Method for Bending Beam Tests of Fibre Reinforced Concrete

Dr. Karoly Peter Juhasz

JKP STATIC

Budapest University of Technology and Economics, Budapest, Hungary

building for the future
Durable·Sustainable·Resilient

06.06.2023

Determining material parameter from material tests (3PBBT)

Material parameters – residual strengths: $f_{R,i,m}$ (i= 1,2,3,4)

↓

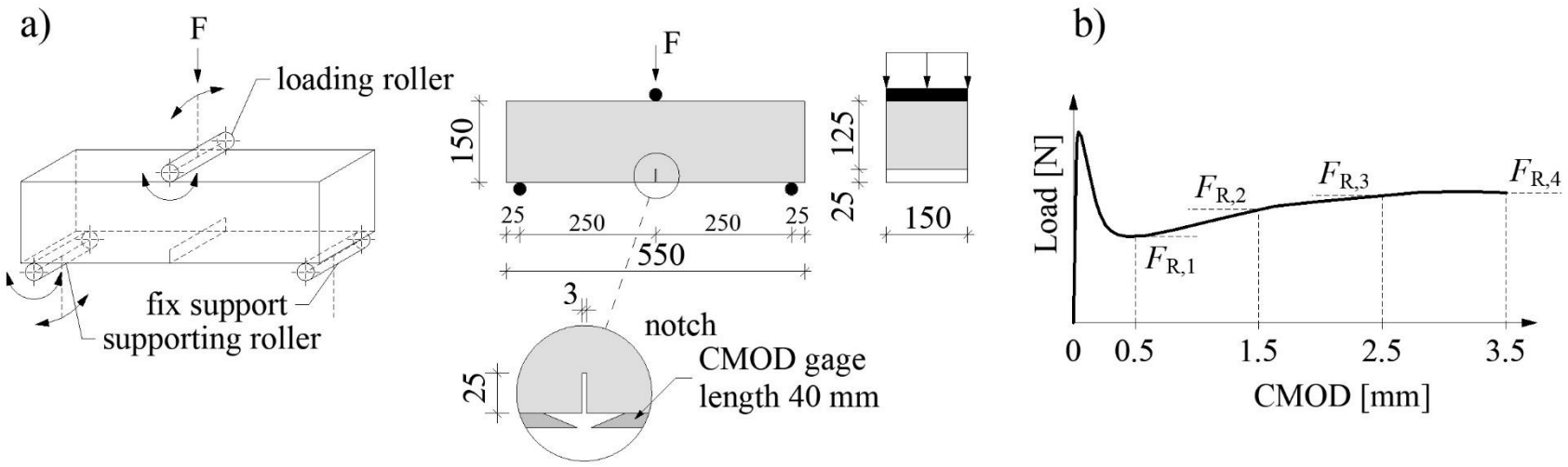
Mean value: $f_{R,i,m}$

↓

Characteristic value: $f_{R,i,k}$

↓

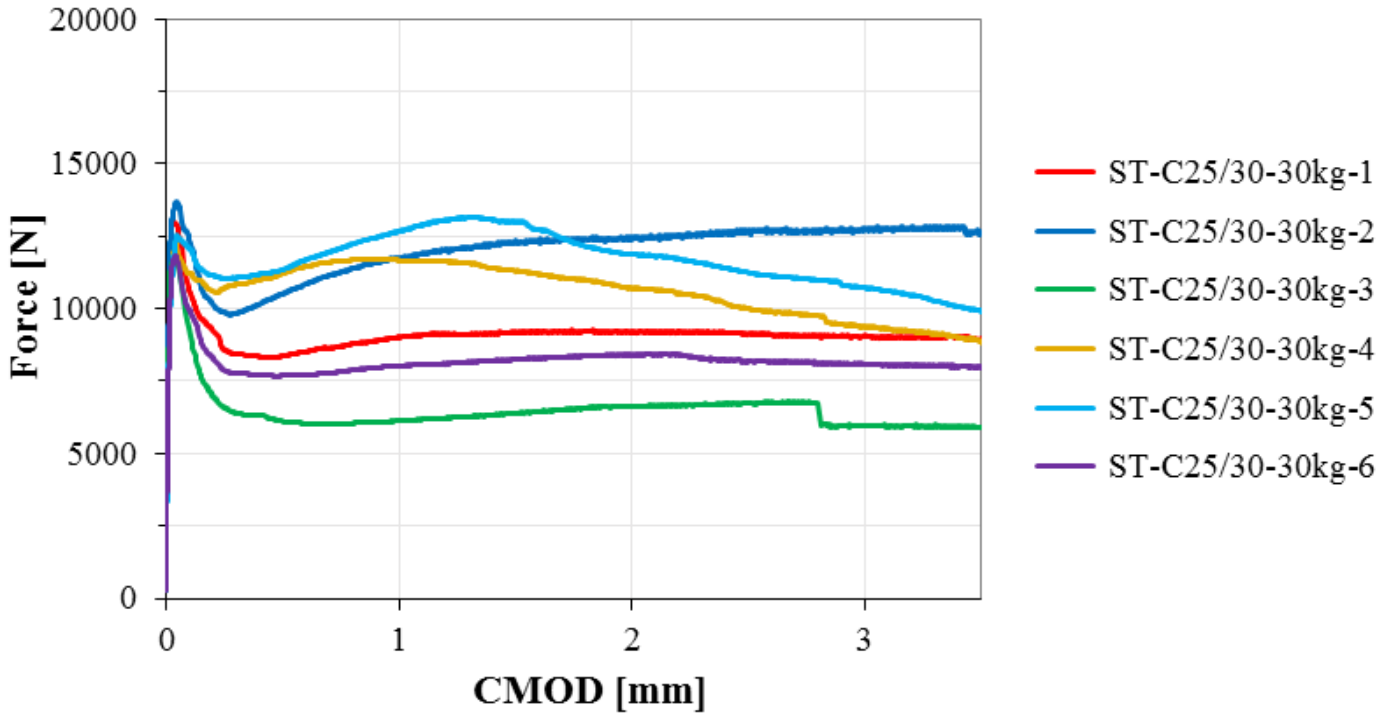
Design values: $f_{R,i,d}$



High scatter of the results

Low characteristic value – even negative

if characteristic value is calculated with statistical method.



Increase the size of the reference area
super size panels (Stefan Bernard)
800 → 1200 mm

Dispersion of the results are lower, but:

1) round panel tests are not used for determining material parameters
2) very heavy specimens

E. S. Bernard, "Development of a 1200-mm-diameter round panel test for post-crack assessment of fiber-reinforced concrete," *Advances in Civil Engineering Materials* 2, no. 1 (2013): 457-471

Why the dispersion is high?

Types of scattering according to Cavalaro and Aguado:

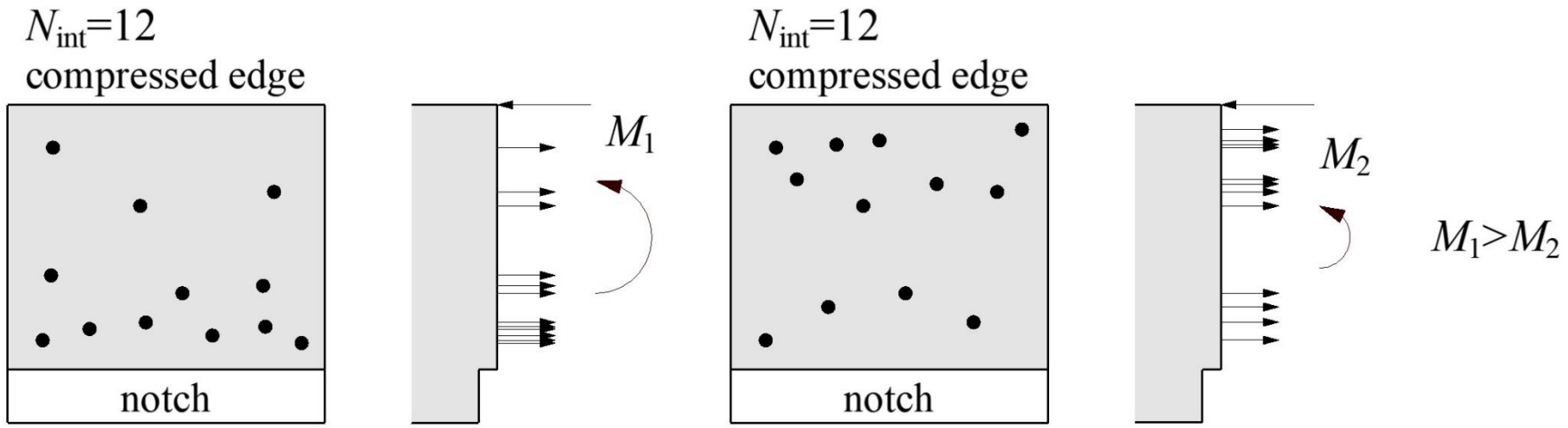
a) Testing procedure scatter
Accuracy of the machine: measuring the force, deflection, etc.

b) Production process scatter
Manufacturing of the specimens, mixing of the concrete, storage.

c) Intrinsic scatter
Location of the fibers on the fracture surface.

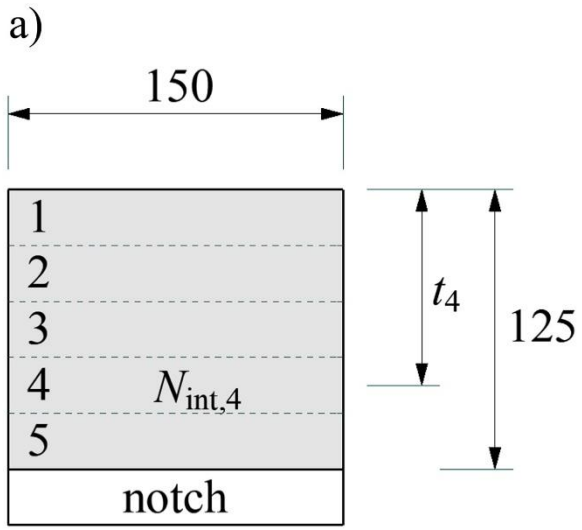
Cavalaro SHP, AguadoA(2015) Intrinsic scatter of FRC: an alternative philosophy to estimate characteristic values. Mater Struct 48(11):3537–3555

The cross section that has more fibres closer to the compressed zone has a smaller moment capacity than the sample that has more fibres farther from the compressed zone.



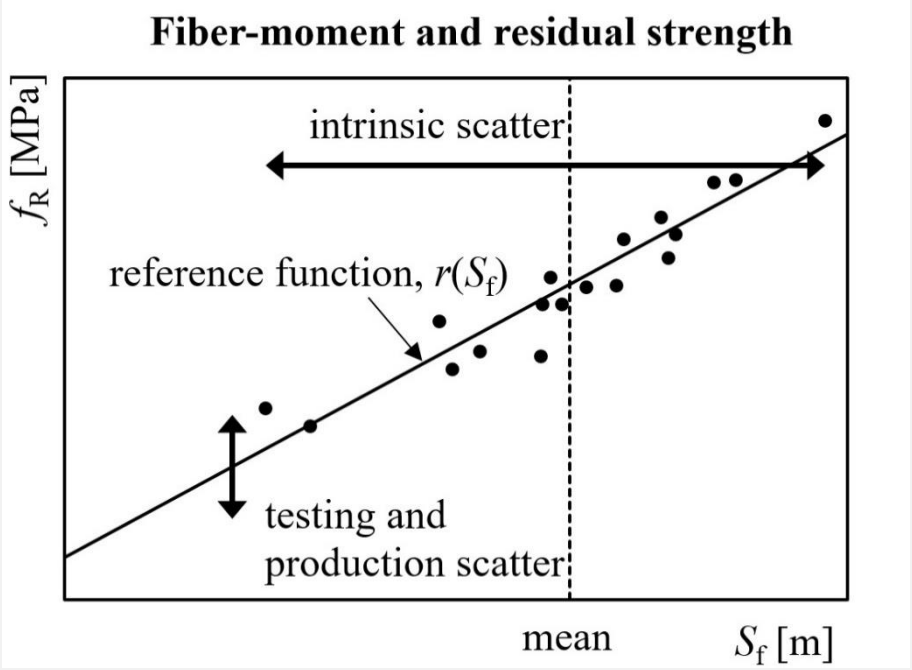
New characteristic of a fracture cross section: *fiber-moment*

$$S_f = \sum_{s=1}^{5} t_s N_{int,s}$$



b)

What is the correlation between fiber-moment (S_f) and residual strength (f_R)?



direct proportionality with a correlation coefficients ~0.9

Characteristic residual strength from fiber-moment

From the **analytical mixing model** we can estimate:

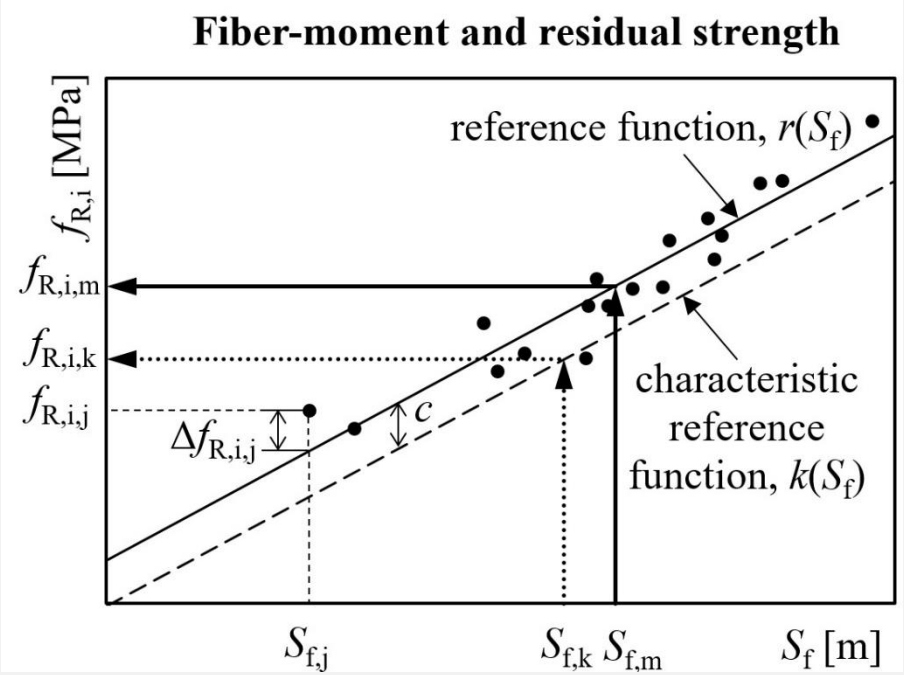
Ideal number of fibers on the surface: $N_{m,a}$

Fiber-moment of N_m fibers: $S_{f,m,a}$

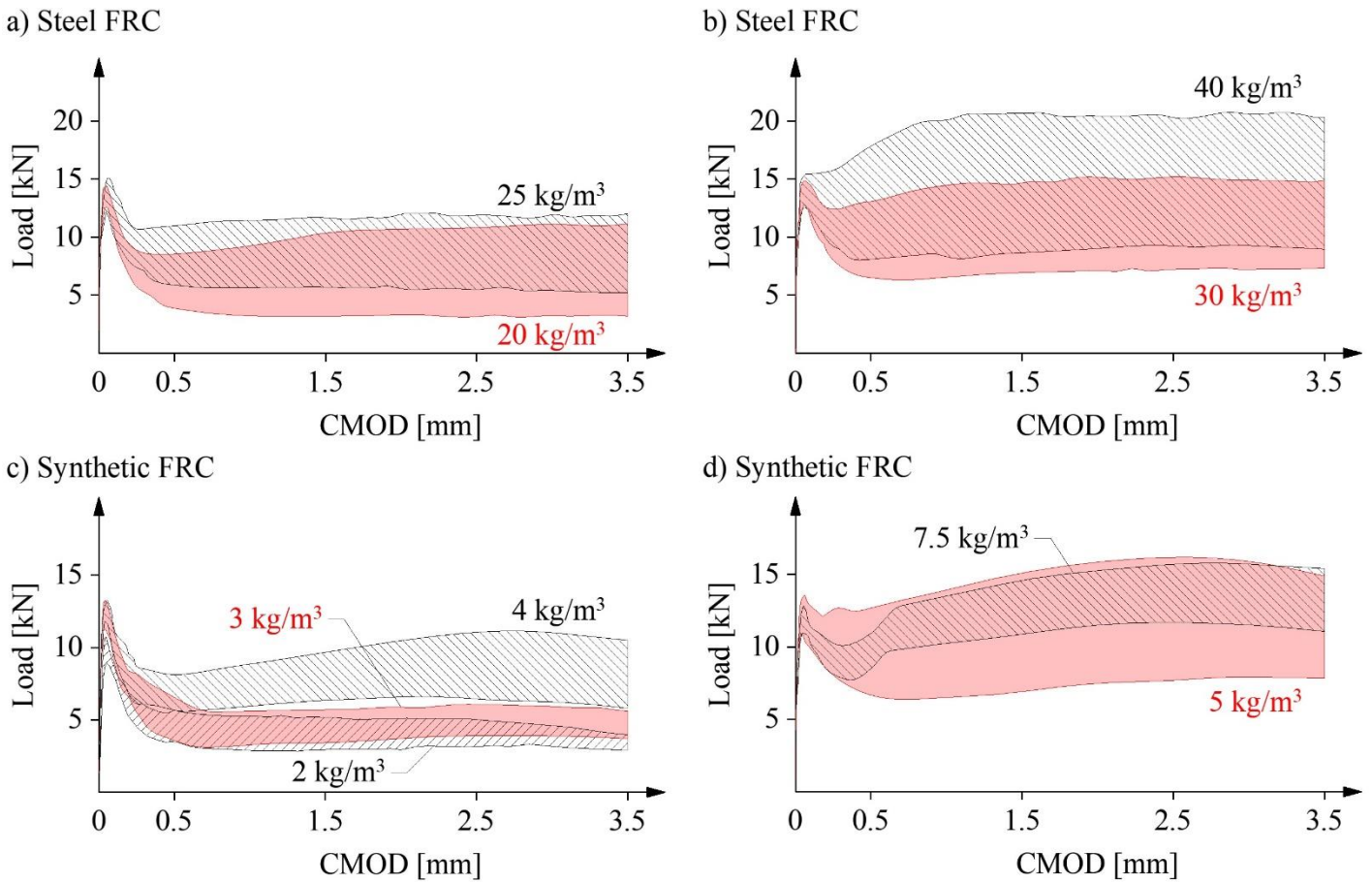
The number of fibres intersecting the cross section at a 95% confidence level: N_k

Fiber-moment of N_k fibers: $S_{f,k,a}$

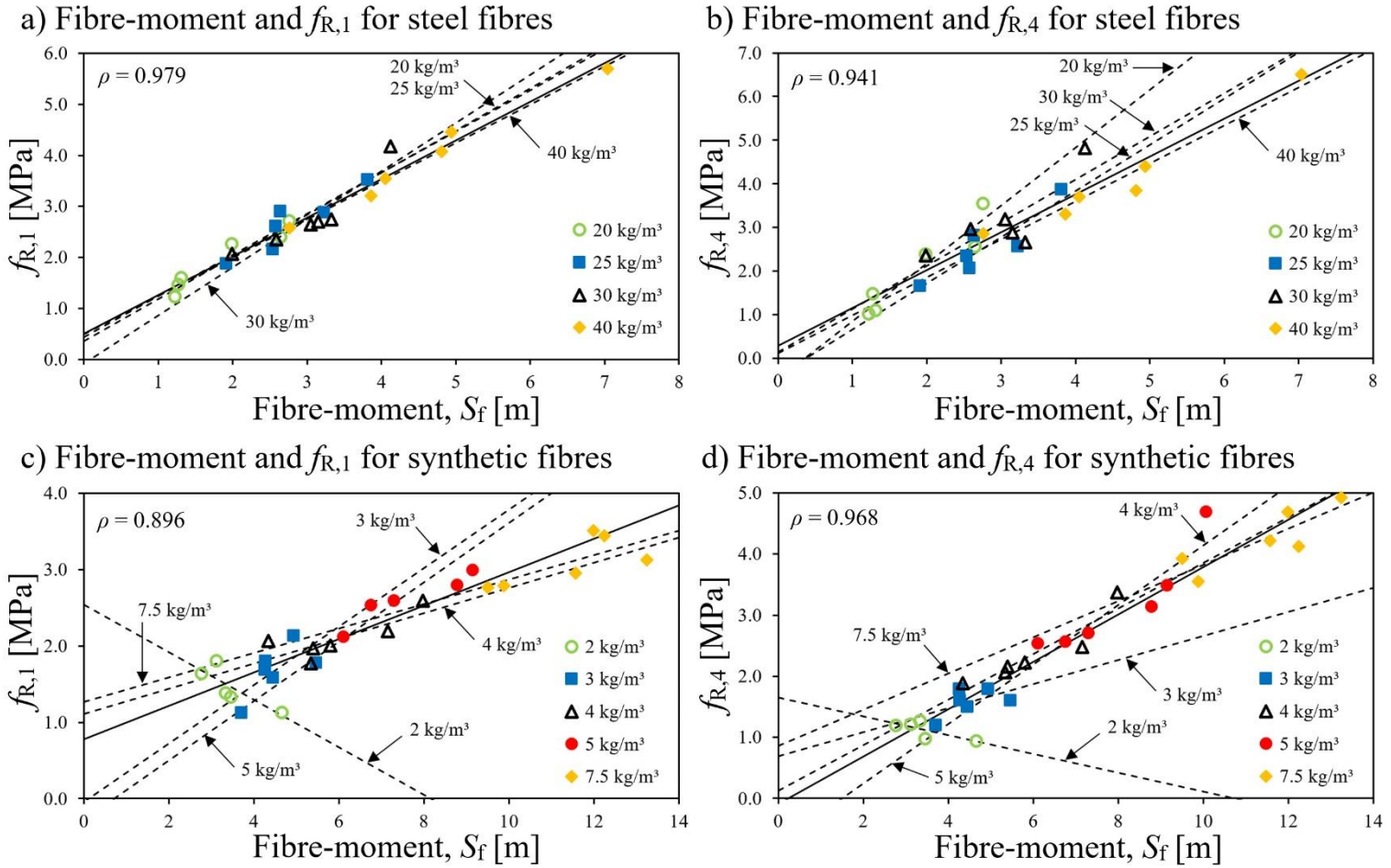
Offset of characteristic reference funcion c



Material test results of steel and macro synthetic fiber reinfoced concrete beams.



Fiber-moment and residual strength diagram.



Results of statistical evaluation and proposed evaluation.

Mean and characteristic values of residual strengths for steel FRC, MPa								
dosage kg/m^3	Statistical evaluation				Proposed evaluation			
	$f_{R,1,m}$	$f_{R,1,k}$	$f_{R,4,m}$	$f_{R,4,k}$	$f_{R,1,m}$	$f_{R,1,k}$	$f_{R,4,m}$	$f_{R,4,k}$
20	1.938	0.645	2.010	*-0.15*	1.938	1.271	2.010	0.793
25	2.658	1.380	2.556	0.897	2.386	1.513	2.207	1.034
30	2.778	1.188	3.146	1.258	2.690	1.634	3.054	1.485
40	3.925	1.555	4.103	1.304	3.437	2.685	3.536	2.398
Mean and characteristic values of residual strengths for steel FRC, MPa								
dosage kg/m^3	Statistical evaluation				Proposed evaluation			
	$f_{R,1,m}$	$f_{R,1,k}$	$f_{R,4,m}$	$f_{R,4,k}$	$f_{R,1,m}$	$f_{R,1,k}$	$f_{R,4,m}$	$f_{R,4,k}$
2	1.455	0.870	1.115	0.791	*1.495*	*1.334*	*1.136*	*0.999*
3	1.686	0.964	1.583	1.102	1.686	0.949	1.583	1.064
4	2.100	1.492	2.364	1.202	2.100	1.613	2.364	1.678
5	2.847	1.399	3.183	1.383	2.847	1.902	3.182	2.038
7.5	3.097	2.394	4.238	3.143	3.097	2.457	4.239	3.387

Advantage

- Specimens with fibers with non-uniform dispersion can be eliminated (both *good* and *bad* dispersion).
- Higher and more realistic characteristic value.
- Characteristic value never will be negative.
- With the mixing model the ideal fiber distribution can be predicted.

Disadvantage

- More labor.
- Method is sensitive for counting of the fibers.


fib Symposium
CEB-FIP
2023 ISTANBUL
5-7 JUNE
İTÜ
TÜRKİYE DEPREM VAKFI
fib CEB-FIP Turkey
Thank you for your attention!
Dr. Karoly Peter Juhasz
JKP STATIC
JKP | STATIC
building for the future
Durable·Sustainable·Resilient
06.06.2023