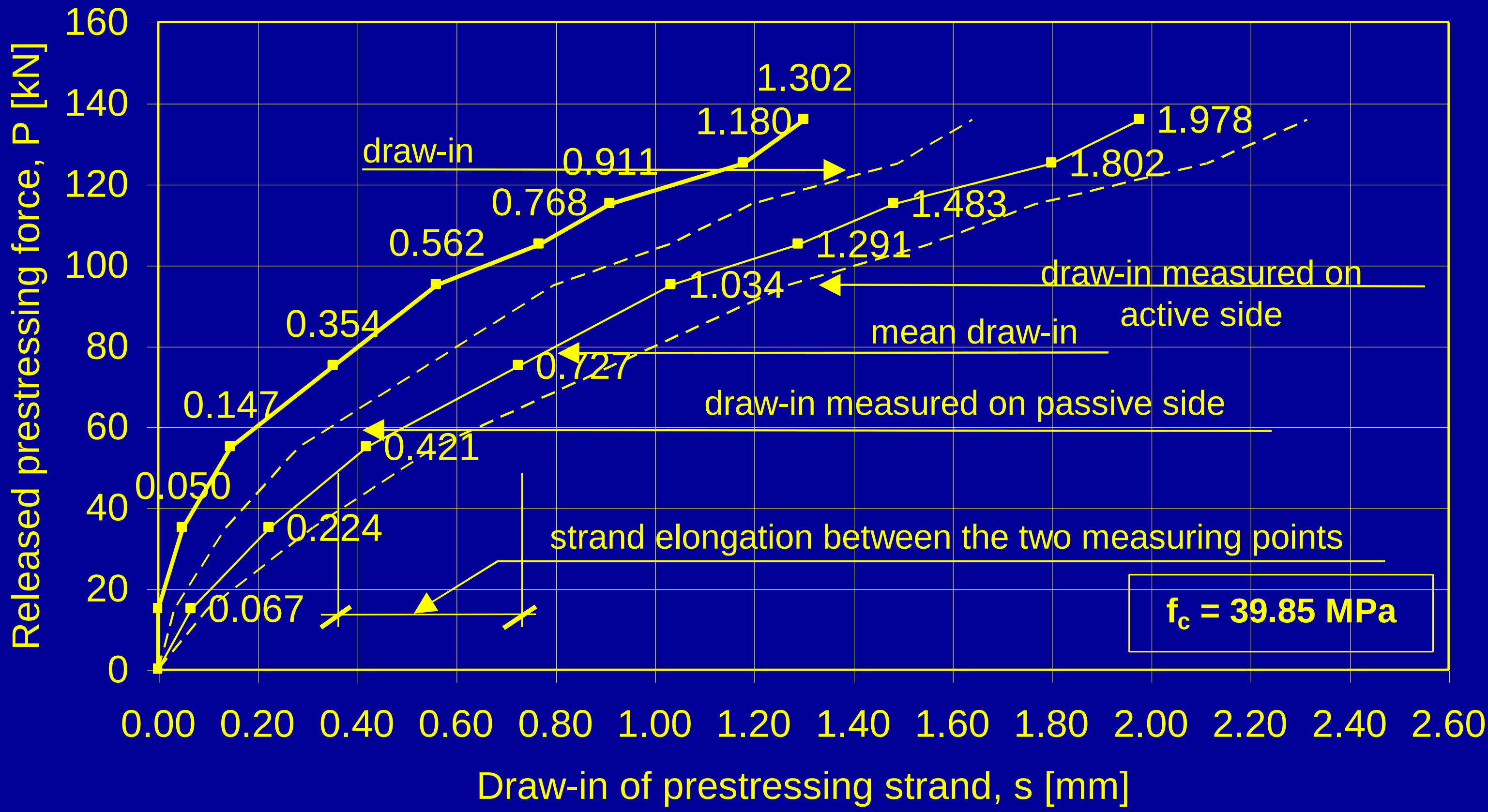


Concrete strains during tension release

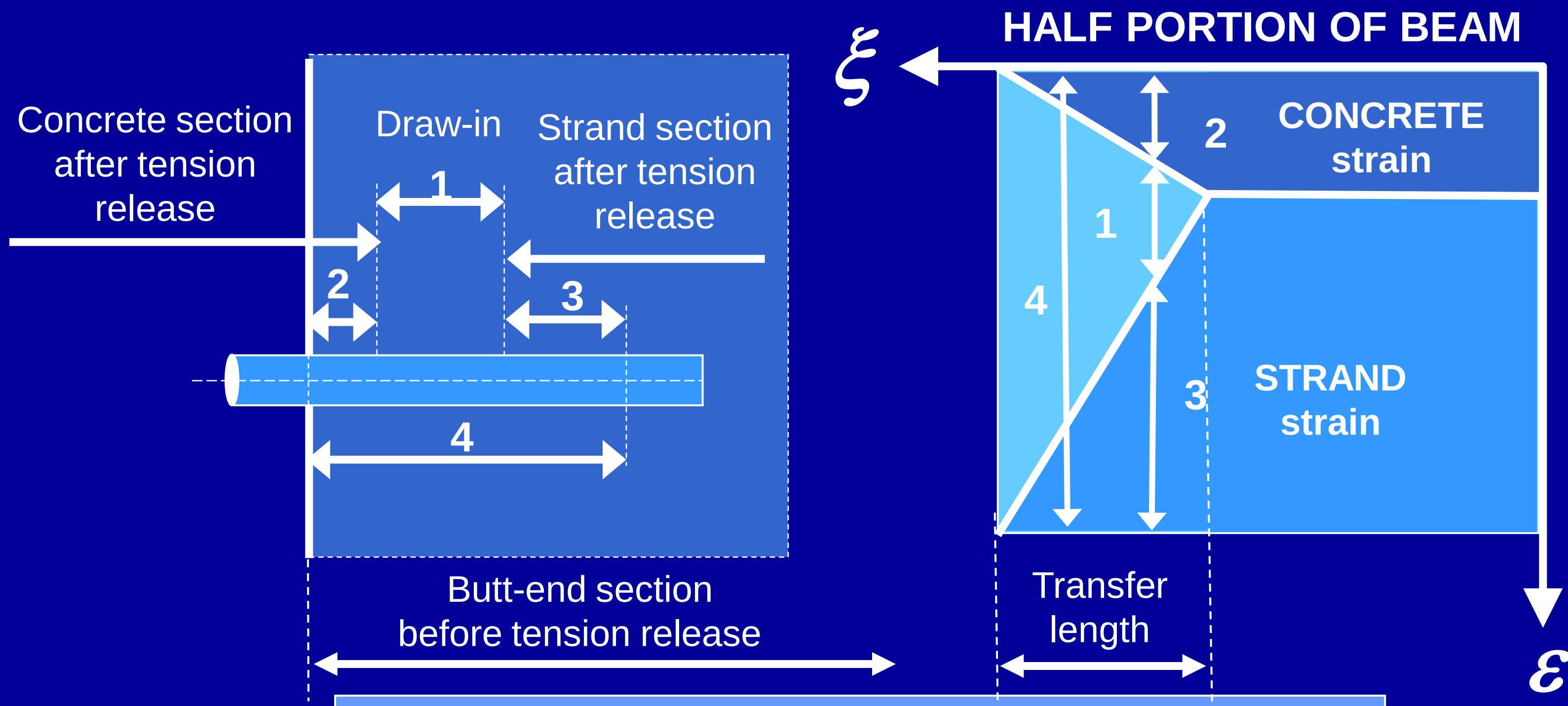


Draw-in of prestressing strand during tension release

PC-G2 - 0.5 V% Dramix® ZC 30/.5



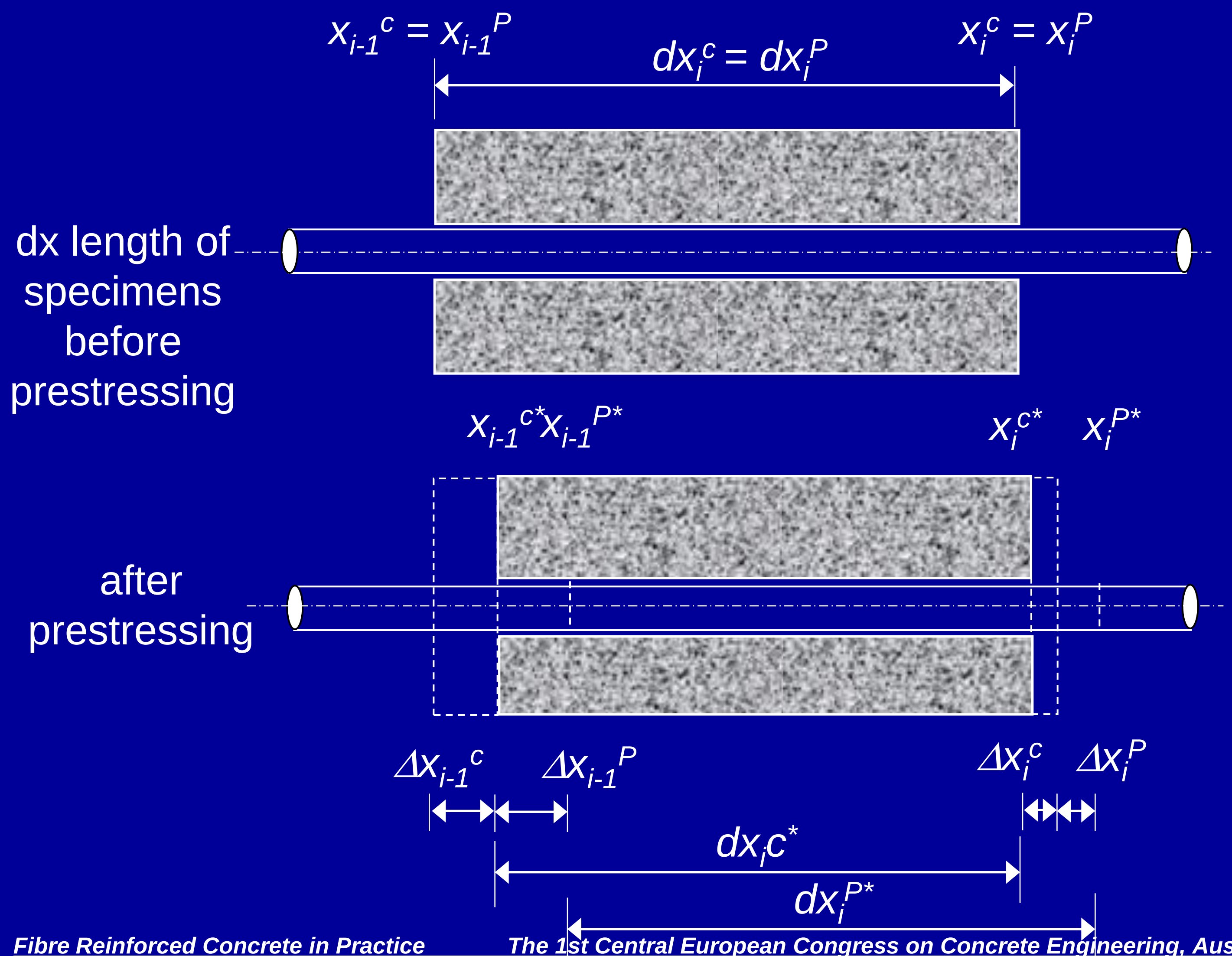
Definition of transfer length



1 4 2 3

$$s_e = \frac{P_0 \ell}{2 A_P E_P} - \int_0^{\ell/2} \varepsilon^c \, d\xi - \int_0^{\ell/2} \varepsilon^P \, d\xi$$

Displacements of a *dx* length specimen



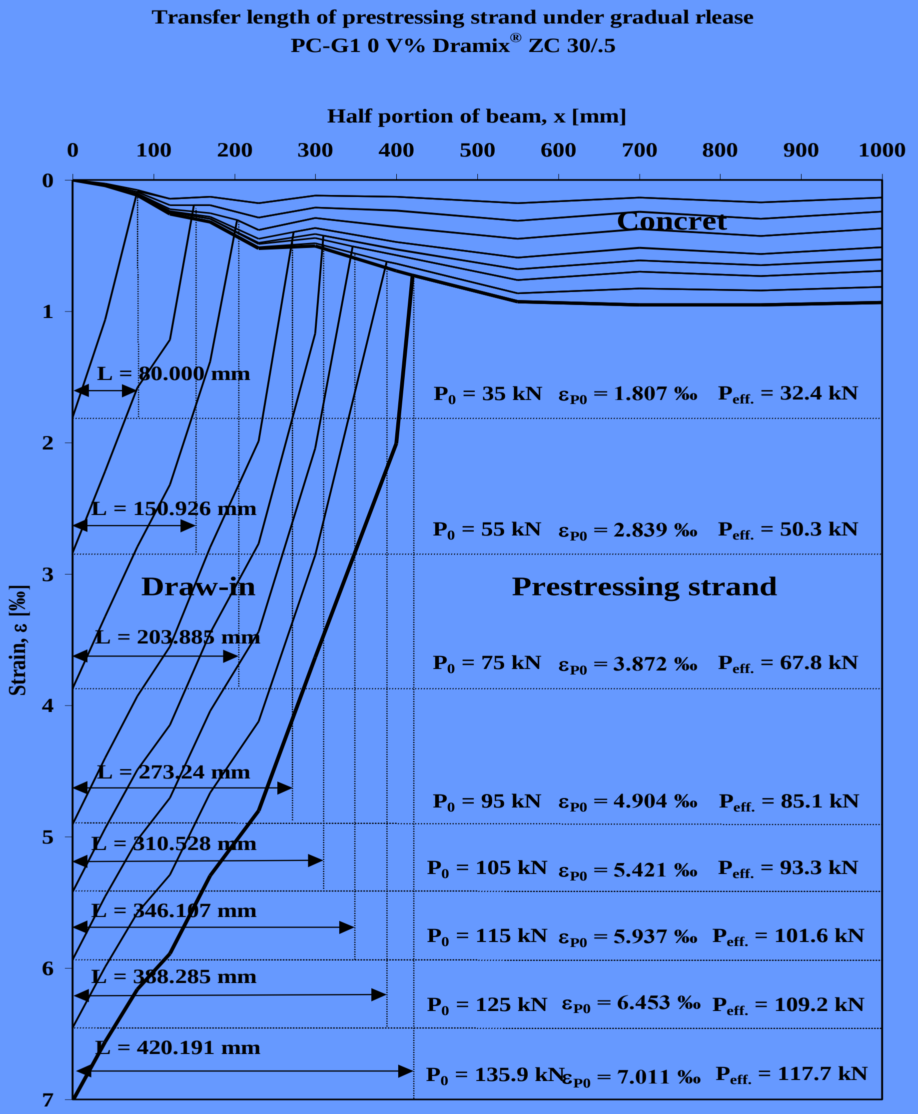
Non-linear equation system

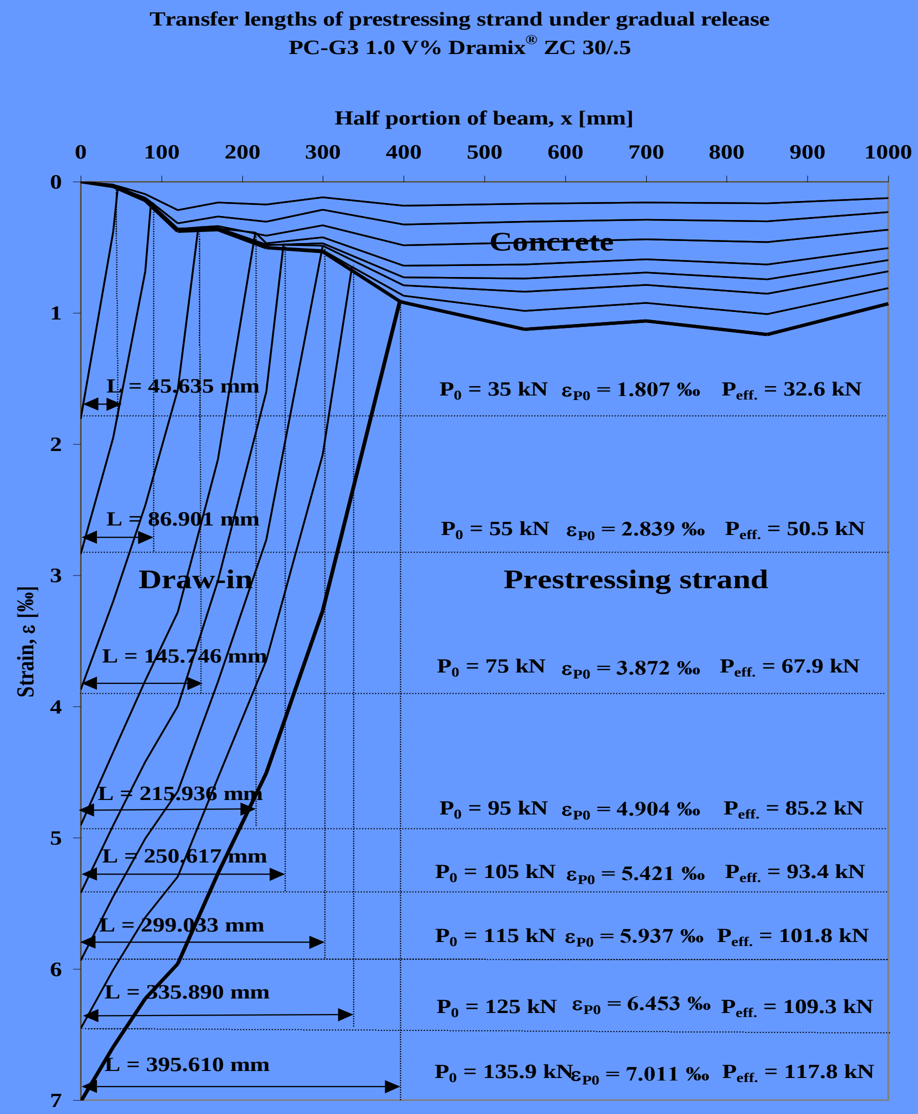
Measured concrete strains

$$dx_i^{P*} = dx_i^c - \frac{\varepsilon_{i-1}^c + \varepsilon_i^c}{2} dx_i^c - a\left(\varepsilon_{i-1}^P\right)^b + a\left(\varepsilon_i^P\right)^b$$

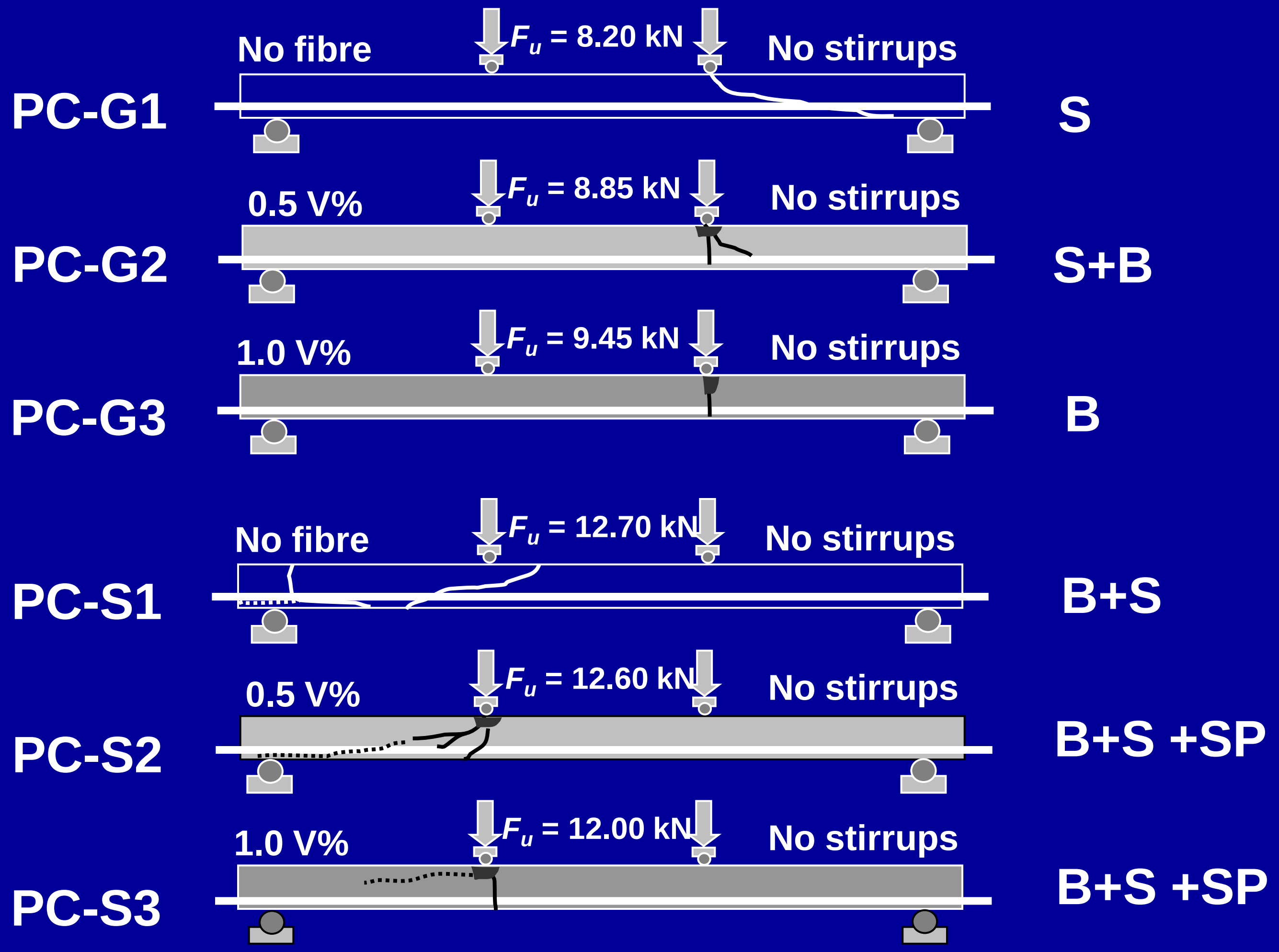
Experimentally determined function

$$a\left(\varepsilon_{i-1}^P\right)^b - a\left(\varepsilon_i^P\right)^b = \frac{\varepsilon_{i-1}^P + \varepsilon_i^P}{2} dx_i^{P*}$$

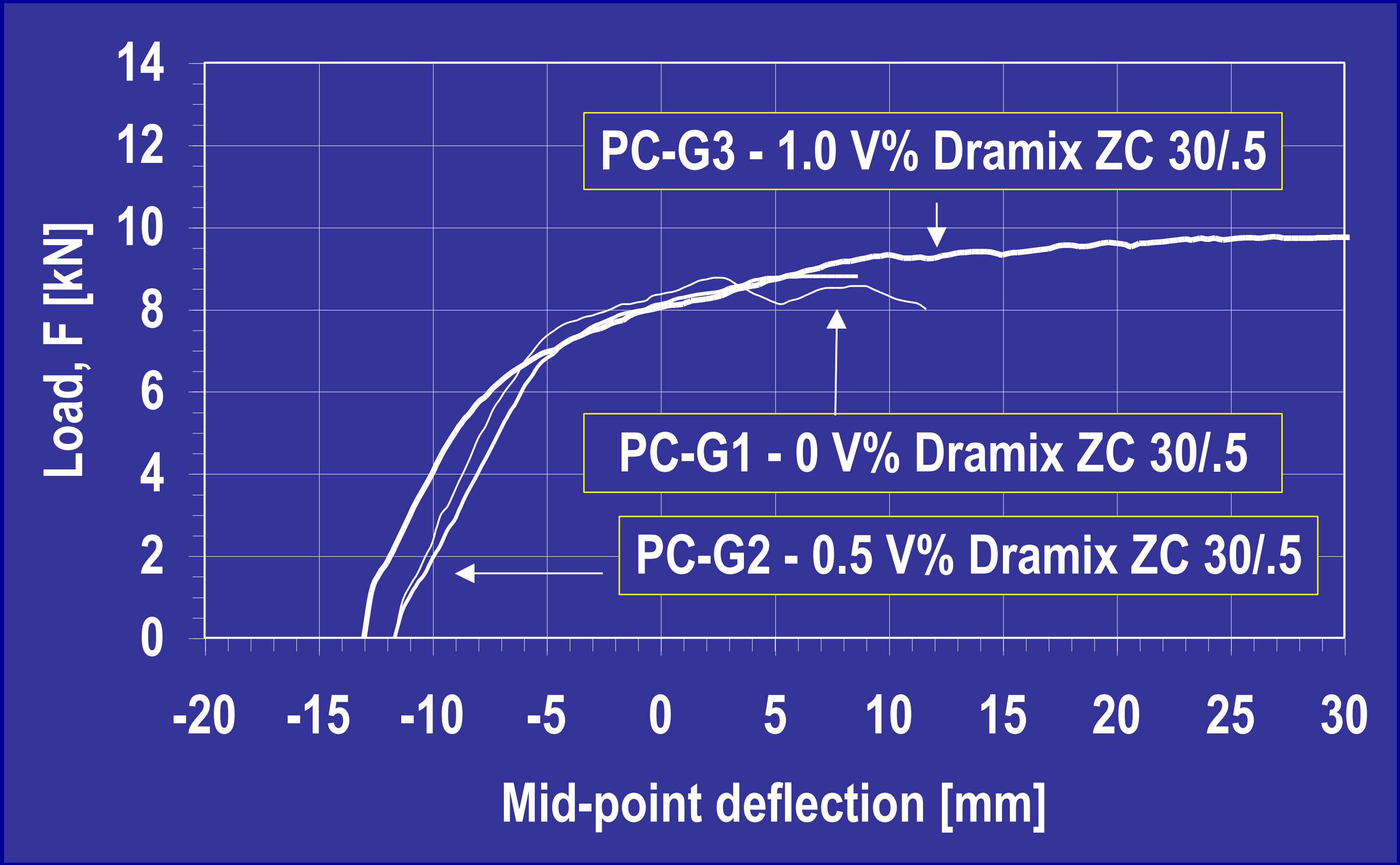

Transfer length of prestressing strand under gradual rlease
PC-G1 0 V% Dramix® ZC 30/.5
Half portion of beam, x [mm]
Strain, ε [‰]
Concret
Draw-in
Prestressing strand
L = 80.000 mm
L = 150.926 mm
L = 203.885 mm
L = 273.24 mm
L = 310.528 mm
L = 346.107 mm
L = 388.285 mm
L = 420.191 mm
P0 = 35 kN εP0 = 1.807 ‰ Peff. = 32.4 kN
P0 = 55 kN εP0 = 2.839 ‰ Peff. = 50.3 kN
P0 = 75 kN εP0 = 3.872 ‰ Peff. = 67.8 kN
P0 = 95 kN εP0 = 4.904 ‰ Peff. = 85.1 kN
P0 = 105 kN εP0 = 5.421 ‰ Peff. = 93.3 kN
P0 = 115 kN εP0 = 5.937 ‰ Peff. = 101.6 kN
P0 = 125 kN εP0 = 6.453 ‰ Peff. = 109.2 kN
P0 = 135.9 kN εP0 = 7.011 ‰ Peff. = 117.7 kN


Transfer lengths of prestressing strand under gradual release
PC-G3 1.0 V% Dramix® ZC 30/.5
Half portion of beam, x [mm]
Strain, ε [‰]
Concrete
Draw-in
Prestressing strand
L = 45.635 mm
L = 86.901 mm
L = 145.746 mm
L = 215.936 mm
L = 250.617 mm
L = 299.033 mm
L = 335.890 mm
L = 395.610 mm
P0 = 35 kN εP0 = 1.807 ‰ Peff. = 32.6 kN
P0 = 55 kN εP0 = 2.839 ‰ Peff. = 50.5 kN
P0 = 75 kN εP0 = 3.872 ‰ Peff. = 67.9 kN
P0 = 95 kN εP0 = 4.904 ‰ Peff. = 85.2 kN
P0 = 105 kN εP0 = 5.421 ‰ Peff. = 93.4 kN
P0 = 115 kN εP0 = 5.937 ‰ Peff. = 101.8 kN
P0 = 125 kN εP0 = 6.453 ‰ Peff. = 109.3 kN
P0 = 135.9 kN εP0 = 7.011 ‰ Peff. = 117.8 kN

Failure loads and failure modes



Load vs. Deflection relationship



Conclusions

Determination methode of stransfer length of prestressing strand based on experiment was developed

Steel fibres produce lower draw-in of the prestressing strand

Steel fibres result 13 to 20% decrease in the transfer length of prestressing strand

Application of fibres provided enough strength to avoid shear failure or splitting failure along the prestressing strand.

Type of failure changed from explosive to ductile

Aknowledgement

- **MKM 150/94.** ***"Behaviour of steel fibre reinforced concrete beams"***
  Project of the Hungarian Ministry of Education
- **OTKA 16683** ***"Toughness of steel fibre reinforced concrete"***
  Project of the Hungarian Research Foundation
- **OTKA T025647** ***"Punching behaviour of steel fibre reinforced concrete slabs"***
  Project of the Hungarian Research Foundation
- **OTKA F025621** ***"Modelling of steel fibre reinforced concrete members"***
  Project of the Hungarian Research Foundation
- **OTKA T025652** ***"Concrete in the next century"***
  Project of the Hungarian Research Foundation

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Thank you very much for your attention!

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