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The Air-Entraining Methodology Decrease of Self-Compacting Concrete

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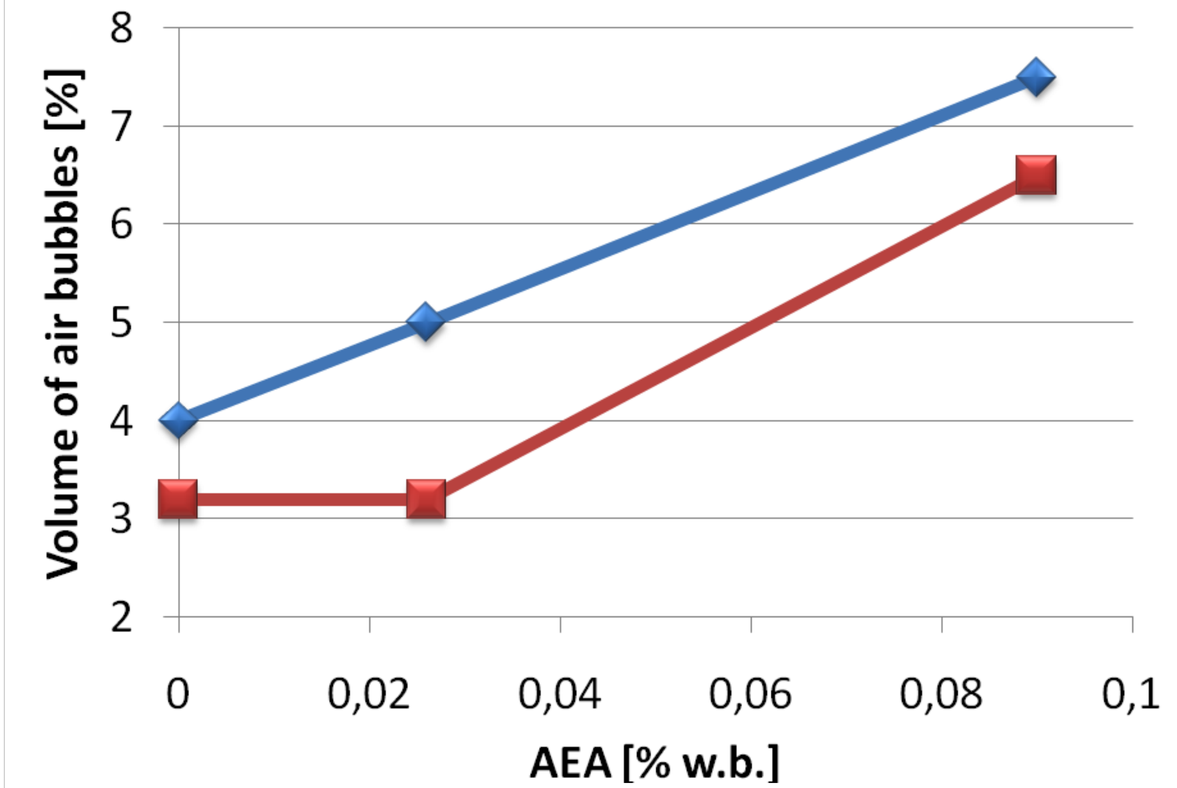


T SCC WITH SP (PC,
VEN IF THE AIR-
NOT USED

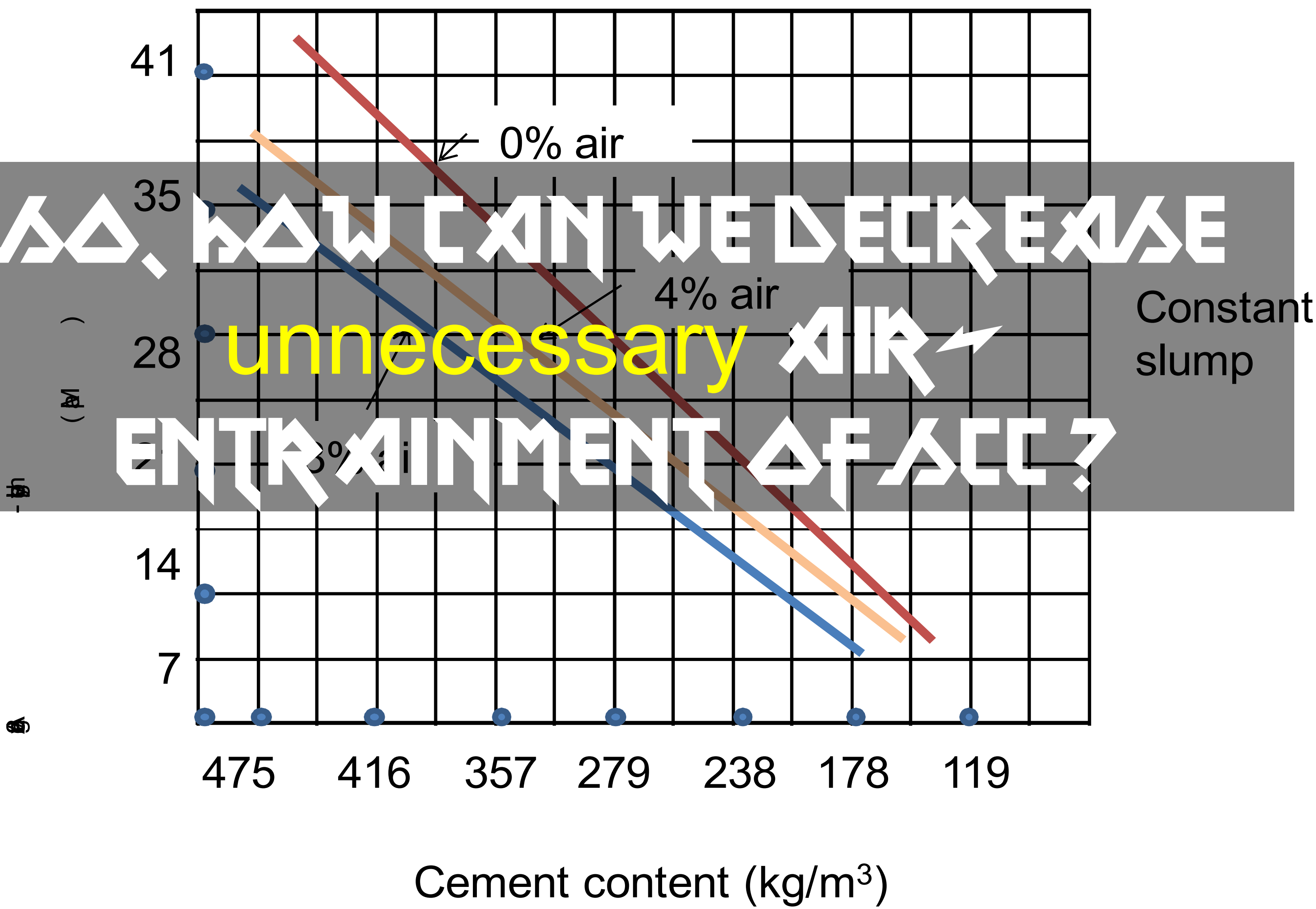
As we can see
rheological

Air
3
2

The flow SCC
millimeters d
3,2 % of air, a
SCC with 720
diameter, incl

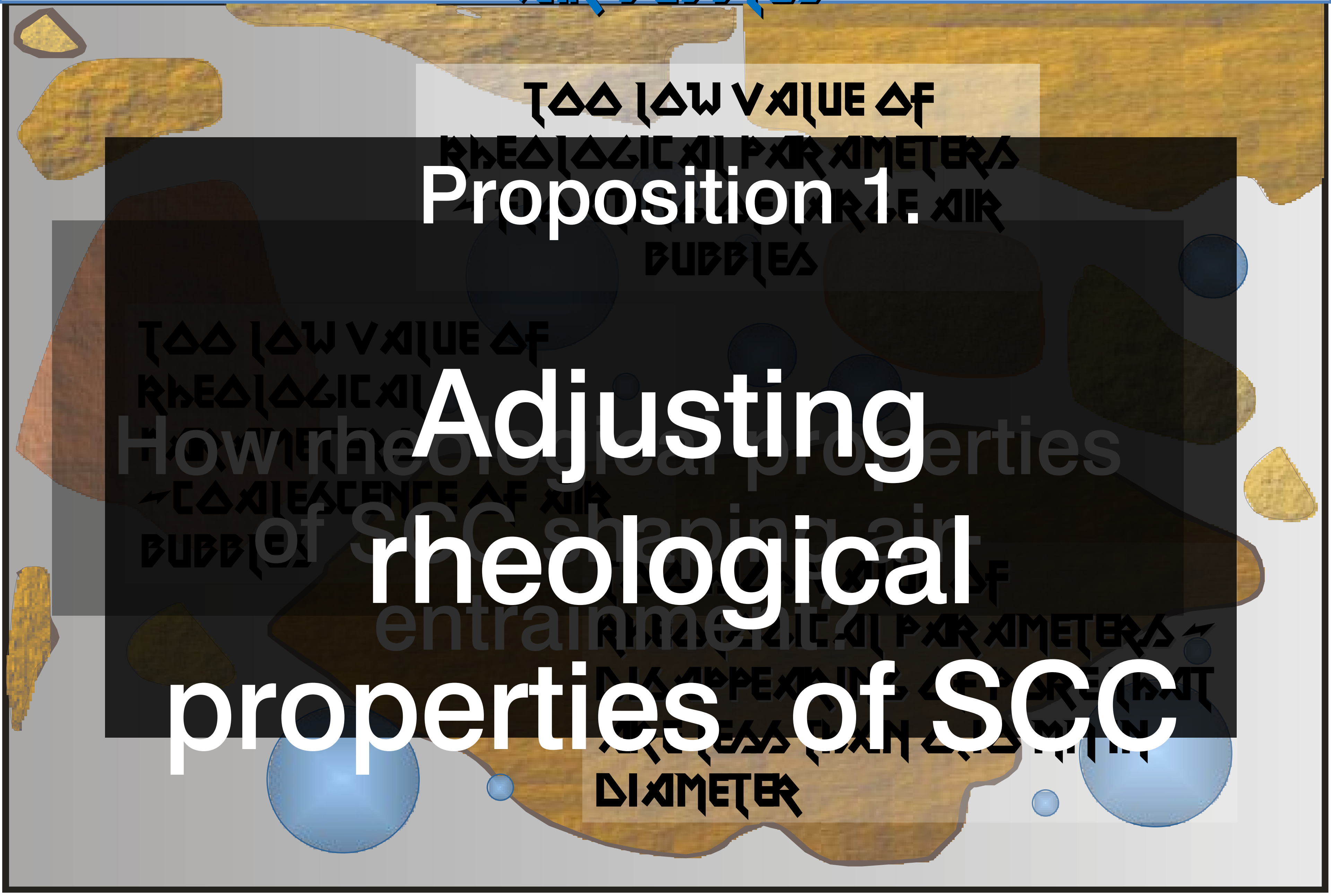
In next step of laboratory research air-entraining admixture was inserted into the same SCC composition. It caused bigger air-entrainment of SCC in proportion to dosage of air-entraining admixture.
So, and in this case rheological

AIR VOLUME IN CONCRETE DECREASE OF CONCRETE COMPRESSIVE STRENGTH



So, how can we decrease unnecessary air-entrainment of SCC?

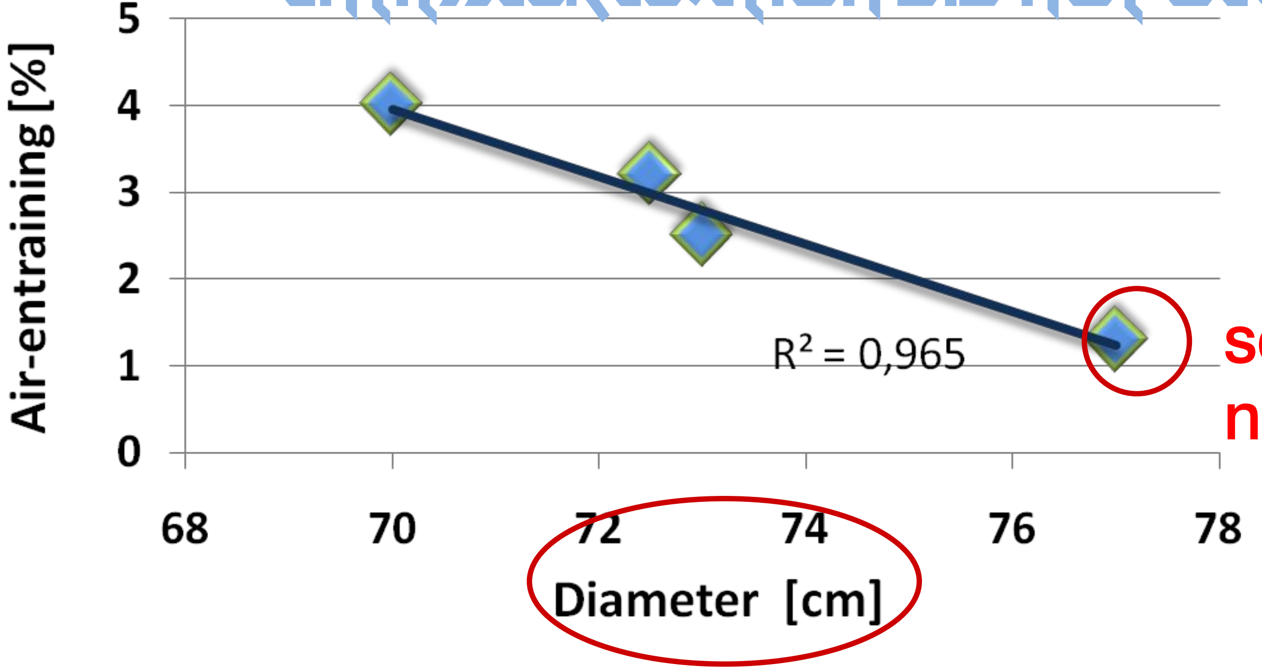
Influence of Rheological Properties of SCC on Air Bubbles



Proposition 1.

Adjusting rheological properties of SCC

LABORATORY RESEARCH SHOWDED THAT SCC WAS NOT AIR-ENTRAINED WHEN DIAMETER FLOW WAS MAXIMIZED UNTIL SEGREGATION DID NOT OCCURE



segregatio
n

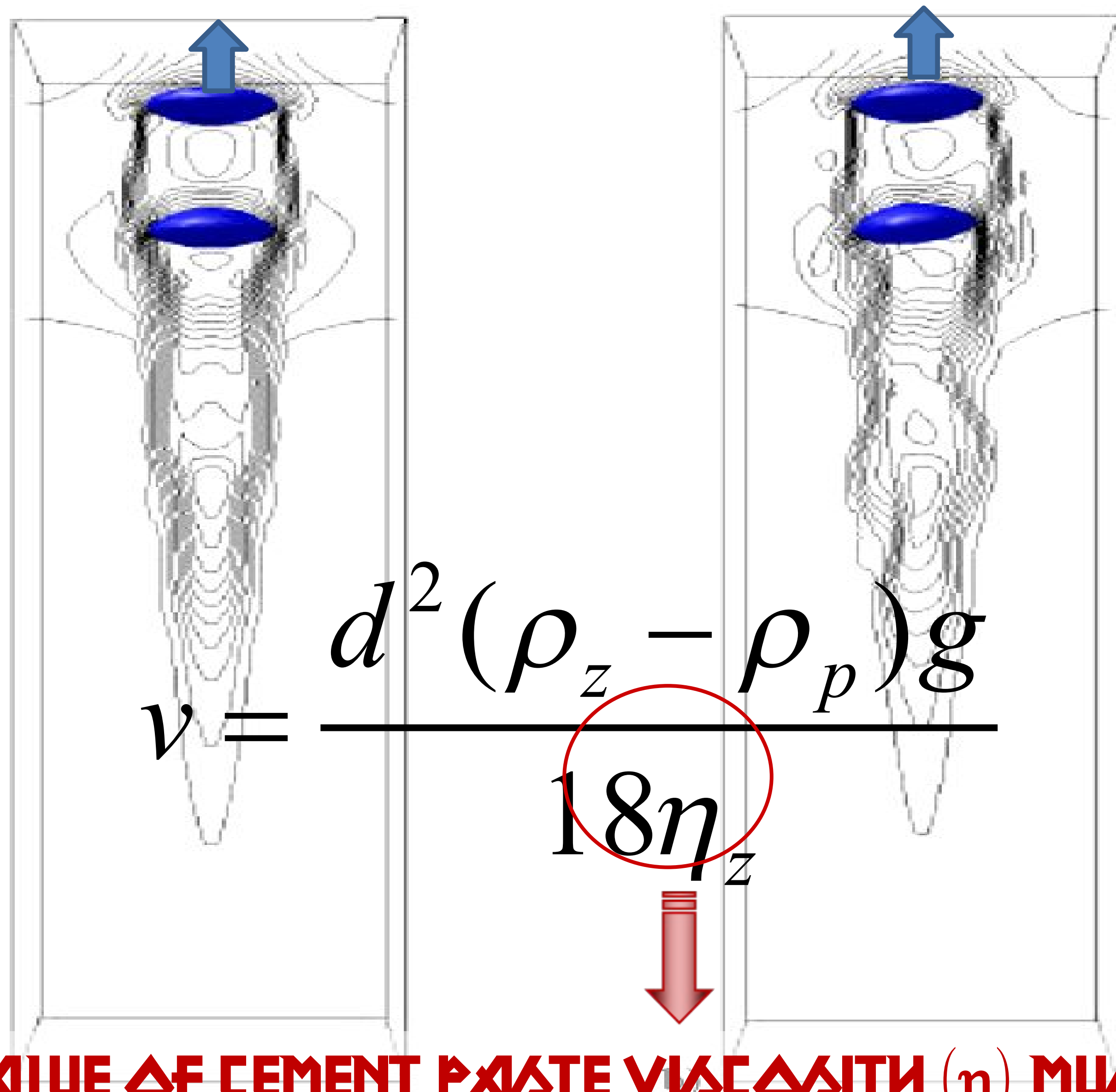
In this case we must use VMA

OUTFLOW QUALIFICATION OF OF AIR

$$(\rho_z - \rho_p) d \cdot g > \tau_0 \cdot A$$

diameter of air bubbles **shape index of air bubbles**

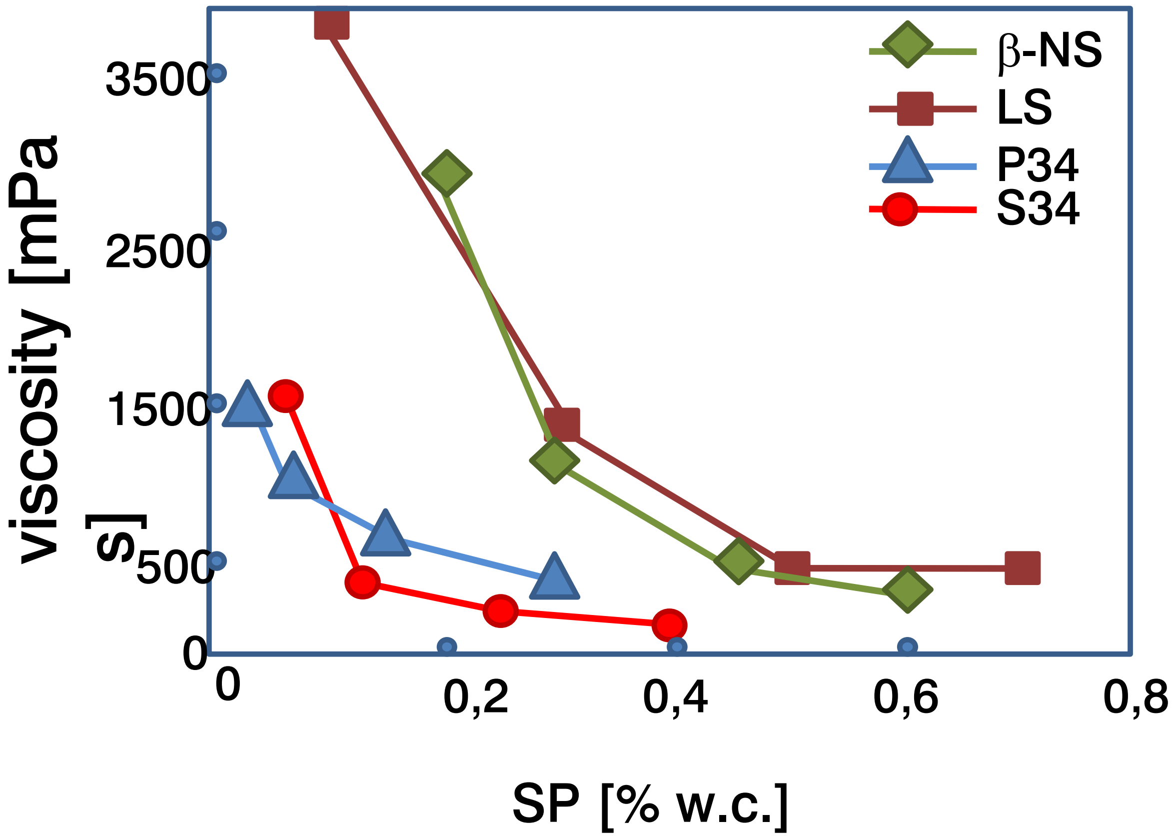
CONCLUSION: SCC WITH SP INCORPORATE NOT TOO MUCH AIR BUBBLES WHEN VALUE OF YIELD STRESS ($_0$) OF



$$v = \frac{d^2(\rho_z - \rho_p)g}{18\eta_z}$$

OREOVER, VALUE OF CEMENT PASTE VISCOSITY (η) MUST BE LOW T
OBTAIN HIGH OUTFLOW SPEED OF AIR BUBBLE

INFLUENCE OF SP TYPE AND VALUE DOSAGE ON CONCRETE MIX VISCOSITY



IF WE KNOW THE VALUE OF CEMENT PASTE VISCOSITY AND YIELD STRESS WE CAN
SHAPE THEM USING TYPE AND DOSAGE SUPERPLASTICIZER TO

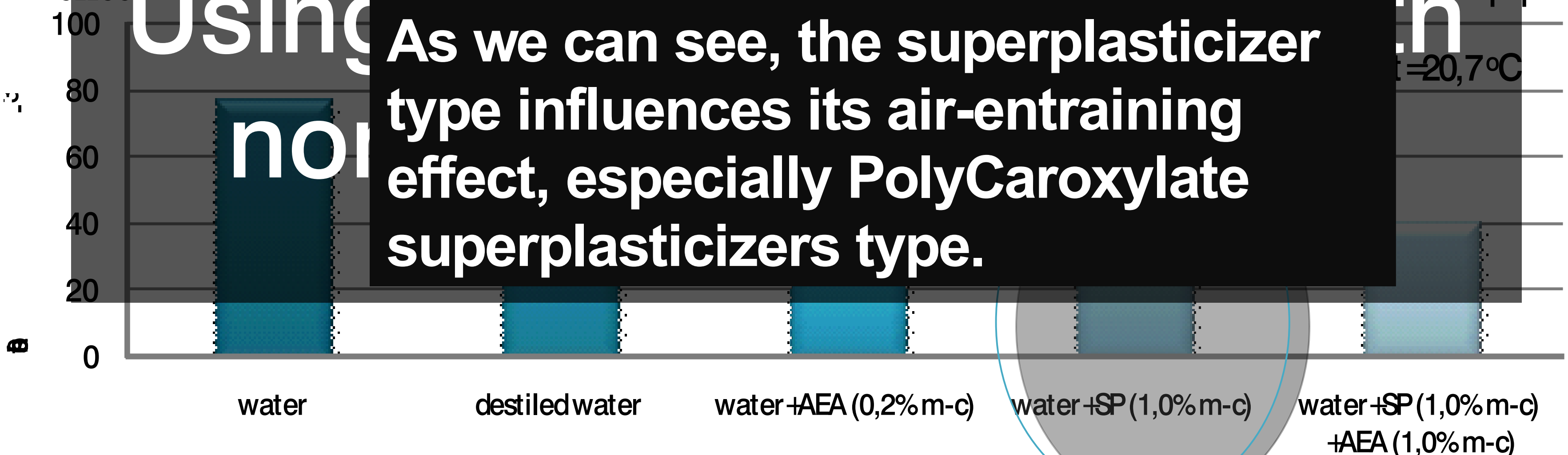
Superplasticizer type and its air-entraining effect

Air-entraining effect of SP is caused i.a. by its influence on surface tension of water

Superplasticizer	Lignosulfian LS	Sulfonated Naphtalene Formaldehyde Condensate SNF	Sulfonated Melanine Formaldehyde Condensate SMF	New Generation Superplasticizers: PolyCarboxylate Polyoxyethylene PCP	New Generation Superplasticizers: Amino Phosphonate Polyoxyethylene AAP
Air-entraining effect	+	++	++	++	++

Proposition 2.

Using ... nor...



As we can see, the superplasticizer type influences its air-entraining effect, especially PolyCaroxylate superplasticizers type.

Superplasticizers decrease the value of surface tension as much as the air-entraining admixture.

The rate of surface tension decreases by usage surface active compounds is followed in accordance with **GIBBS EQUATION:**

$$-\frac{d\sigma}{dc} = RT\,\frac{\Gamma_i^s}{c}$$

where:

dσ – change of surface tension

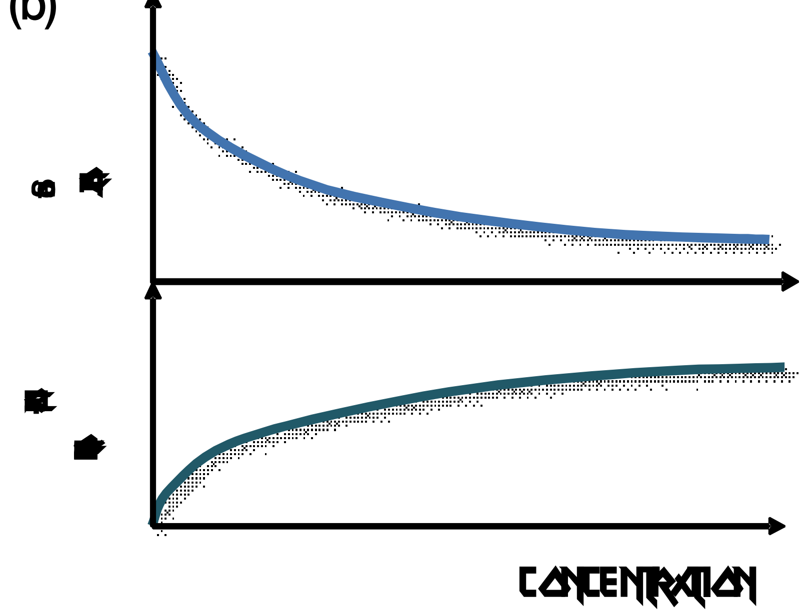
dc – change of given substance concentration in the solution,

Γ^s_i – surface concentration (mol/m²),

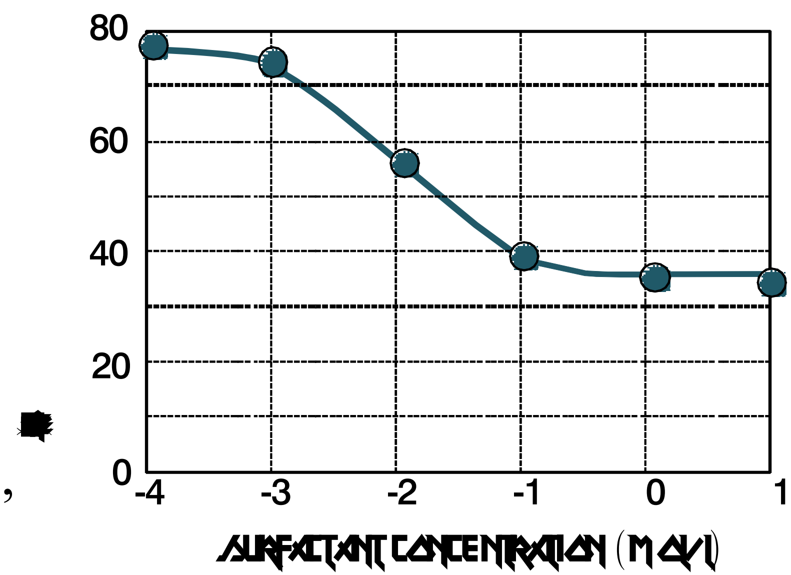
c – constituent concentration,

R – gas constant,

T – temperature.

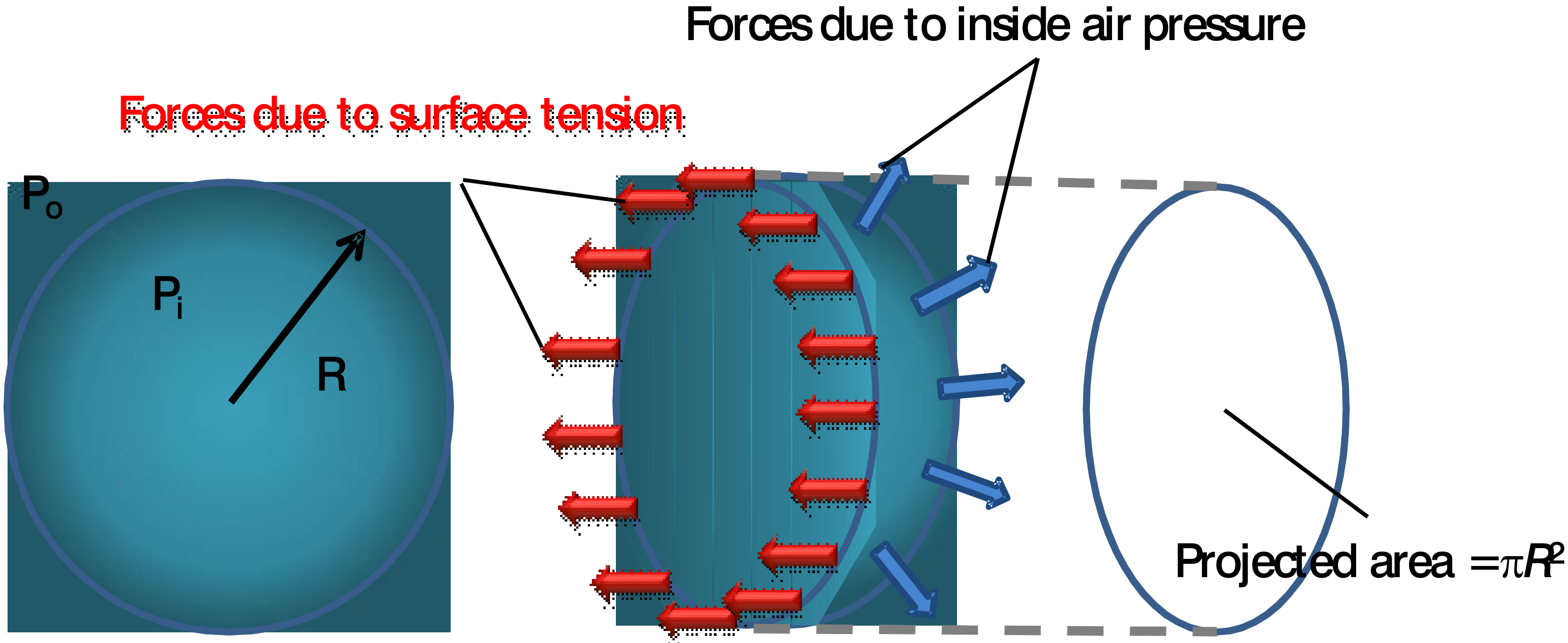


Rapid change of surface tension and foam production over a concentration range



Rapid change of surface tension over a relatively small concentration range

IN THE PICTURE WE CAN SEE, HOW AIR BUBBLE IS FORMATED BY THE SURFACE TENSION

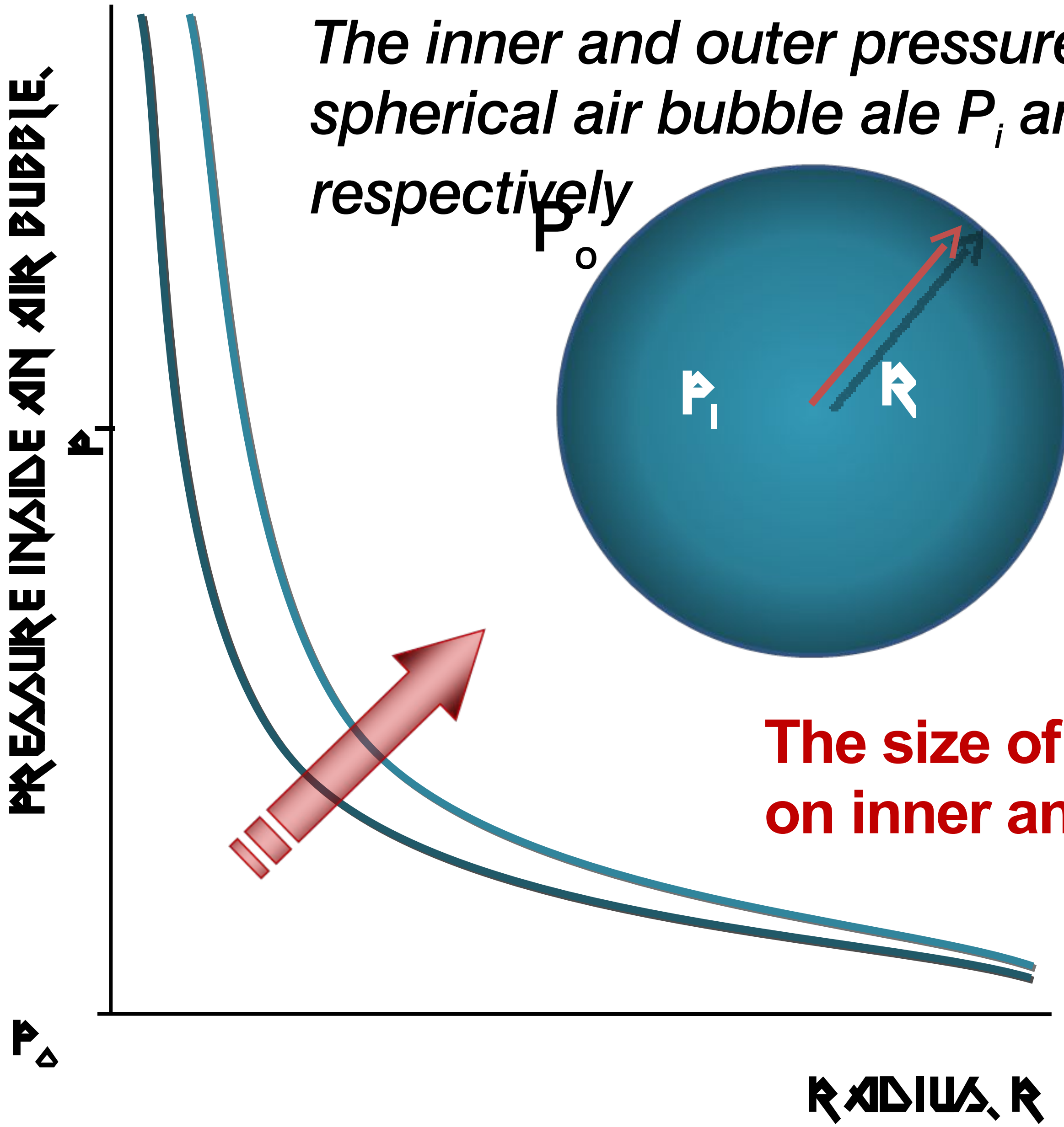


(a) Spherical air bubble (b) free-body diagram for right-half of air bubble

the forces pointing to the left are due to the surface tension. The forces pointing perpendicular to the hemispherical surface are due the air pressure inside the bubble

$$P_i - P_o = 2g/R \quad \text{- Laplace's law}$$

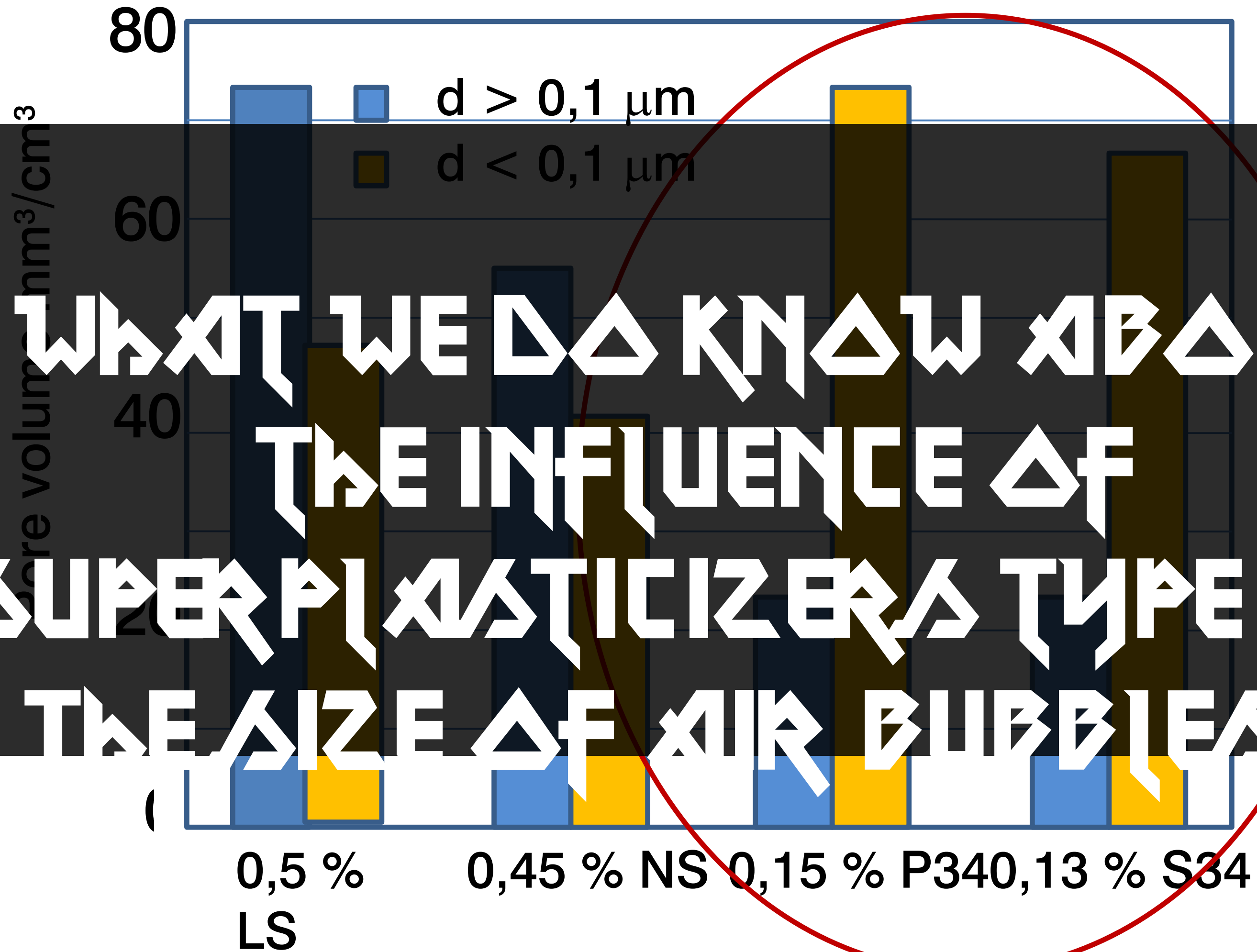
The inner and outer pressures on the spherical air bubble ale P_i and P_o, respectively



The size of air bubbles depe
on inner and outer pressure

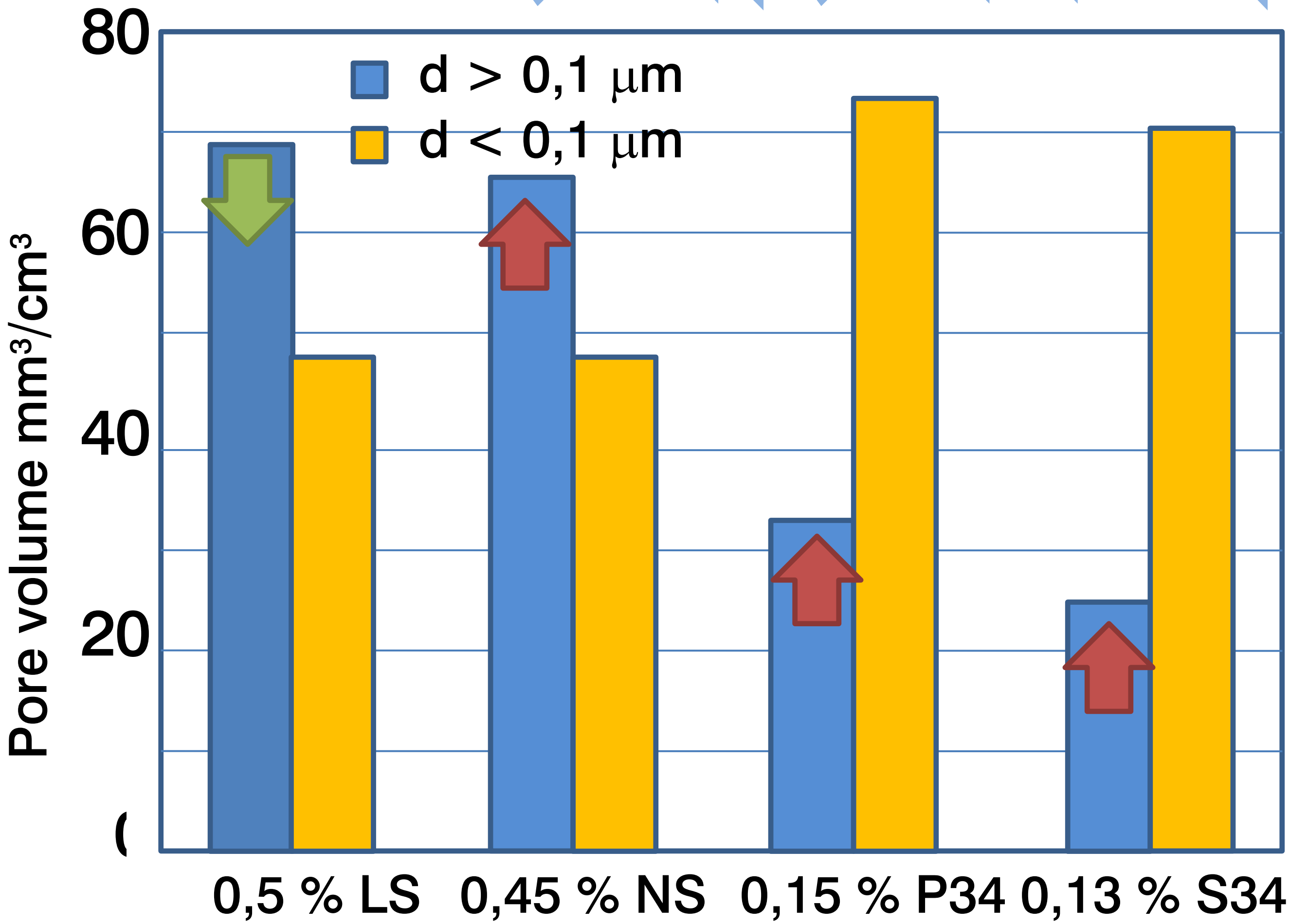
Infuence of Naphthalene (-NS), refined lignin sulfonate (LS) i polycarboxylate (P34, S34) superplasticizer on porosity structure of (28 days)

PolyCarboxylate superplasticizers decrease the volume of pore diameter more than other superplasticizer

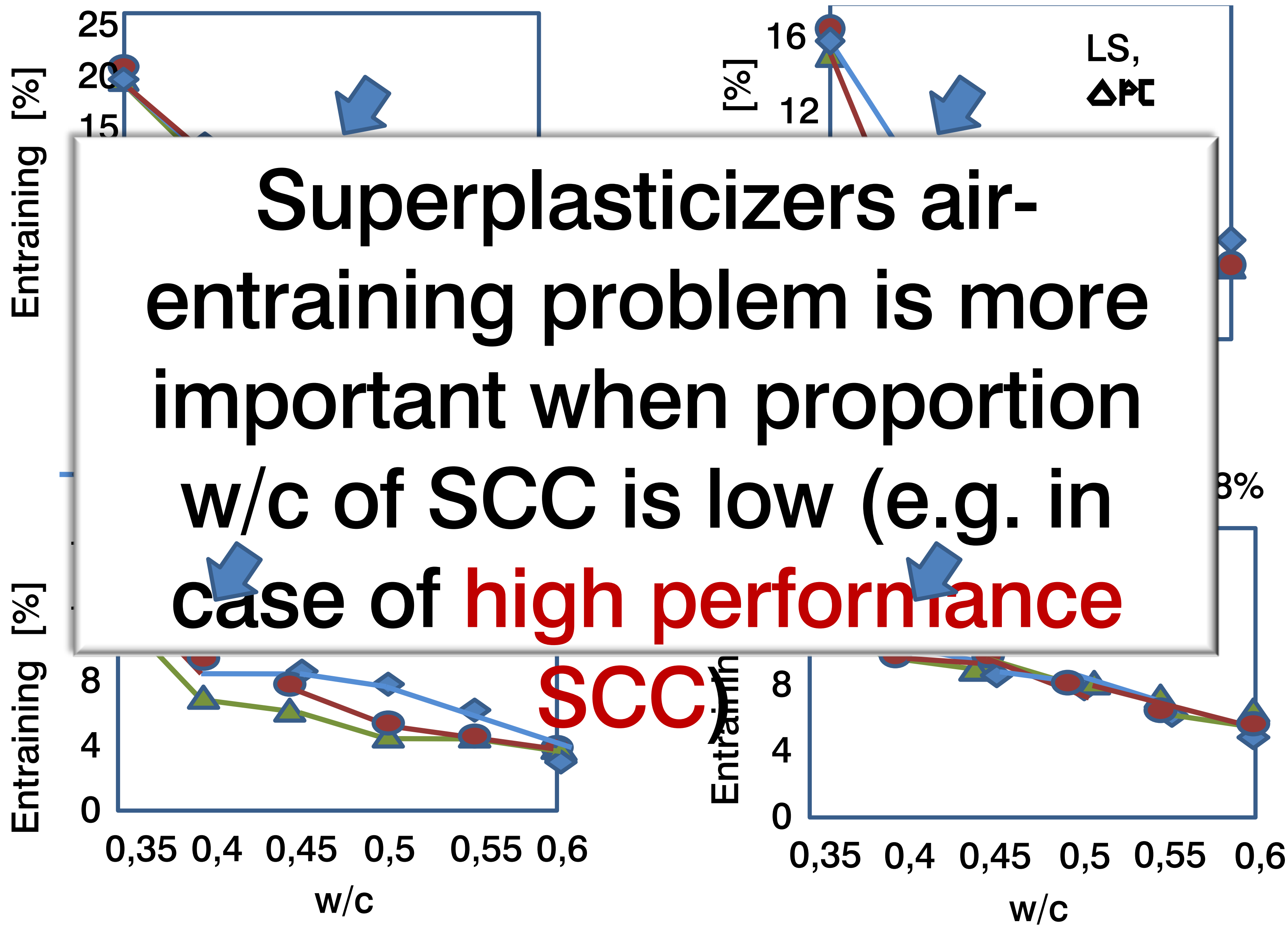


What we do know about the influence of superplasticizers type on the size of air bubbles ?

BUT VOLUME OF PORE WITH D > 0,1 μM INCREASE AFTER 91 DAYS ...SO, ACCORDING THIS RESEARCH ALL TYPE OF SP CAUSE AIR-ENTRAINING OF SCC



when the w/c proportion of SCC is low – air-entrainment of SCC is high



Superplasticizers air-entraining problem is more important when proportion w/c of SCC is low (e.g. in case of high performance SCC)

Lignosulfonic acid (LS)

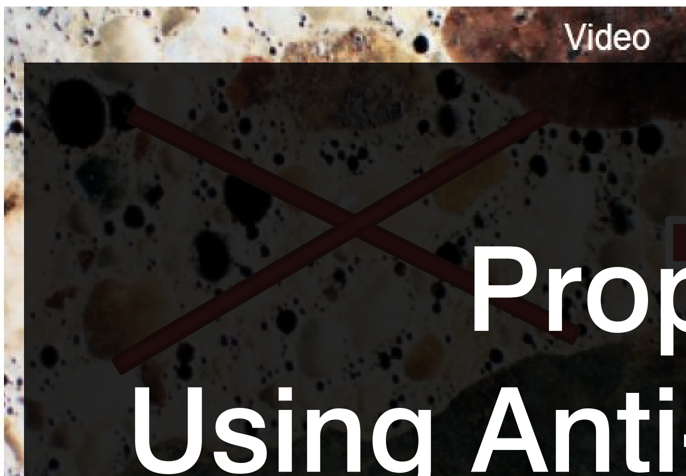
Portland cement (OPC), Low alkali cement (LAC), and white cement (WC)

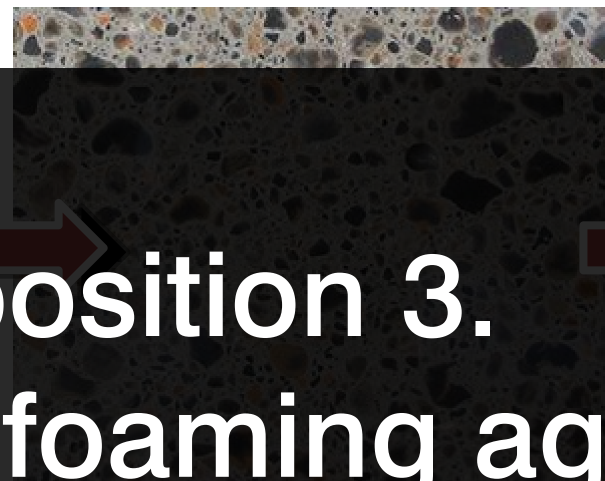
Anti-foaming agents:

e.g. Polyoxy Ethylene/propylene ether mixture

It causes:

can damage air bubbles





Better performance of SCC

Proposition 3.
Using Anti-foaming agents

Some type of anti-foaming agents: are compatible with polycarboxylate type superplasticizer and most air-entraining agent, especially with Vinsol type air-entraining agent.

DISPERSION RATE OF PARTICLES DEPENDS ON MODIFICATION EFFECT SURFACE LAYER OF PARTICLES BY TYPE SP

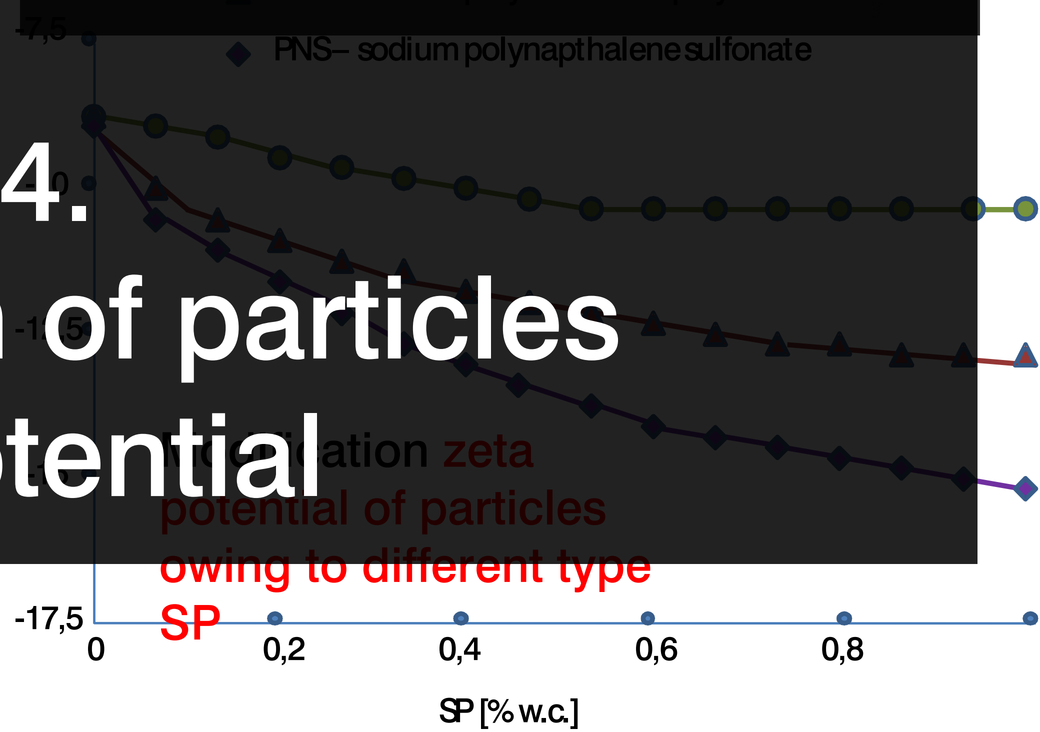
It cause:

Lon diffusion layer containing zeta potential

WE SHOULD USE THIS SP TYPE WHICH CAN CHANGE SURFACE LAYER OF PARTICLES TO NOT PERMIT AIR BUBBLES connect with particles

Dispersion of air bubbes and cement particions and

Proposition 4. Modification of particles electrical potential



Modification zeta potential of particles owing to different type SP

Conclusions

…w can we decrease air-entrainment of…

1) Adjusting the rheological properties of SCC:

- SCC with SP do not incorporate not to much air bubbles when value of yield stress ($_0$) of SCC is not high
- Value of viscosity ( ) should not be high to increase

2) Using superplasticizers with non air-entraining affect

3) Using anti-foaming agents to eliminate air bubbles.

4) Modification of electric particles potential to help air bubbles outflow

Laboratory research is still continued and its results will show which of this method is most effective