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ANALYSIS OF THE EFFECT OF VARIOUS LIMESTONES IN THE CEMENT COMPOSITION ON RHEOLOGICAL PROPERTIES OF MORTARS

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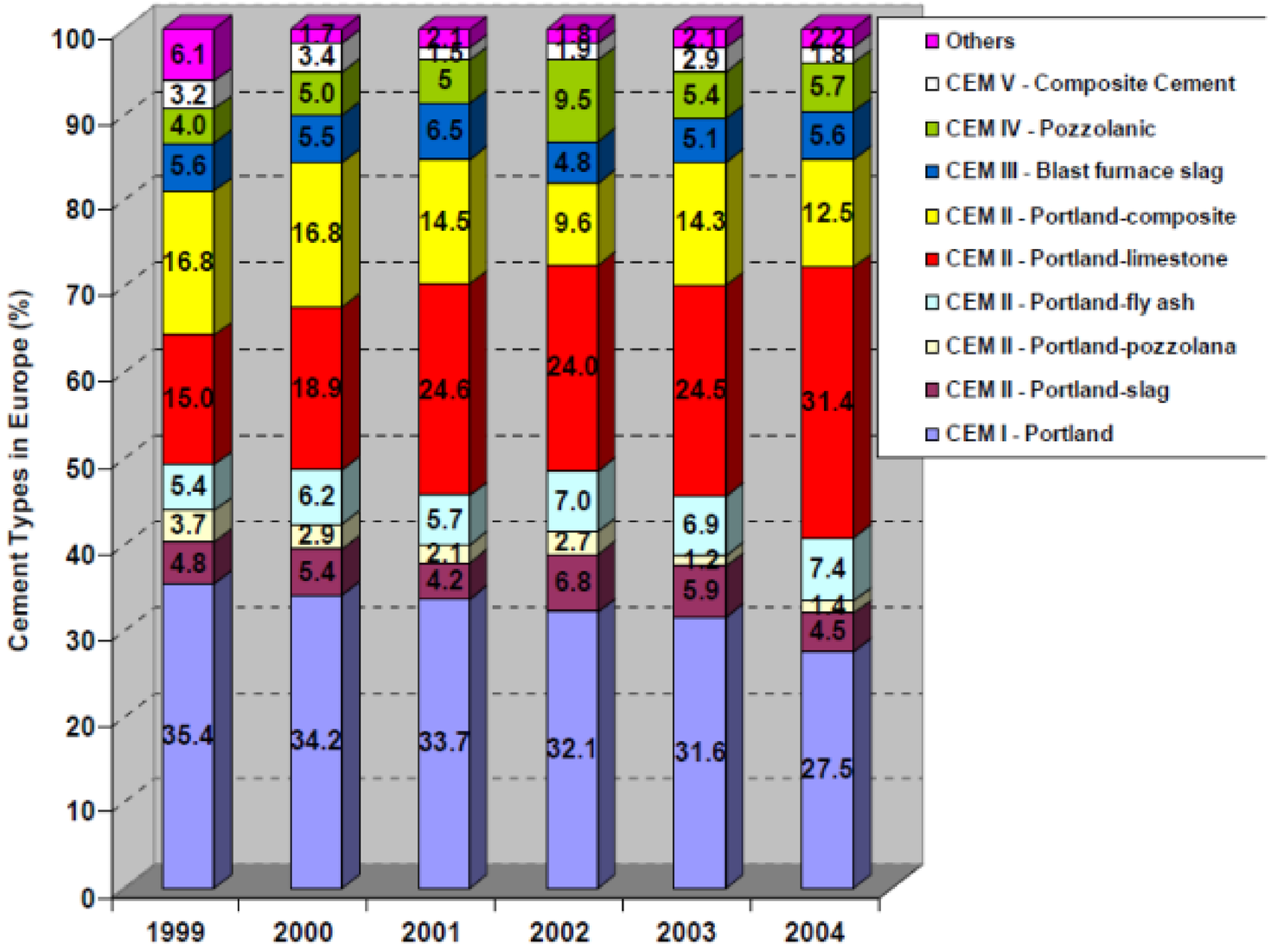
LIMESTONE AS A MAIN CONSTITUENT OF CEMENT

As cement industry continues to implement more sustainable materials and technologies, limestone cements are becoming increasingly popular in Europe.

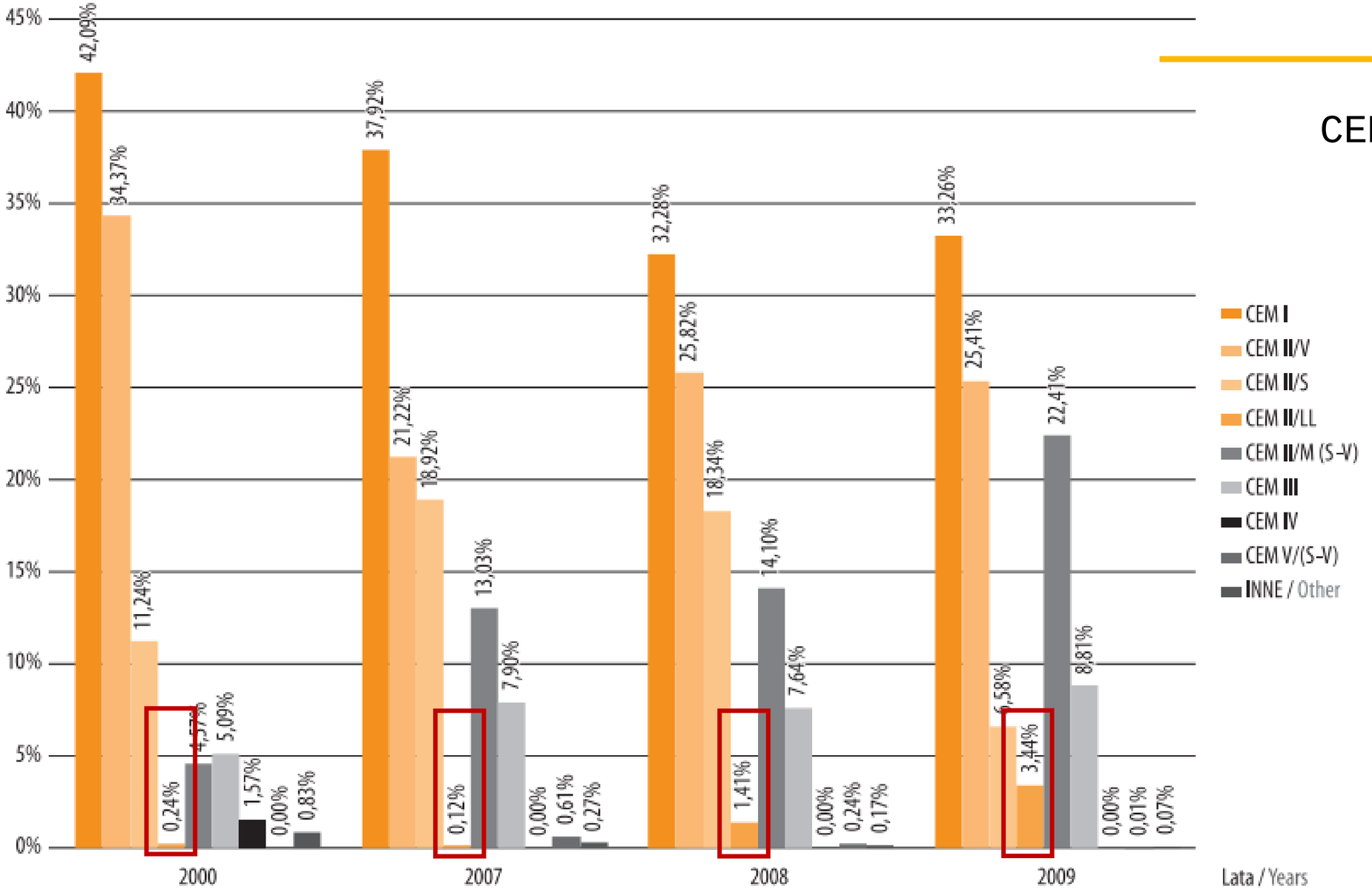
Type	Name	Range of limestone content, mass %
CEM II/A-L	Portland-limestone cement	6 to 20
CEM II/A-LL	Portland-limestone cement	6 to 20
CEM II/A-M	Portland composite cement	Less than 20
CEM II/B-L	Portland-limestone cement	21 to 35
CEM II/B-LL	Portland-limestone cement	21 to 35
CEM II/B-M	Portland composite cement	Less than 35

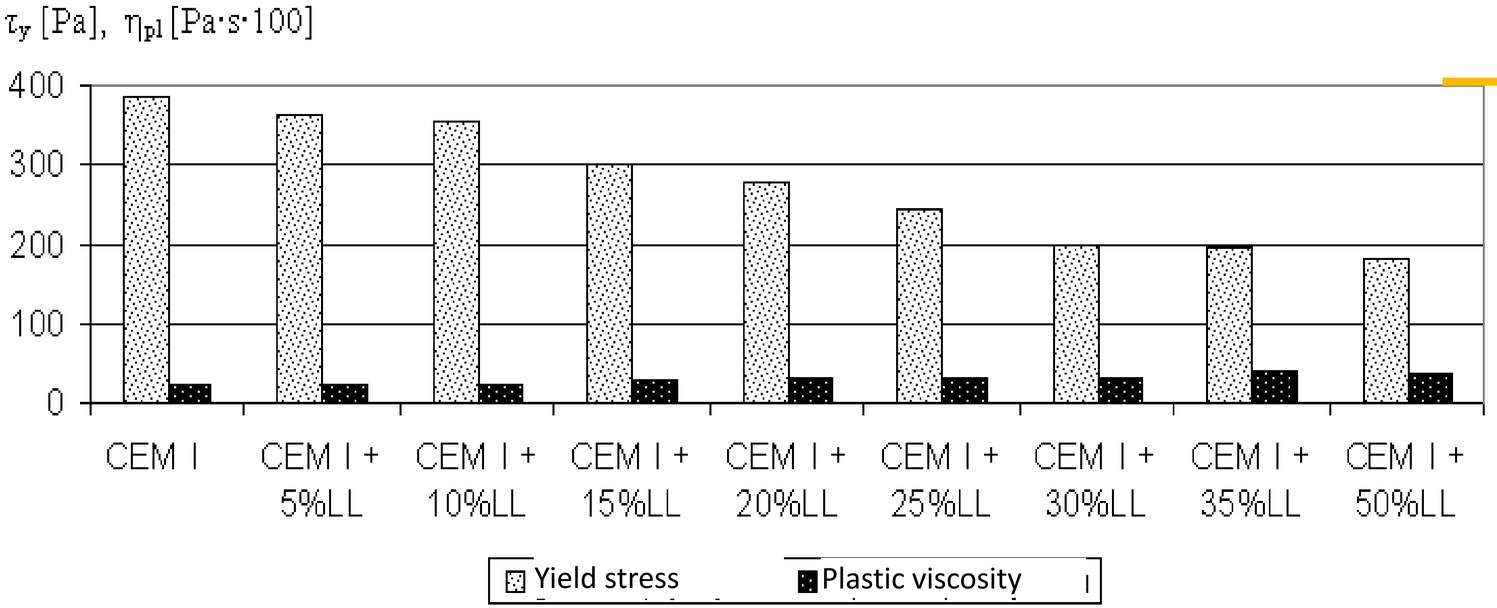


CEMENT PRODUCTION IN EUROPE

(Hooton, R. D., Nokken, M. A., and Thomas, M. D. A., Portland-Limestone Cement: State-of-the-Art Report and Gap Analysis for CSA A3000)

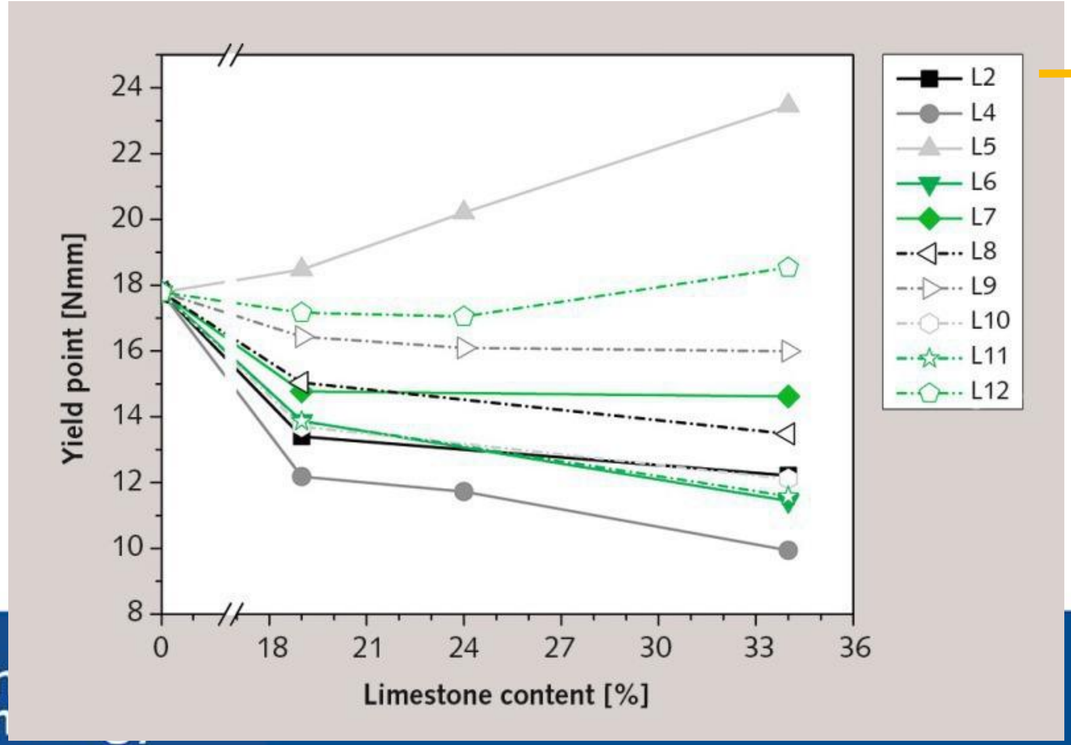
CEMENT PRODUCTION IN POLAND





YIELD STRESS AND PLASTIC VISCOSITY OF LIMESTONE CEMENTS

(Magdalena Piechówka, PhD thesis „The effect of limestone addition on the properties of multi-component cements properties”, 2010 [in Polish])



YIELD STRESS OF LIMESTONE CEMENTS

(Gerd Bolte, Maciej Zajac , „Limestone requirements for high-limestone cements” ZKG 4/2016)

AIM OF THE RESEARCH

The aim of the research was to compare limestones' influence on rheological porperties:

- Yield stress,
- Plastic viscosity

of mortars, both in relation to type of limestone, and its specific surface area.

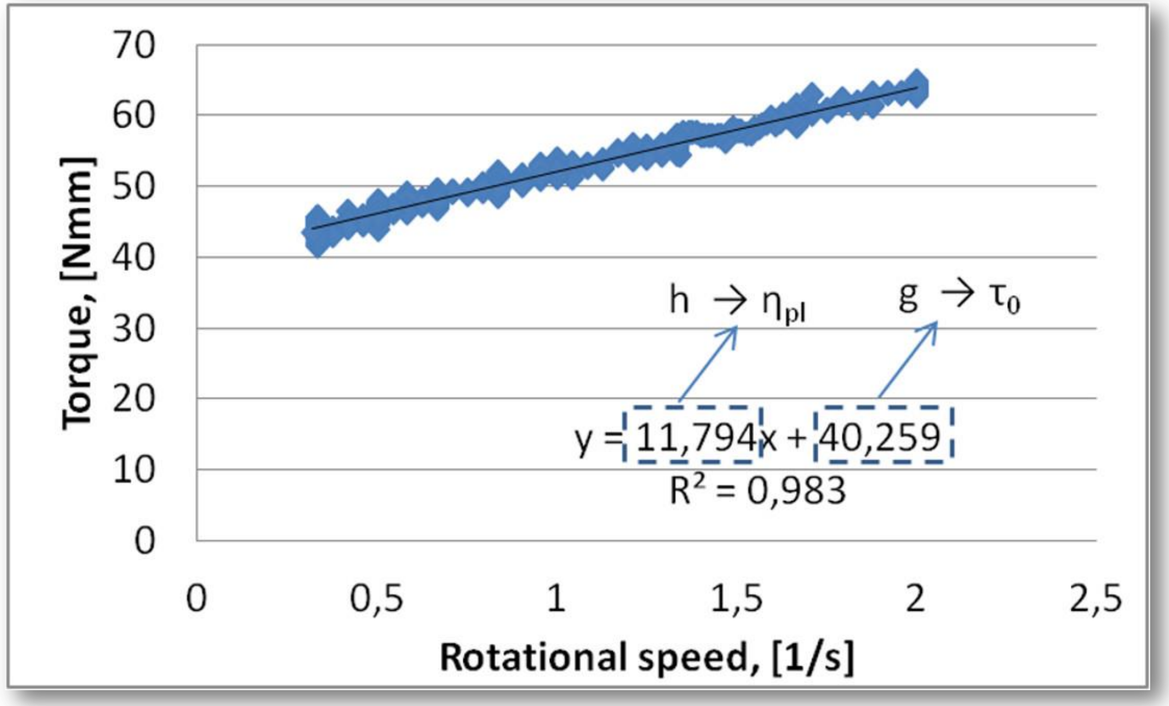
PART 1

RESEARCH METHODS AND MATERIALS

TESTING METHODS

Rheological parameters were obtained using simplified Bingham model:

$$M = g + hN$$



M – torque,
N – rotational speed
g – shear resistance → yield stress τ_0
h – plastic flow resistance → plastic viscosity η_{pl}

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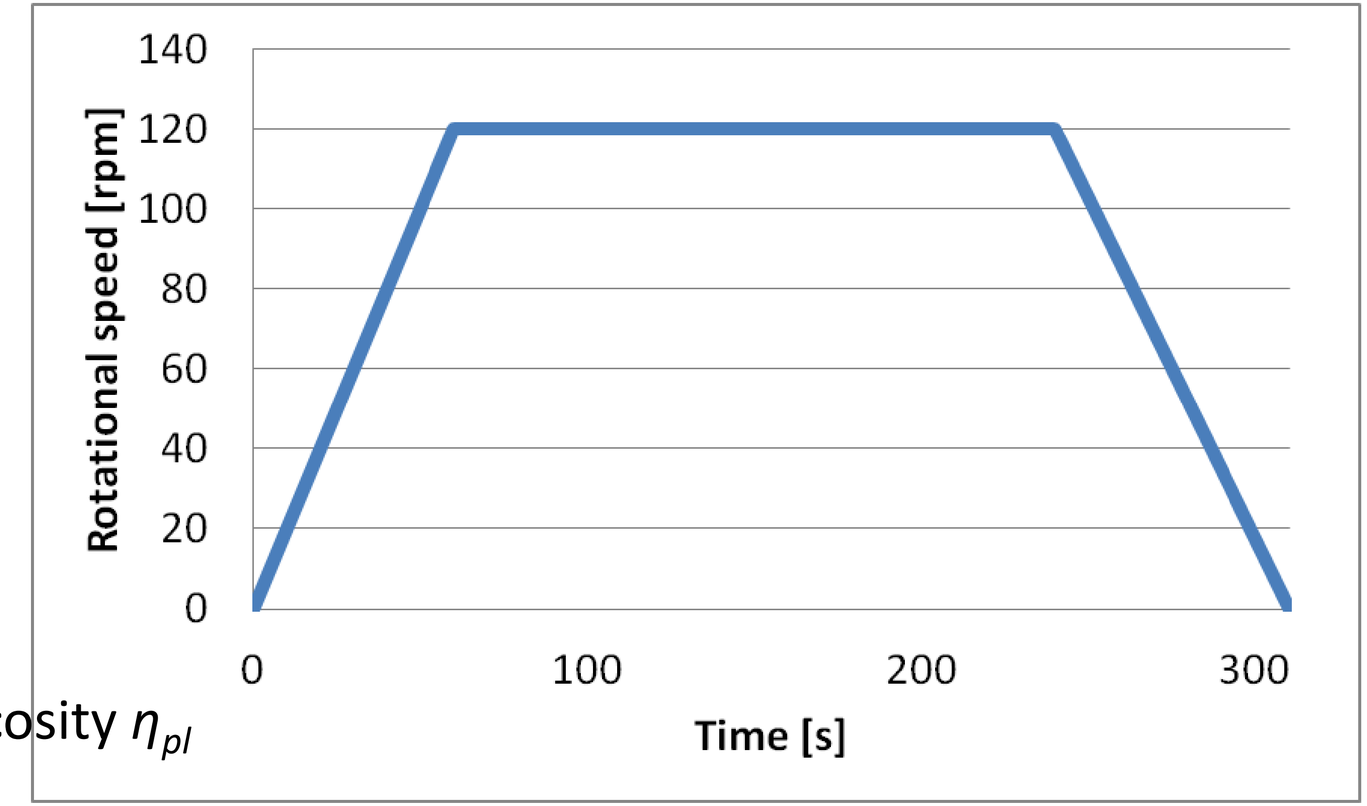

COMPOSITION OF MORTARS

	CEMENT [g]	TYPE OF LIMESTONE	LIMESTONE [g]	SAND [g]	W/C RATIO	WATER [g]
CEM I 42,5	450		-	1350	0.55	247.5
15%	382,5	LL-N, LL-T, LL-B, LL-H, LL-C, LL-F, LL-K LL-TR LL-W	67,5			
30%	315		135			
40%	270		180			

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9 TYPES OF LIMESTONE

COMPOSITION OF MORTARS

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CEM I 42,5	450	-	-	1350	0.55	247.5
6%	423	LL-T1, LL-B1	27			
10%	405		45			
20%	360		90			
30%	315		135			

PART 2

TEST RESULTS

YIELD STRESS

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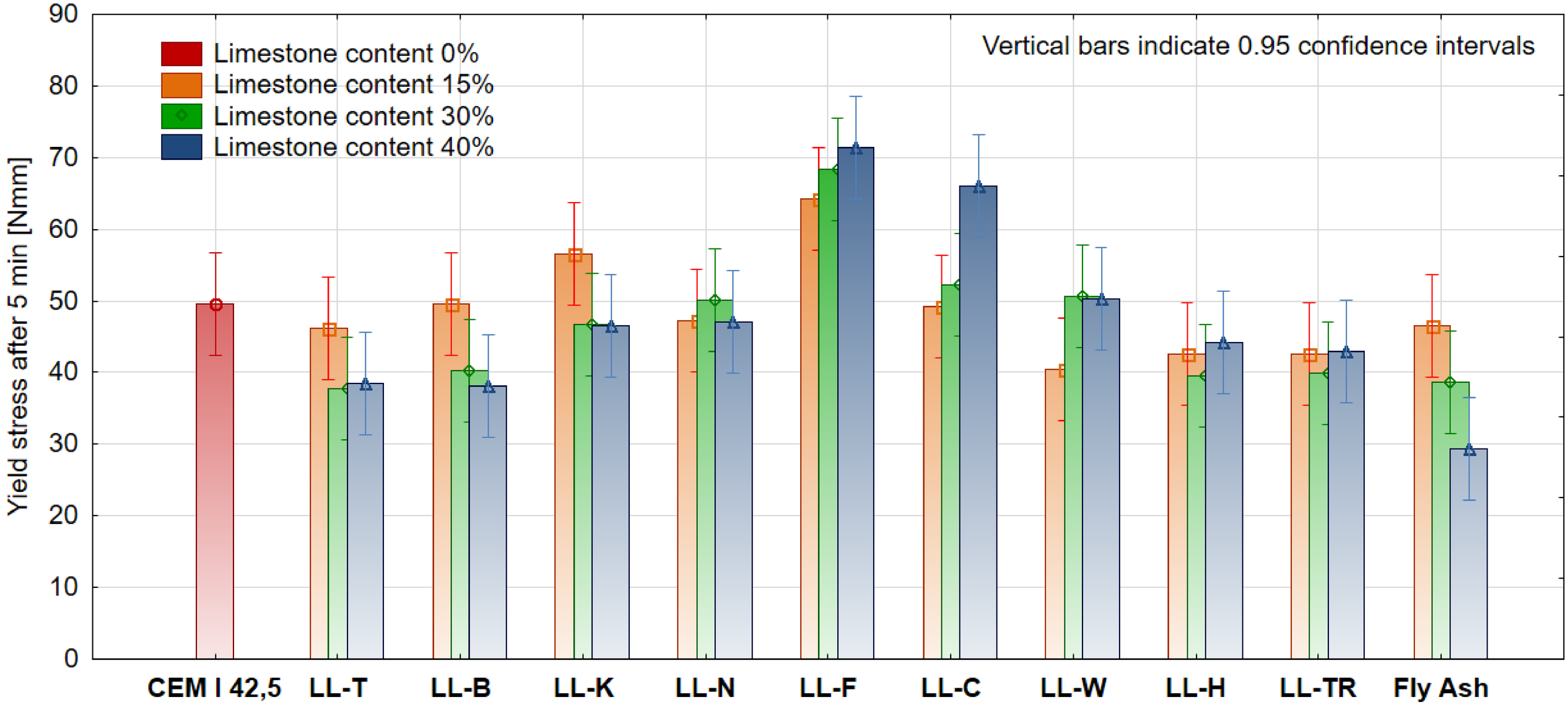
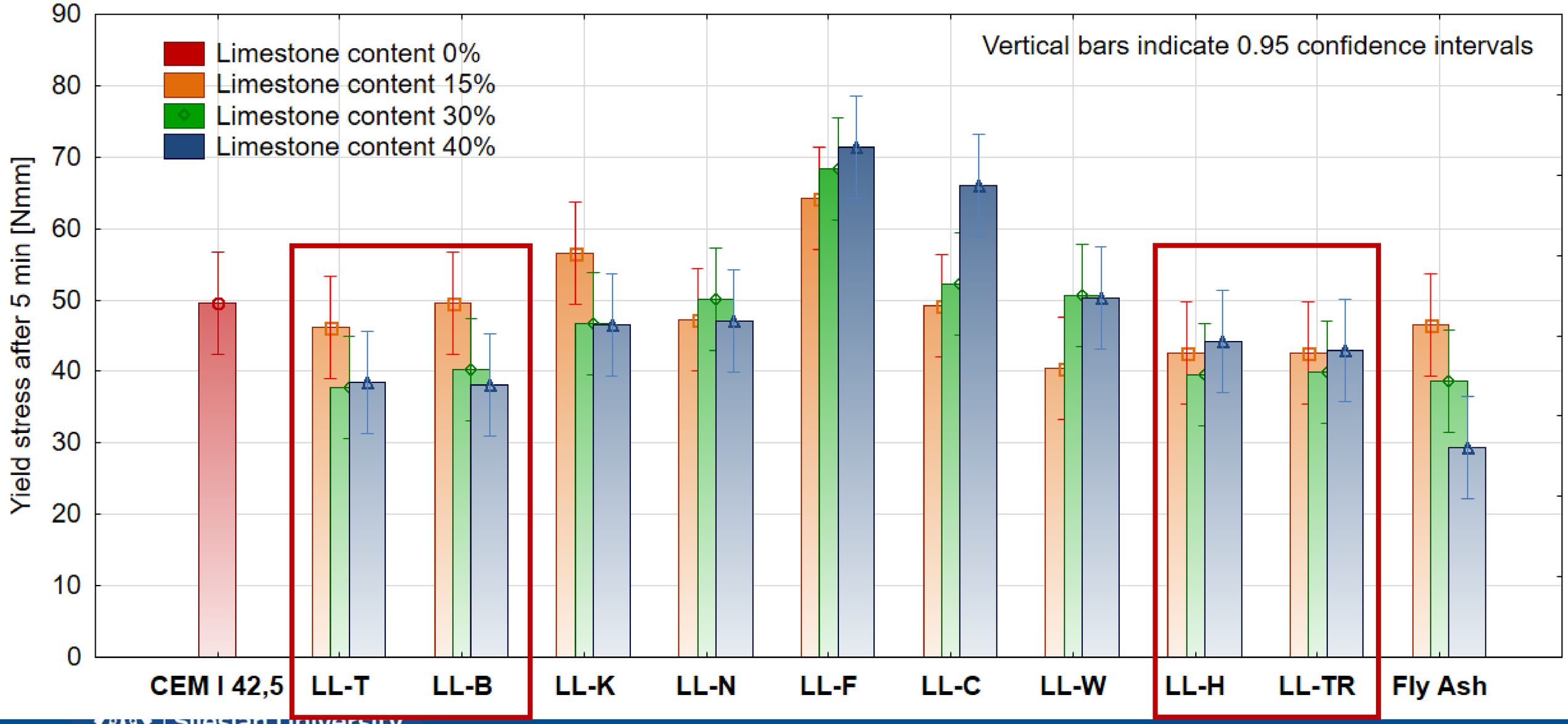
YIELD STRESS AFTER 5 MIN



YIELD STRESS AFTER 5 MIN



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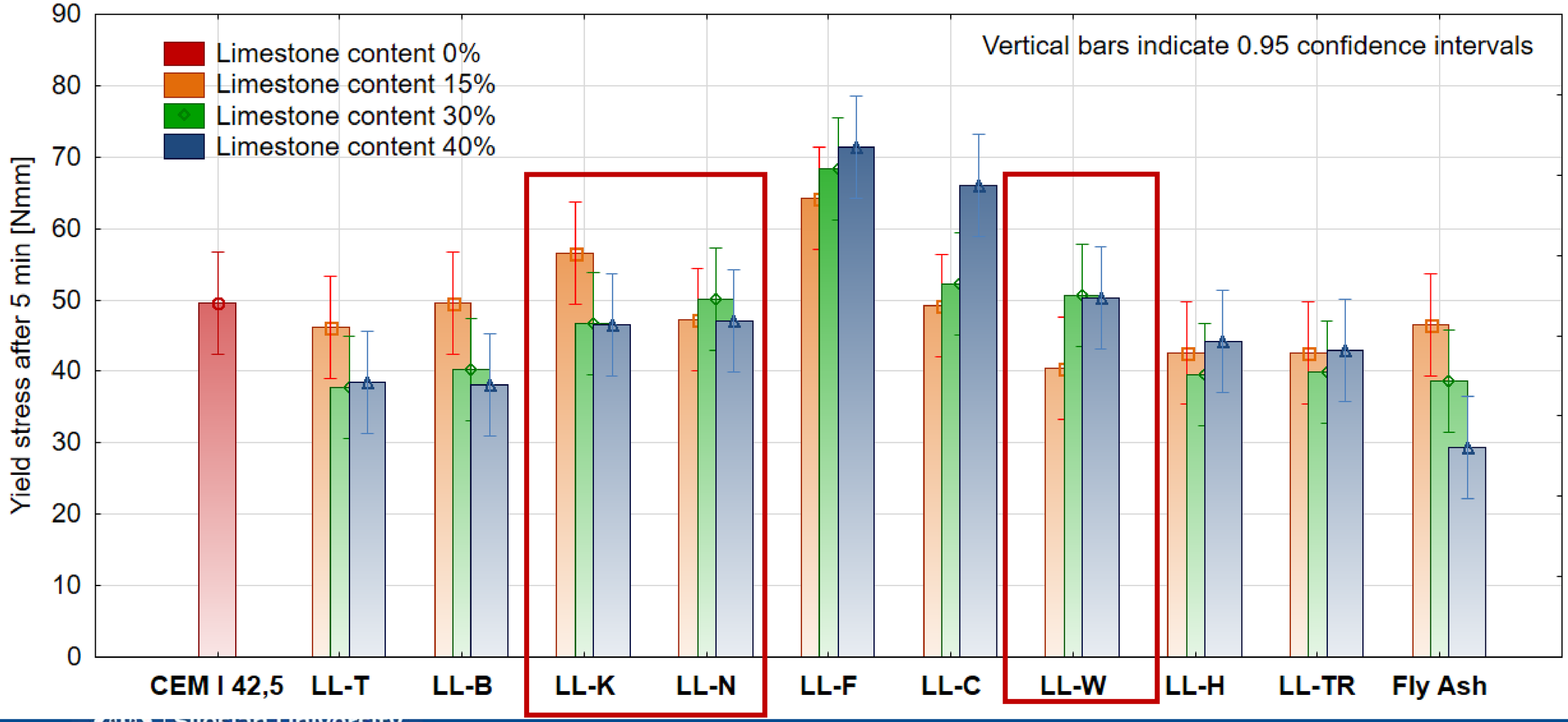

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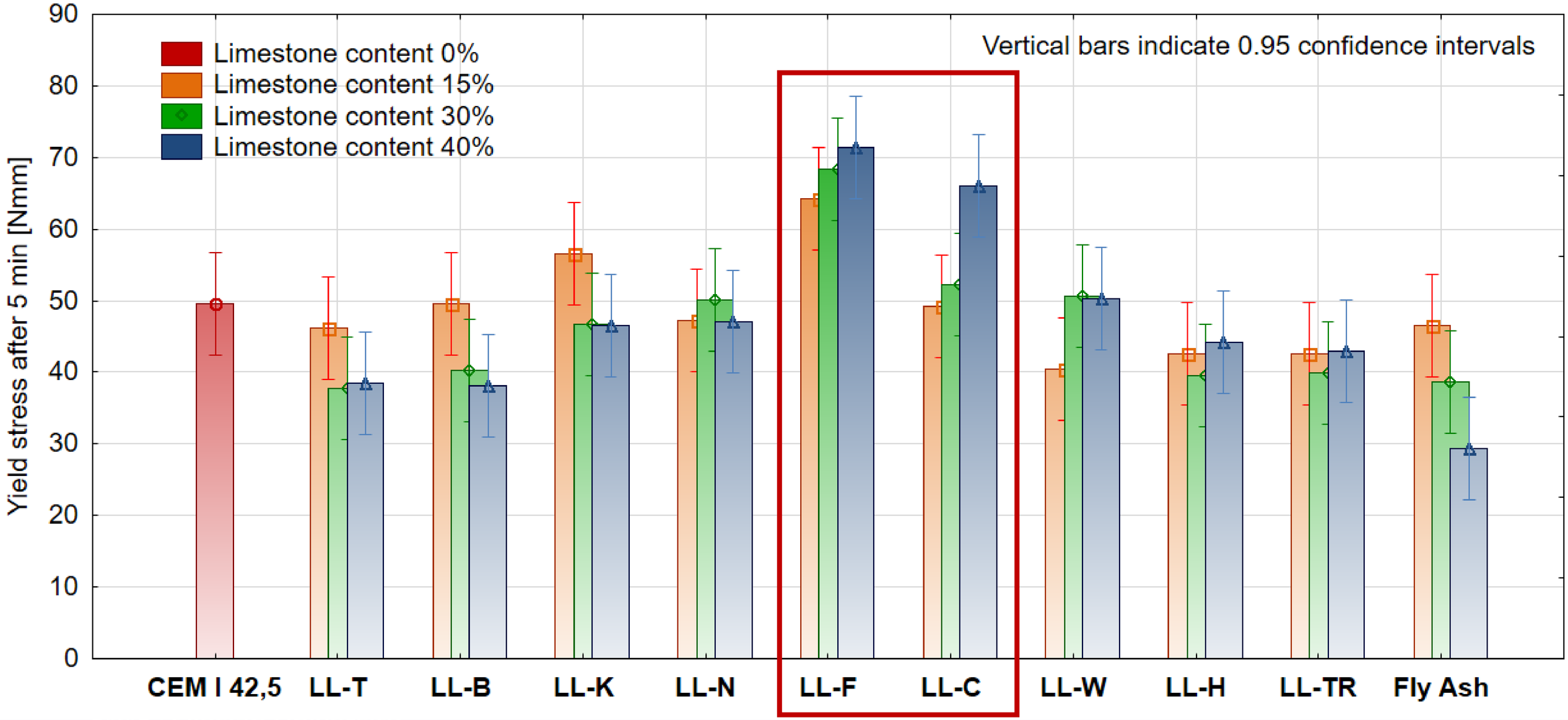
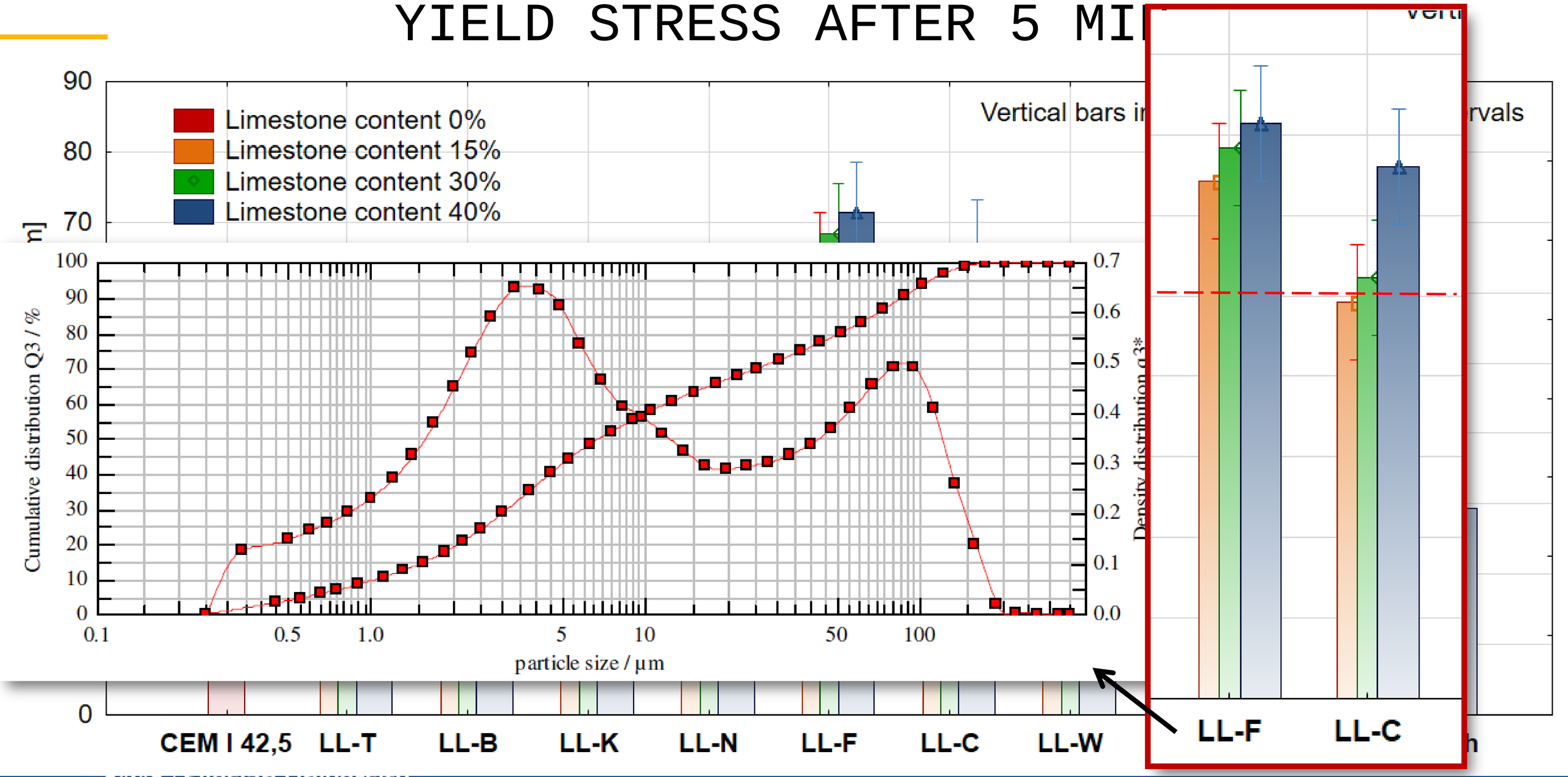
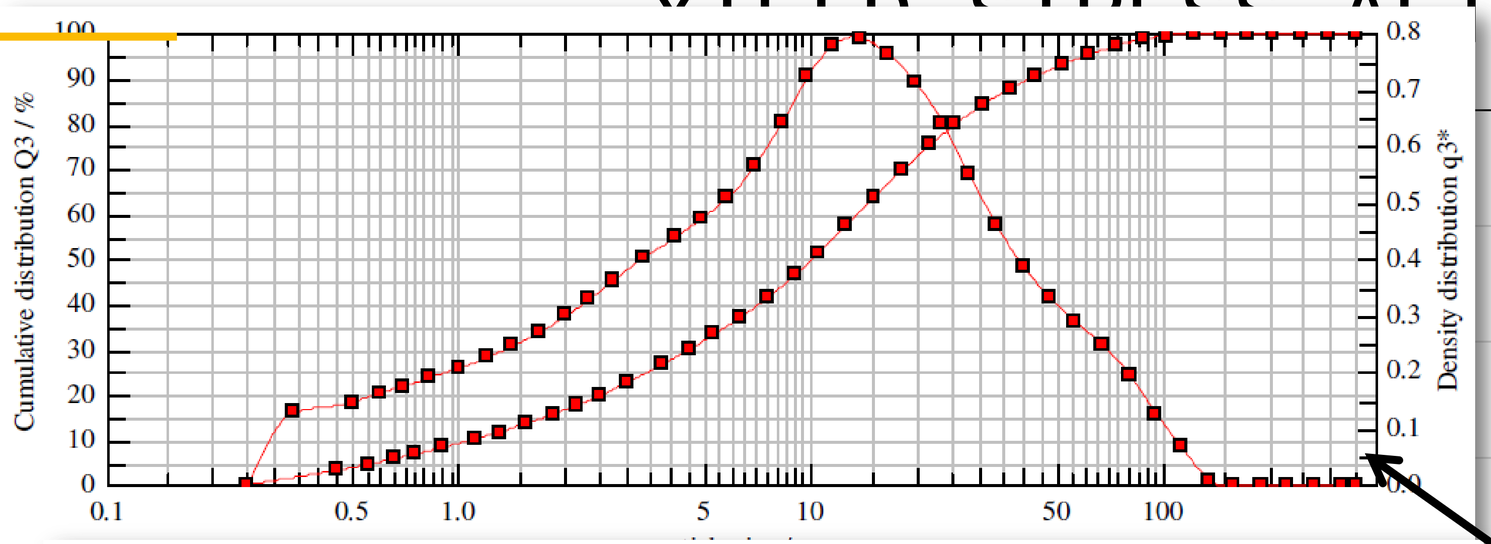
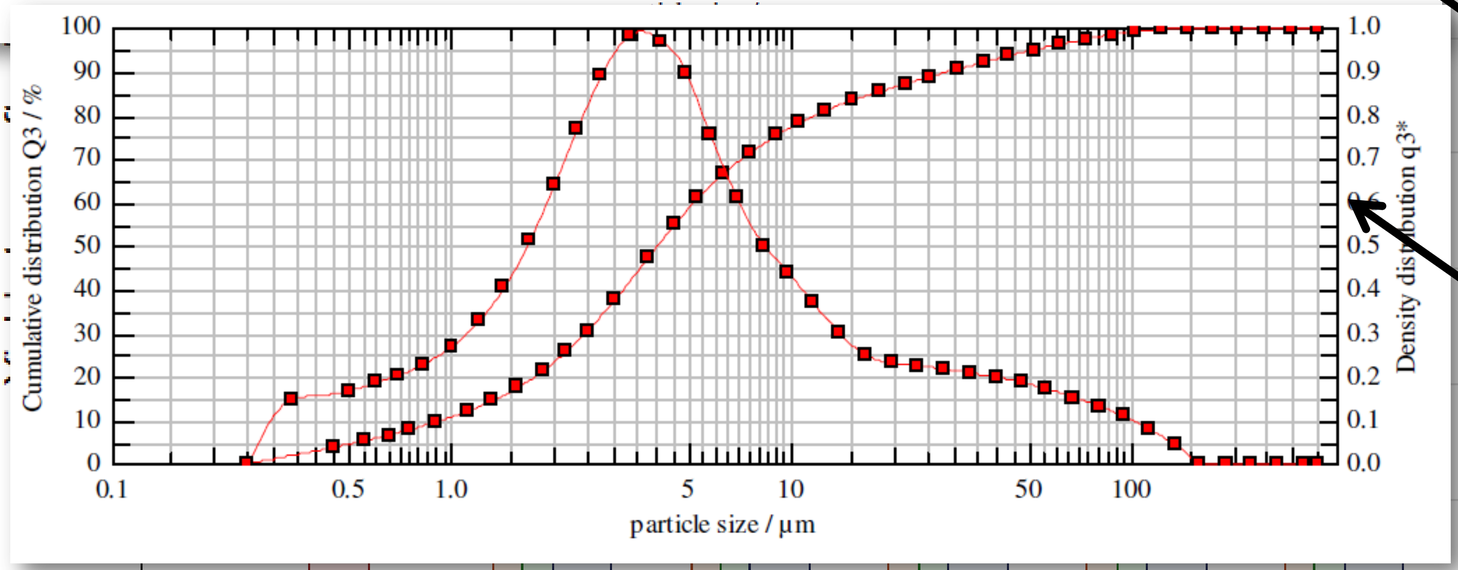


YIELD STRESS AFTER 5 MI



YIELD STRESS AFTER 5 MIN





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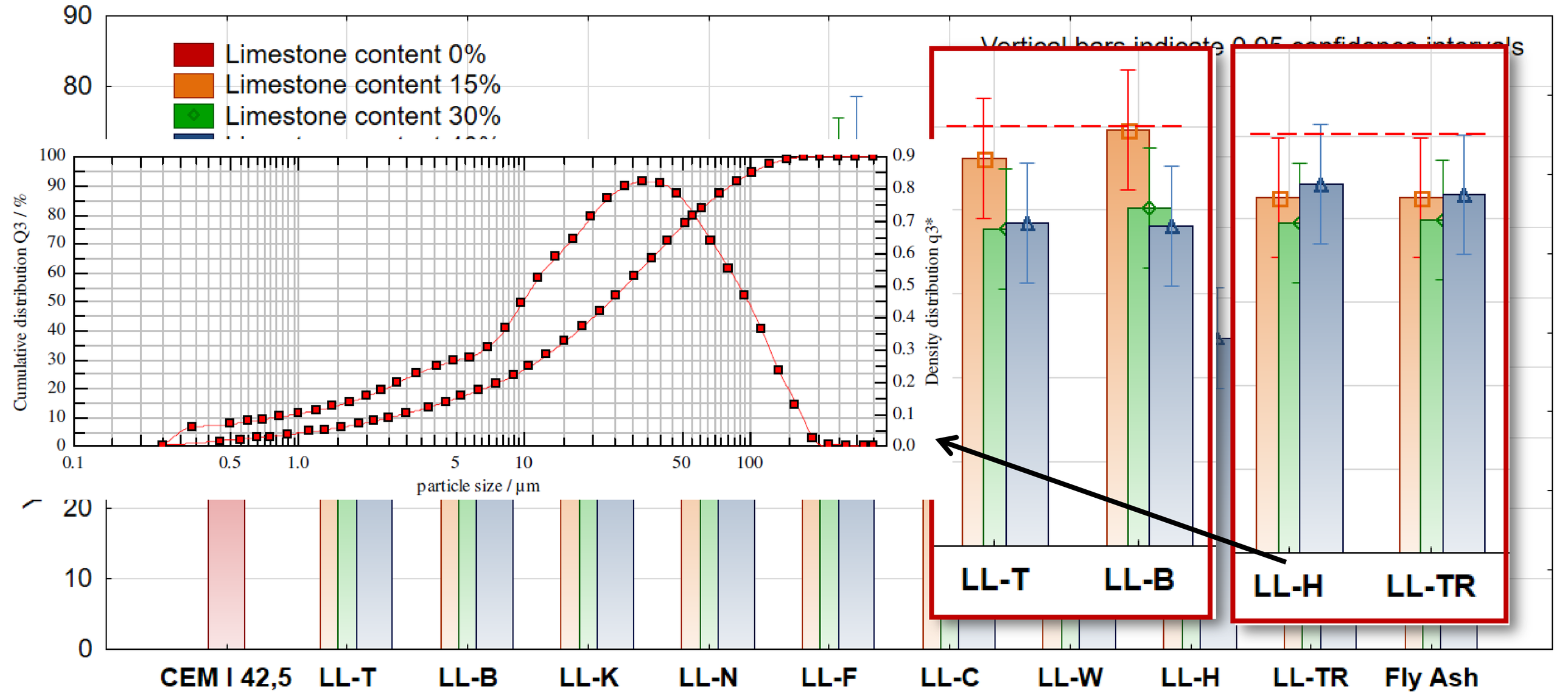

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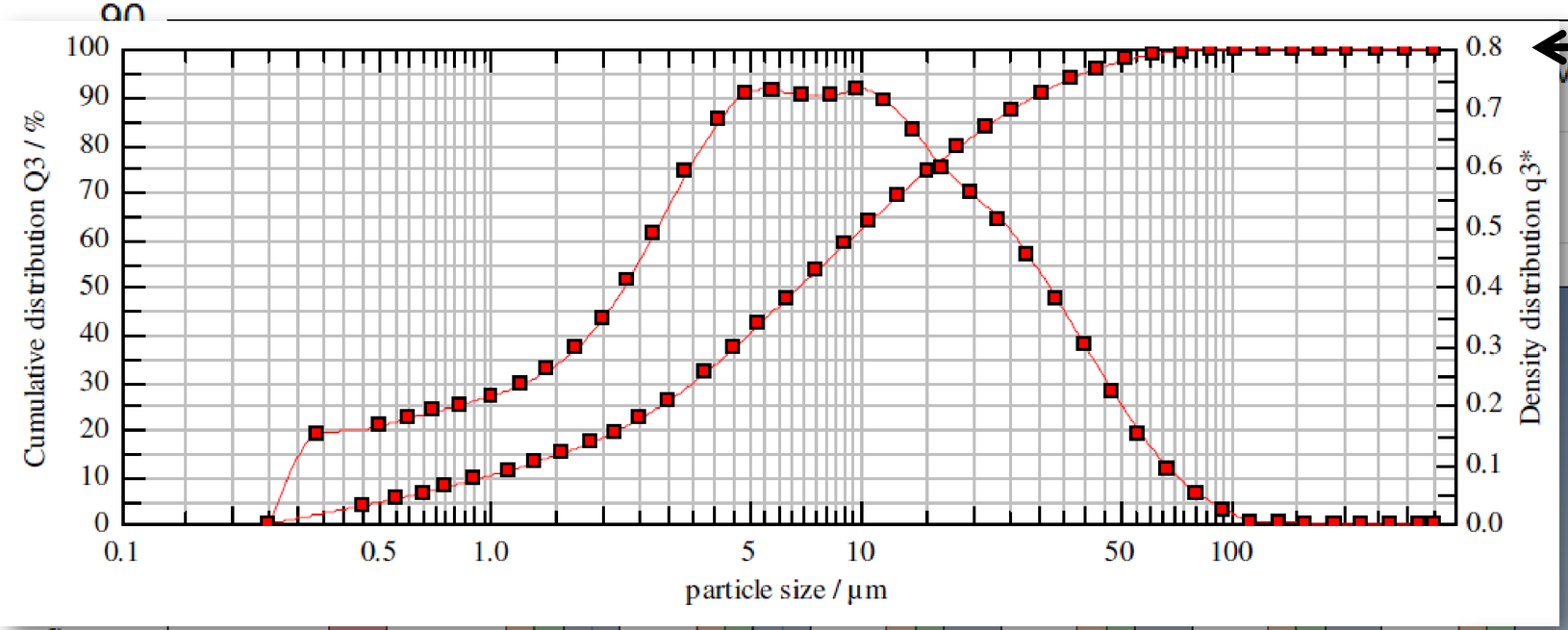
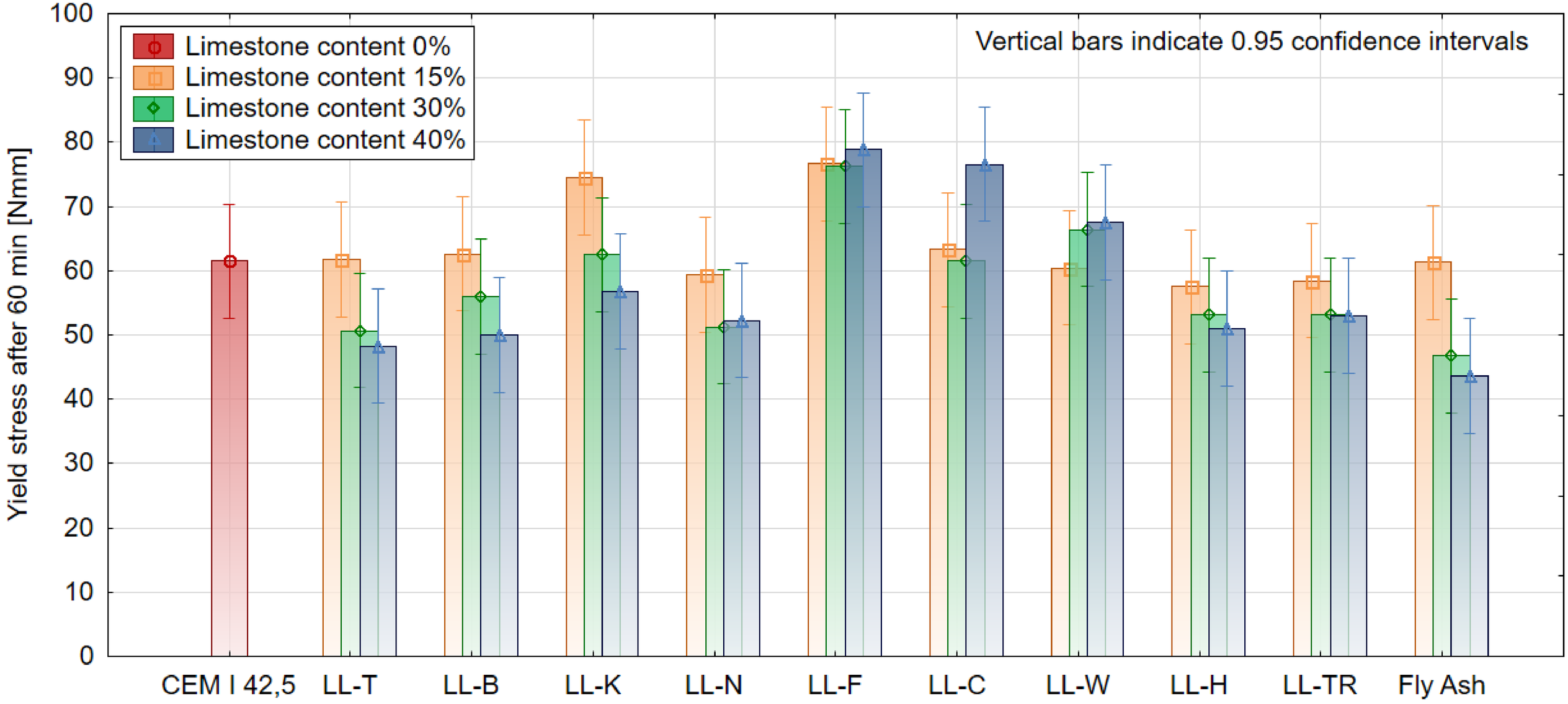


YIELD STRESS AFTER 60 MIN



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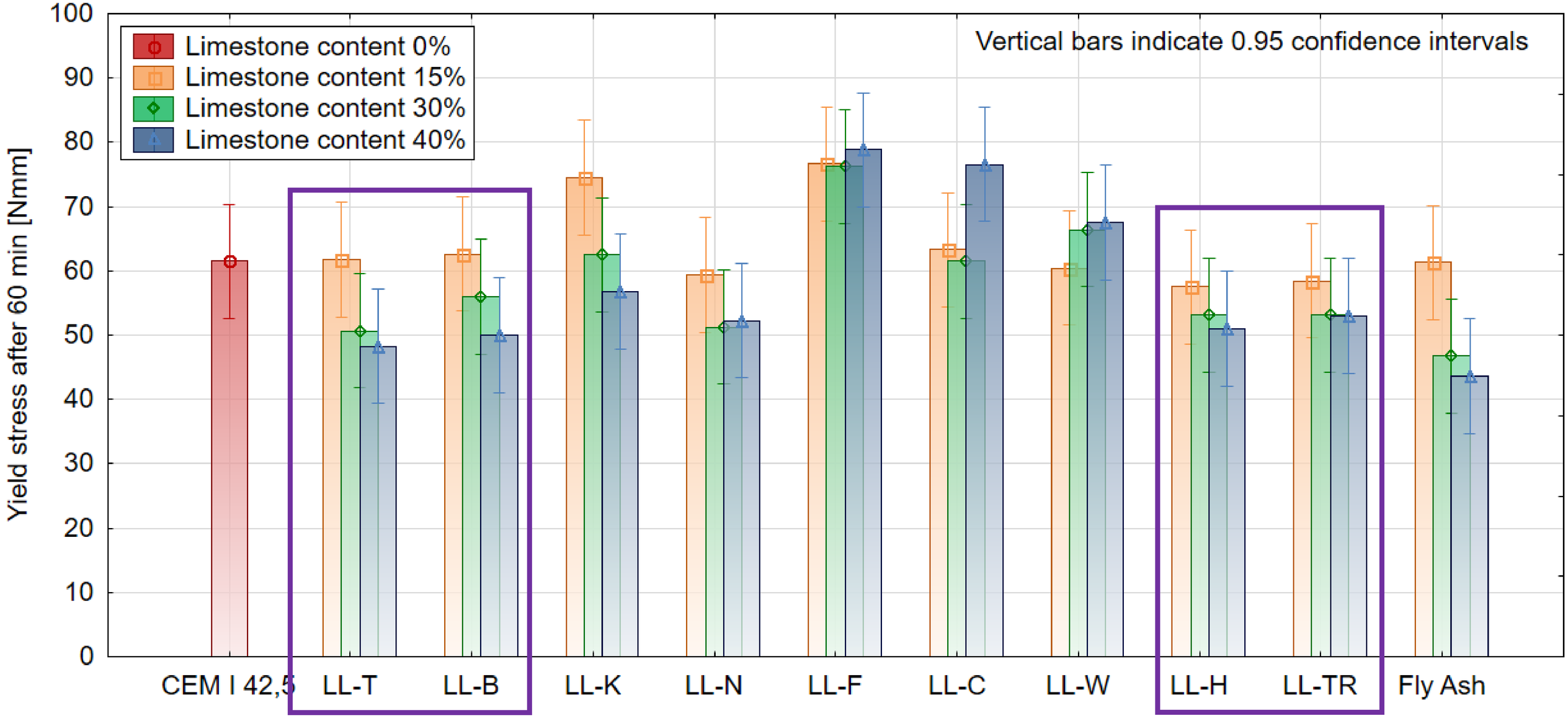

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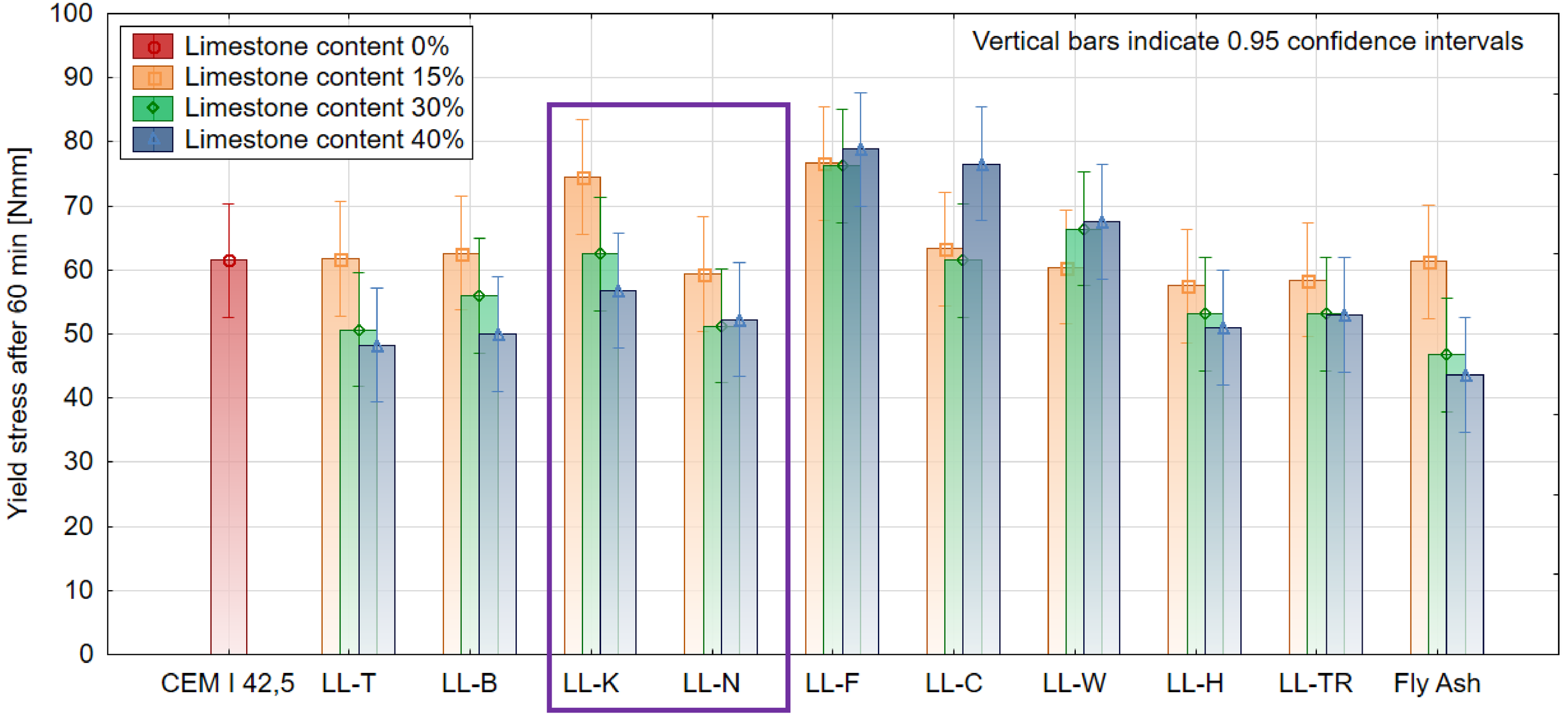
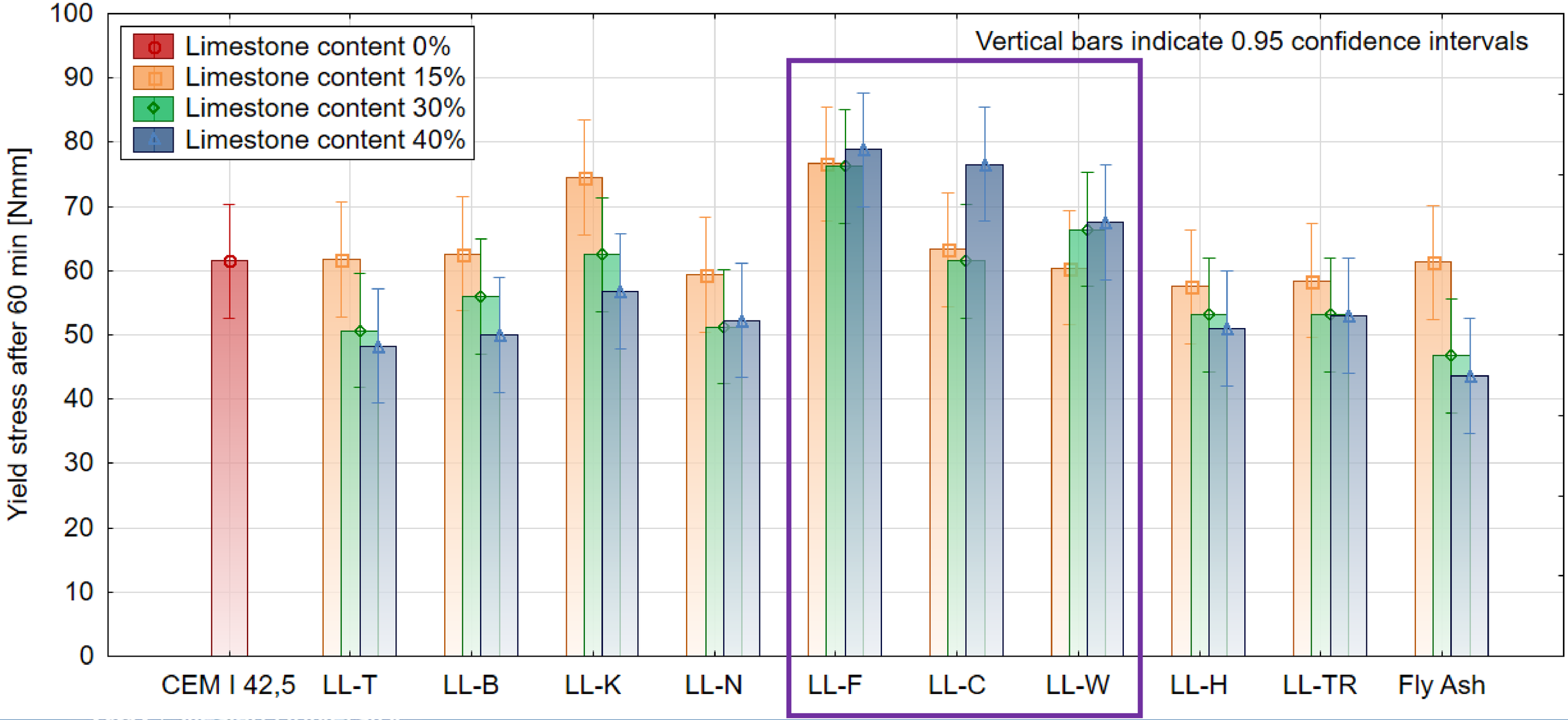
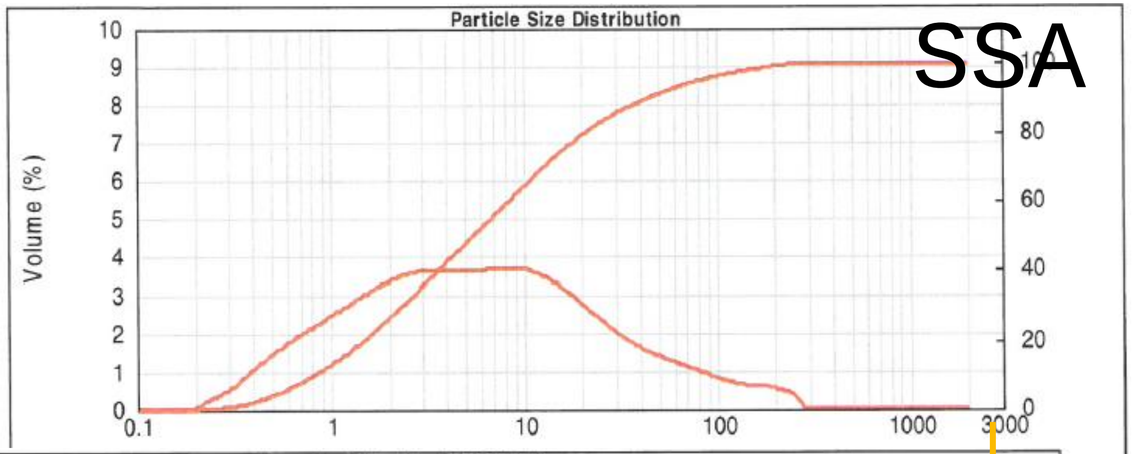
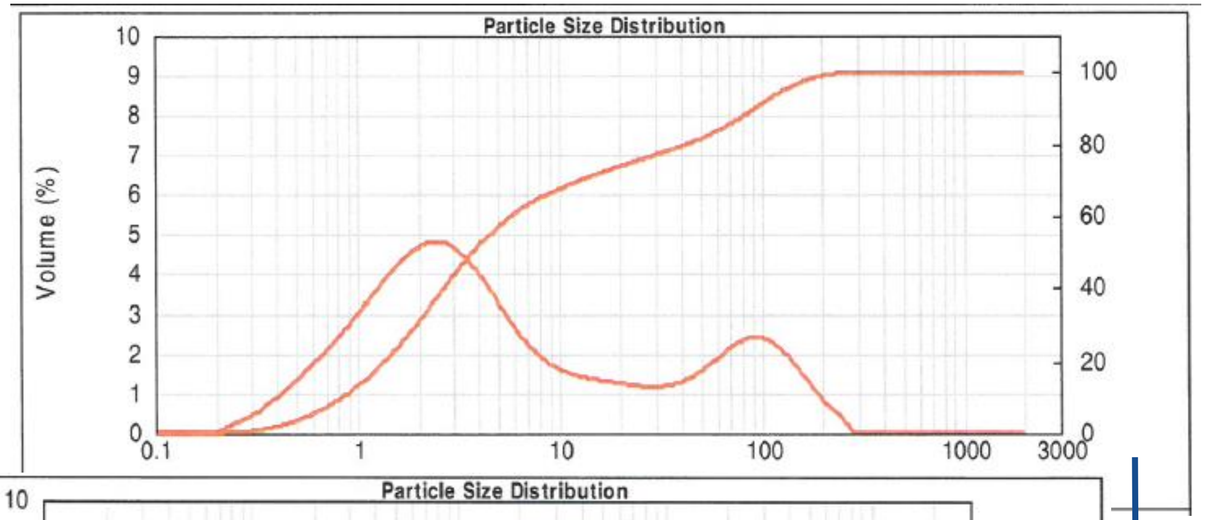


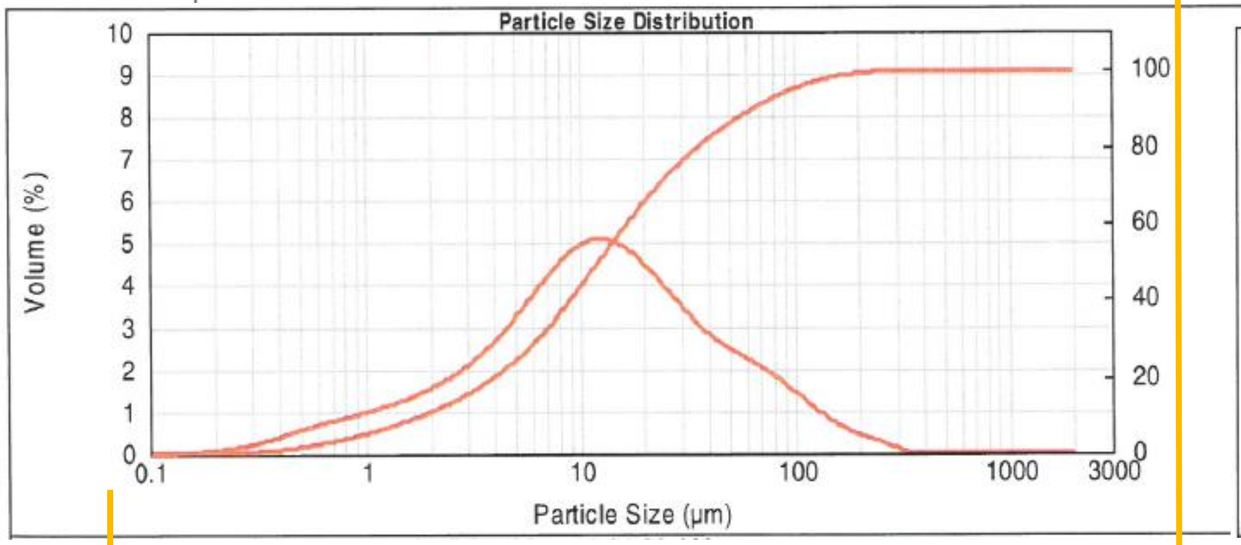
YIELD STRESS AFTER 60 MIN

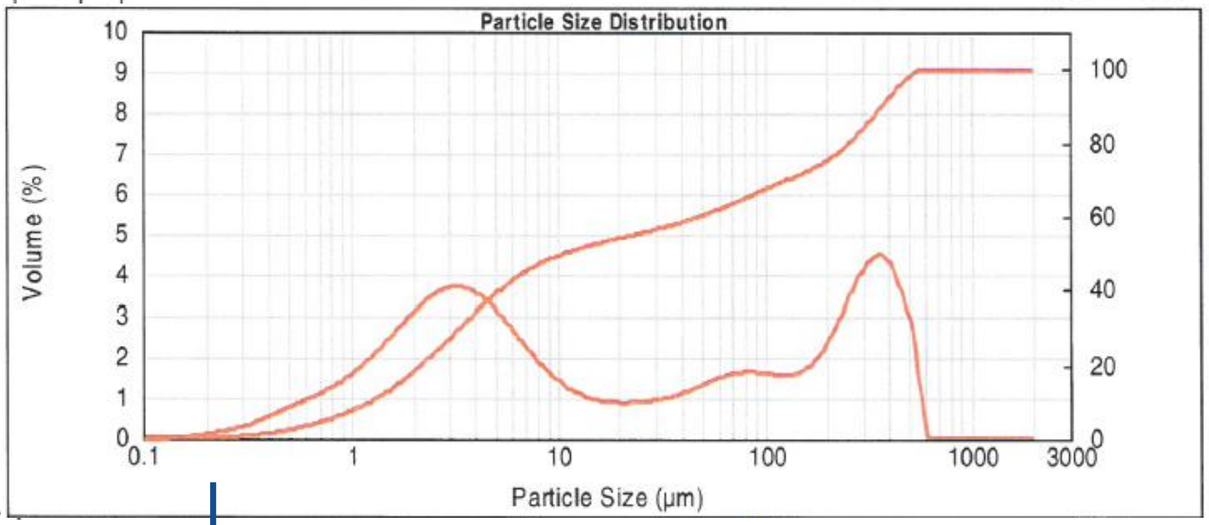


YIELD STRESS IN RELATION TO SSA









LL T1
(4980 cm^2/g)

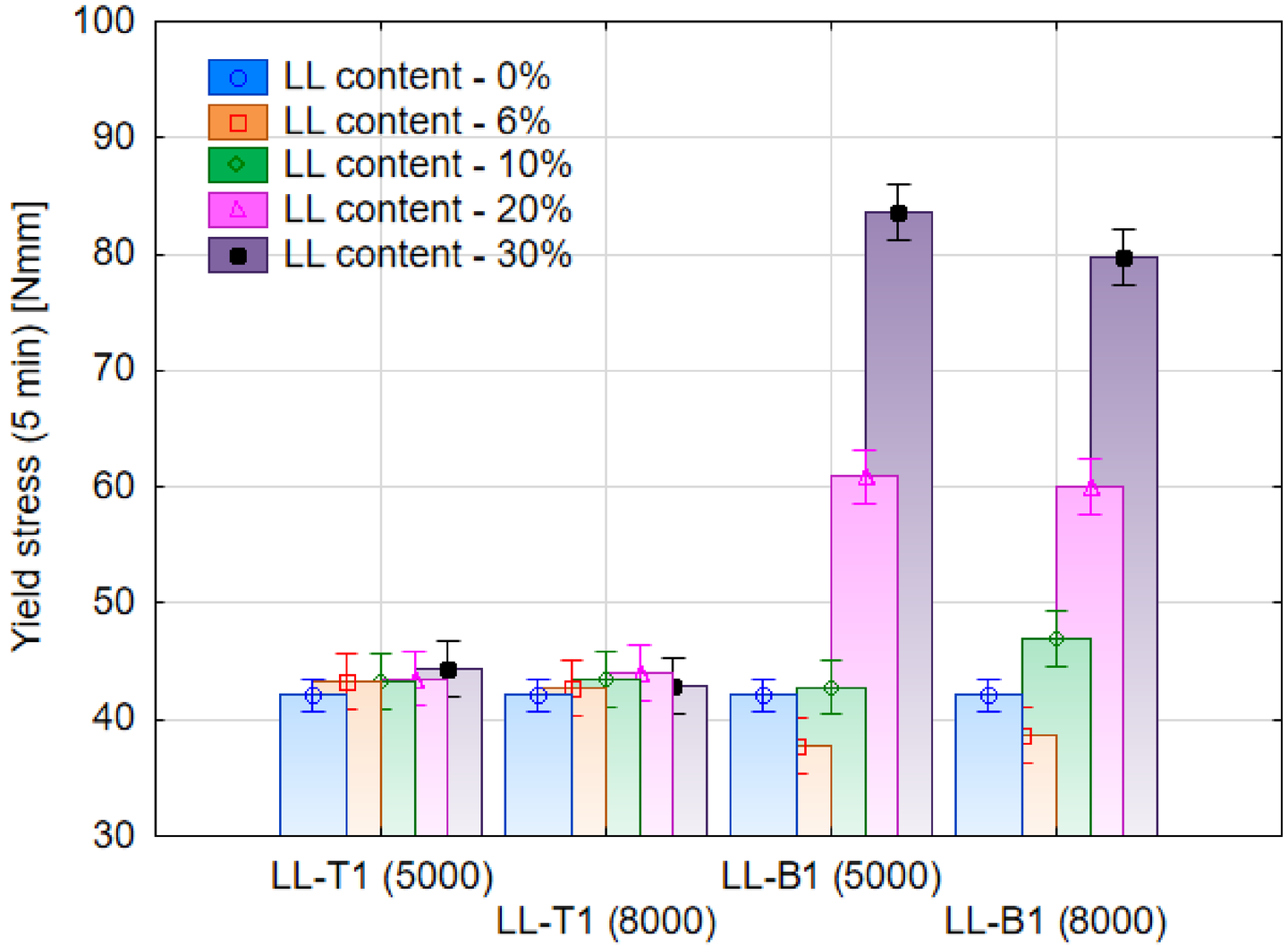
LL T1
(8120 cm^2/g)

LL B1
(5120 cm^2/g)

LL B1
(8220 cm^2/g)

YIELD STRESS IN RELATION TO SSA

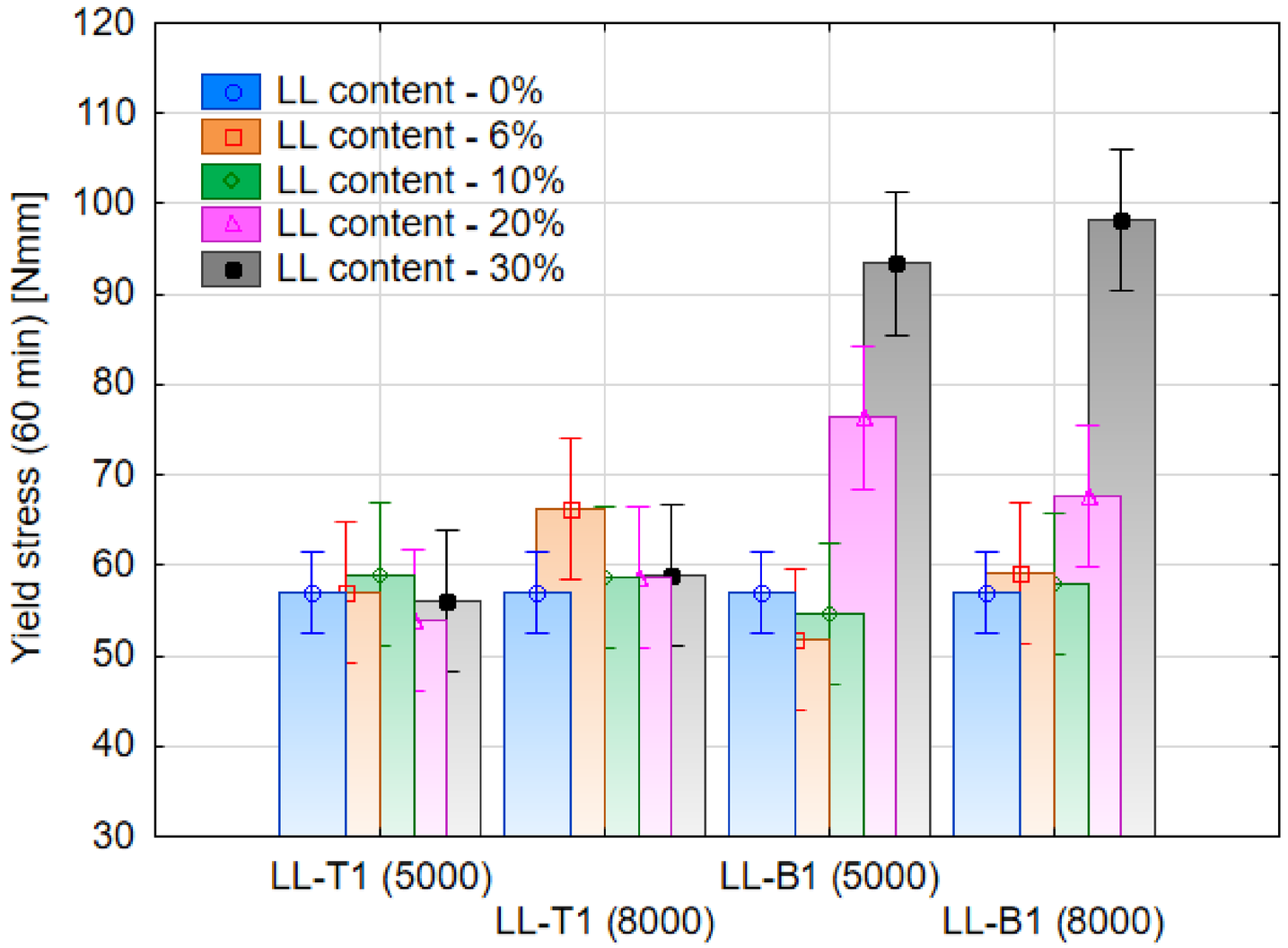
Specific suface area of cements T1 and B1 has no visible influence on the yield stress of mortars 5 min after mixing.



YIELD STRESS IN RELATION TO SSA

Specific suface area of cements T1 and B1 has no visible influence on the yield stress of mortars 5 min after mixing.

This effect carries over after 1h after mixing.



PLASTIC VISCOSITY

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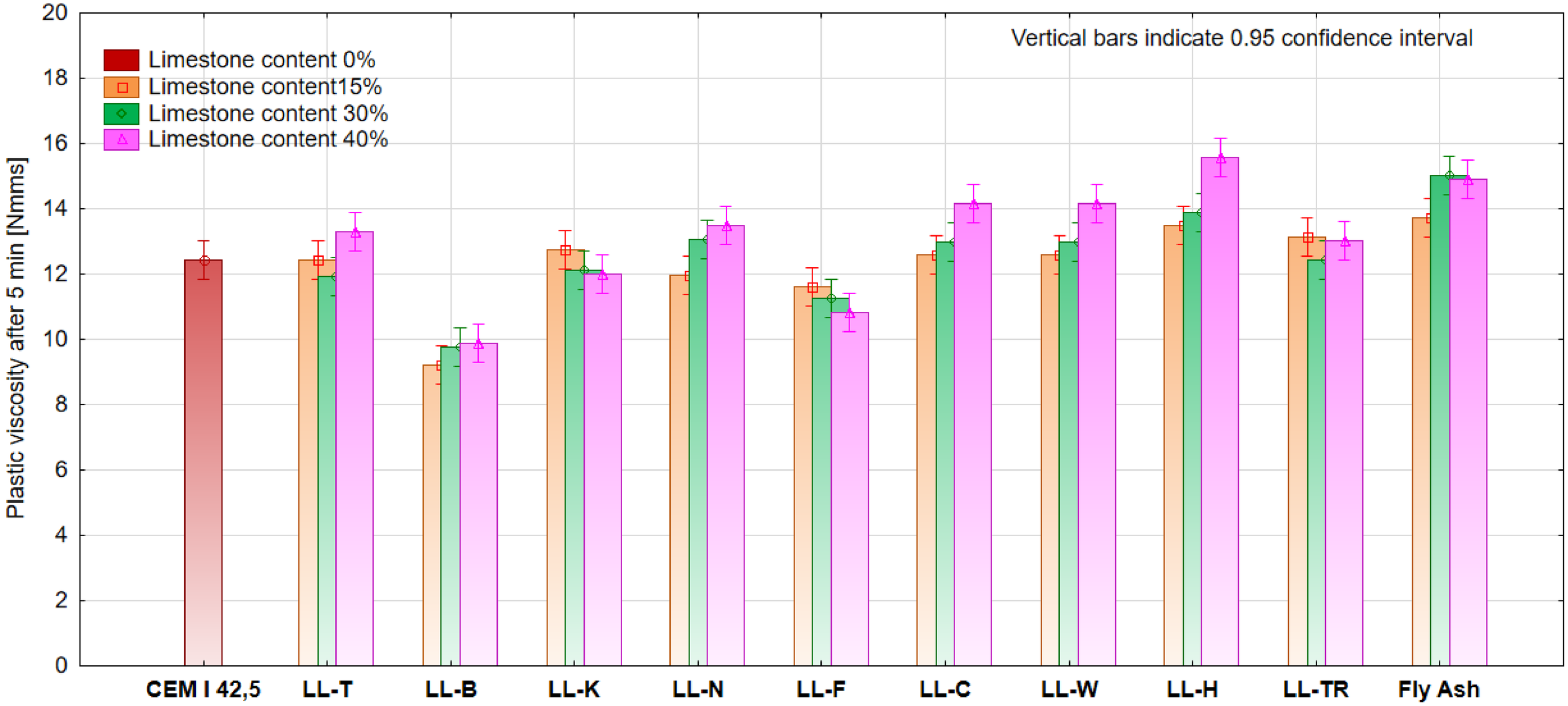
PLASTIC VISCOSITY AFTER 5 MIN



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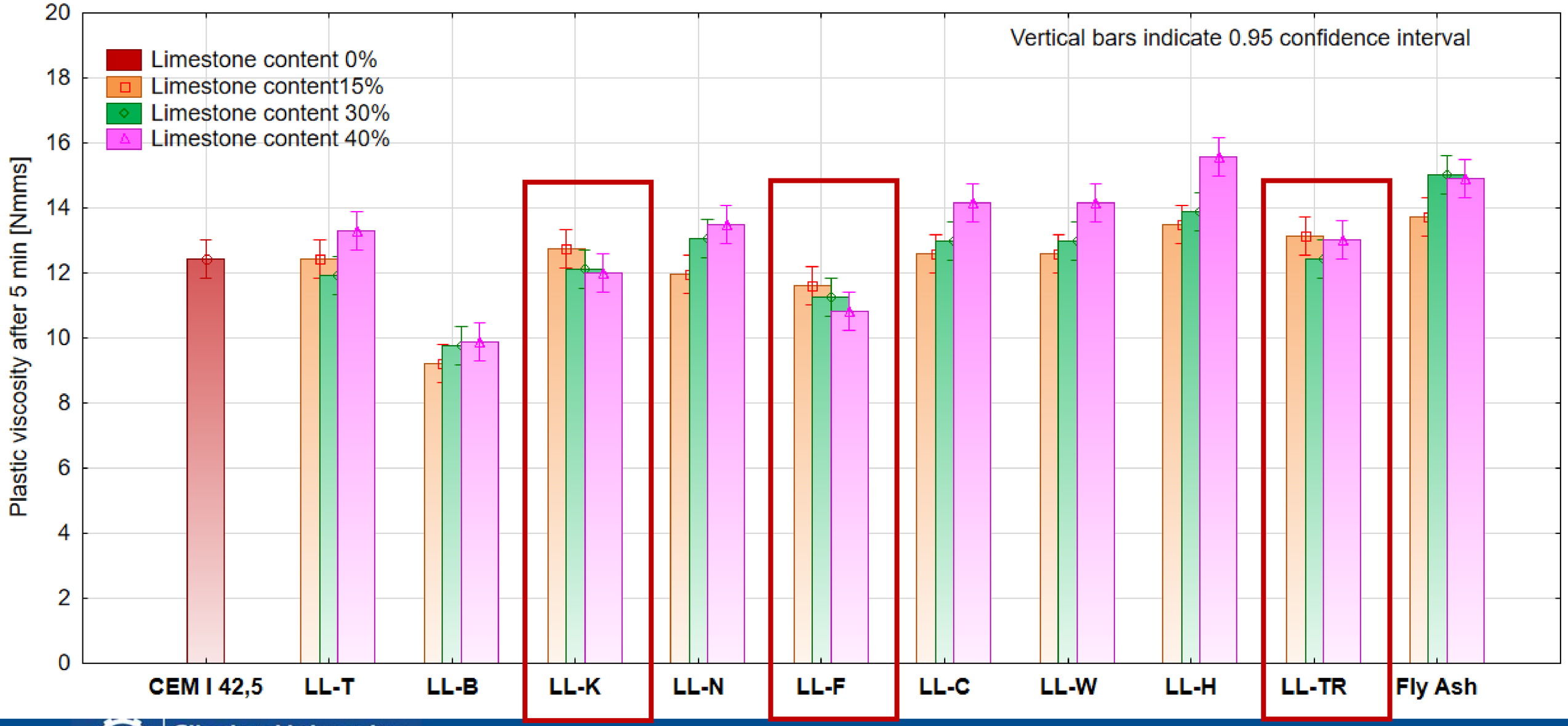
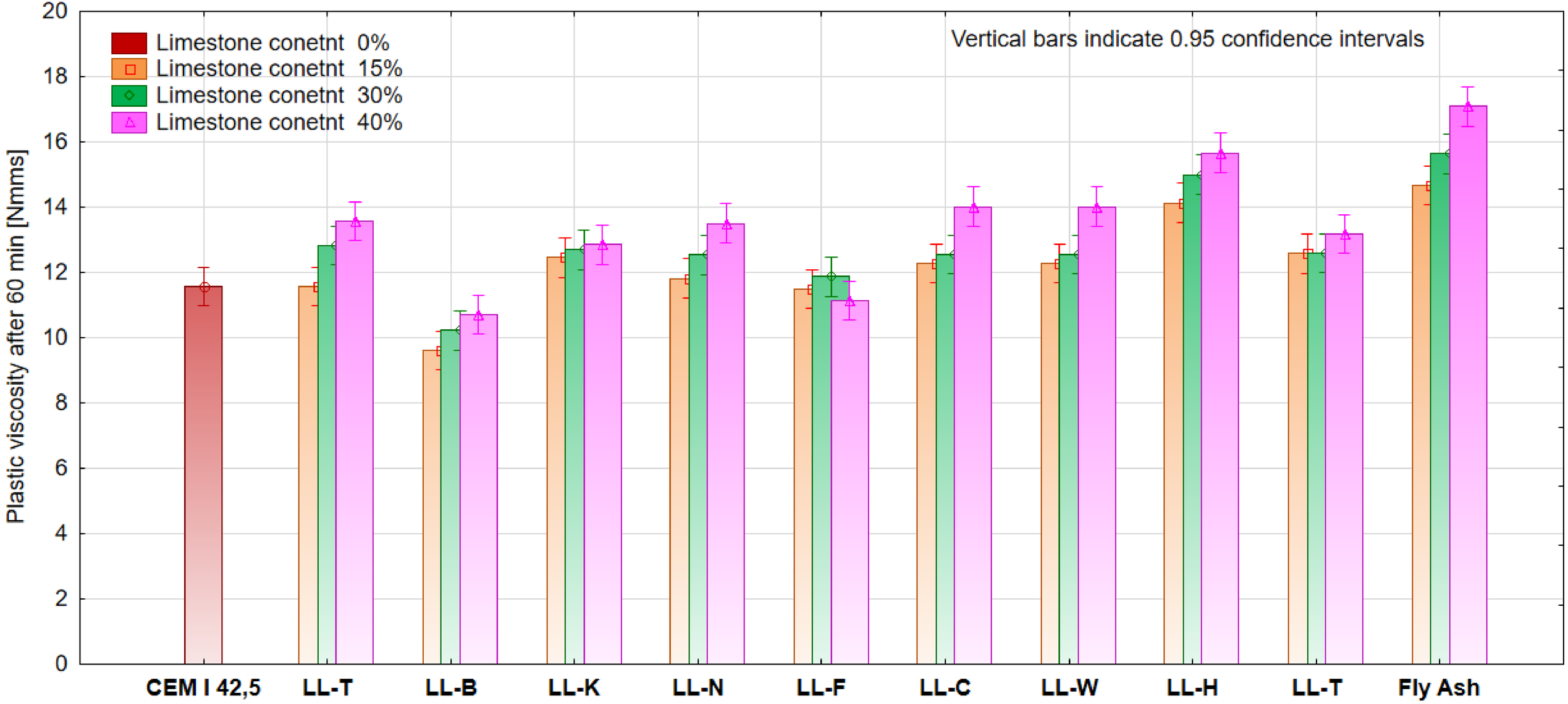
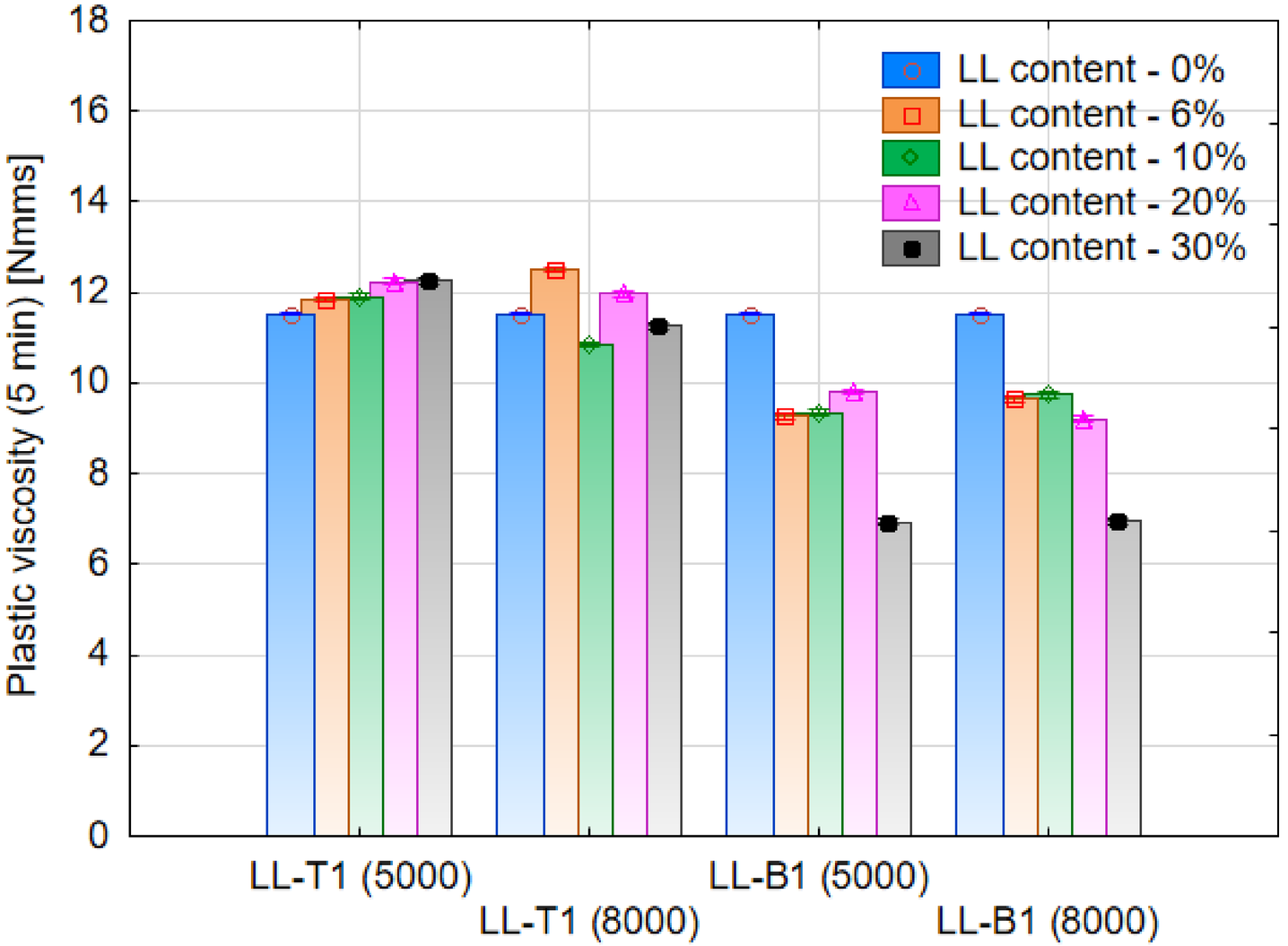


PLASTIC VISCOSITY AFTER 60 MIN



PLASTIC VISCOSITY IN RELATION TO SSA

Specific suface area of cements T1 and B1 has no visible influence on the plastic viscosity of mortars 5 min after mixing.

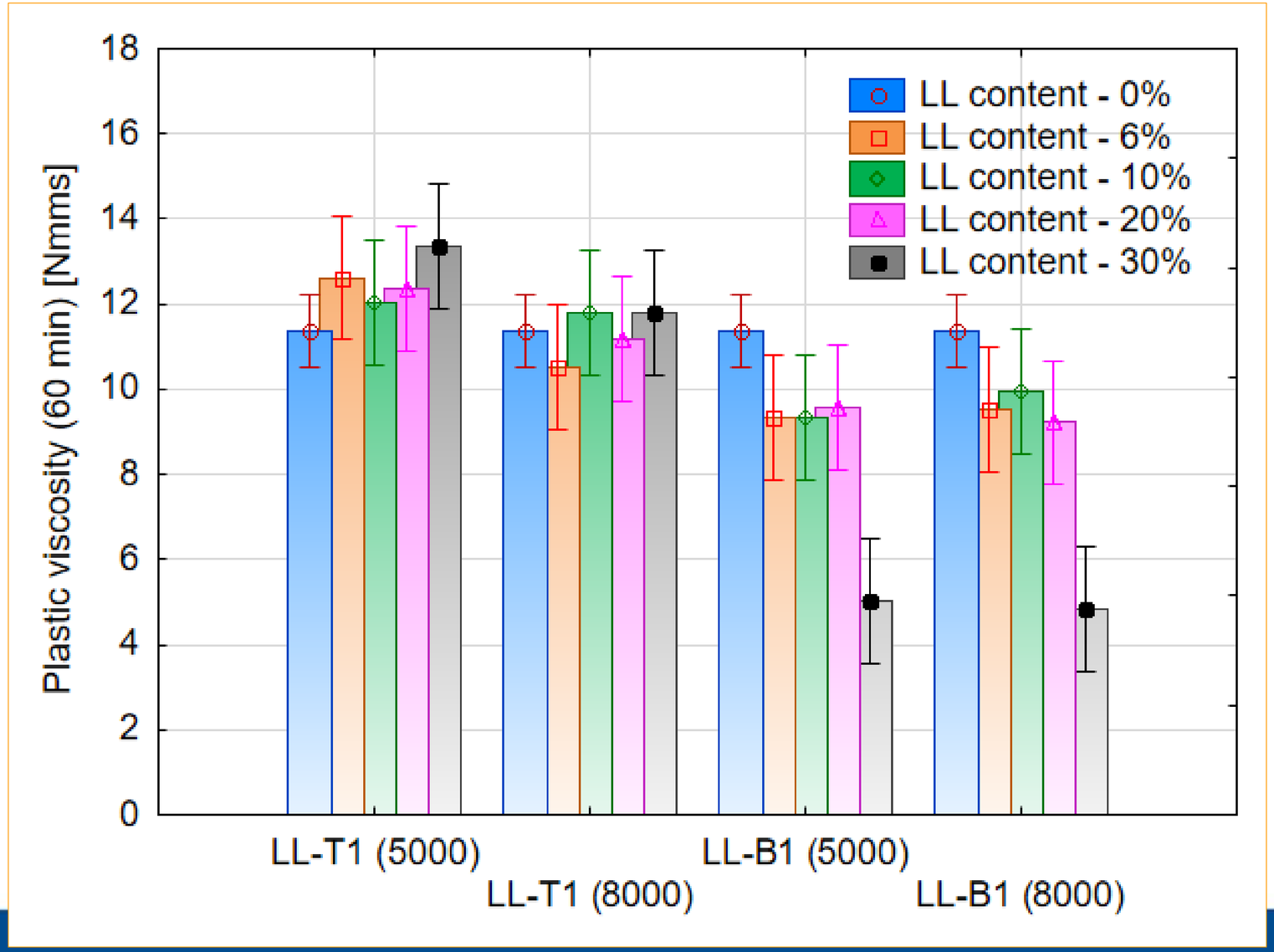


PLASTIC VISCOSITY IN RELATION TO SSA

Specific suface area of cements T1 and B1 has no visible influence on the plastic viscosity of mortars 5 min after mixing.

35

The effect of SSA is also not visible after 60 min.



PART 3

CONCLUSIONS

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- Type of limestone plays important part in shaping the rheological properties of the mortars. Addition of limestone can improve, not change or worsen the yield stress of mortar, depending on its type.
- The effect of limestone on rheology might be liked to its particle size distribution. Bimodal, non-continous distribution may lead to worsening of yield stress of mortars, while symmetrical dystribution may improve charateristics.
- Specific surface area of a limestone does not significantly affect the yield stres and plastic viscosity. Type of limestone plays a more pivotal role.
- Addition of limestone to cement in amount of 15-40% does not significantly affect the plastic viscosity of the mortar

THANK YOU FOR YOUR ATTENTION

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