On the influence of entrained air (EA) on rheology of paste and mortar

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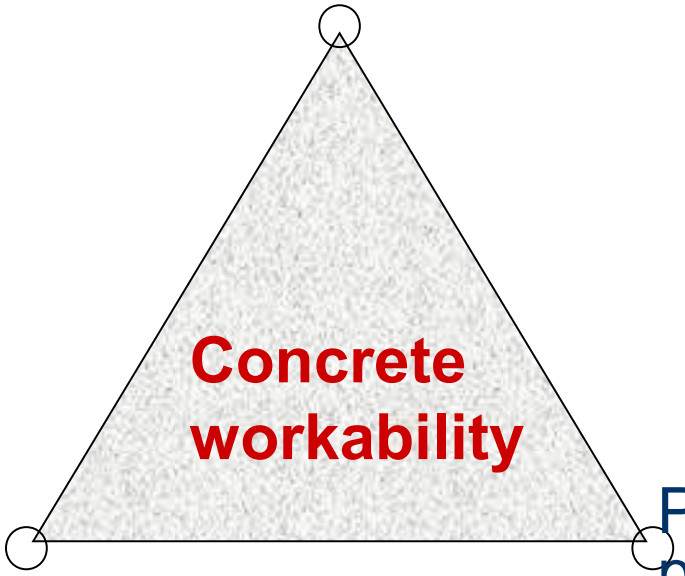
Motivation

- Role of EA in the Particle-Matrix-Model (PMM)
- EA as a tool to improve workability of SCC?

PMM (Mørtsell 1996)

The volume relation between matrix and particles



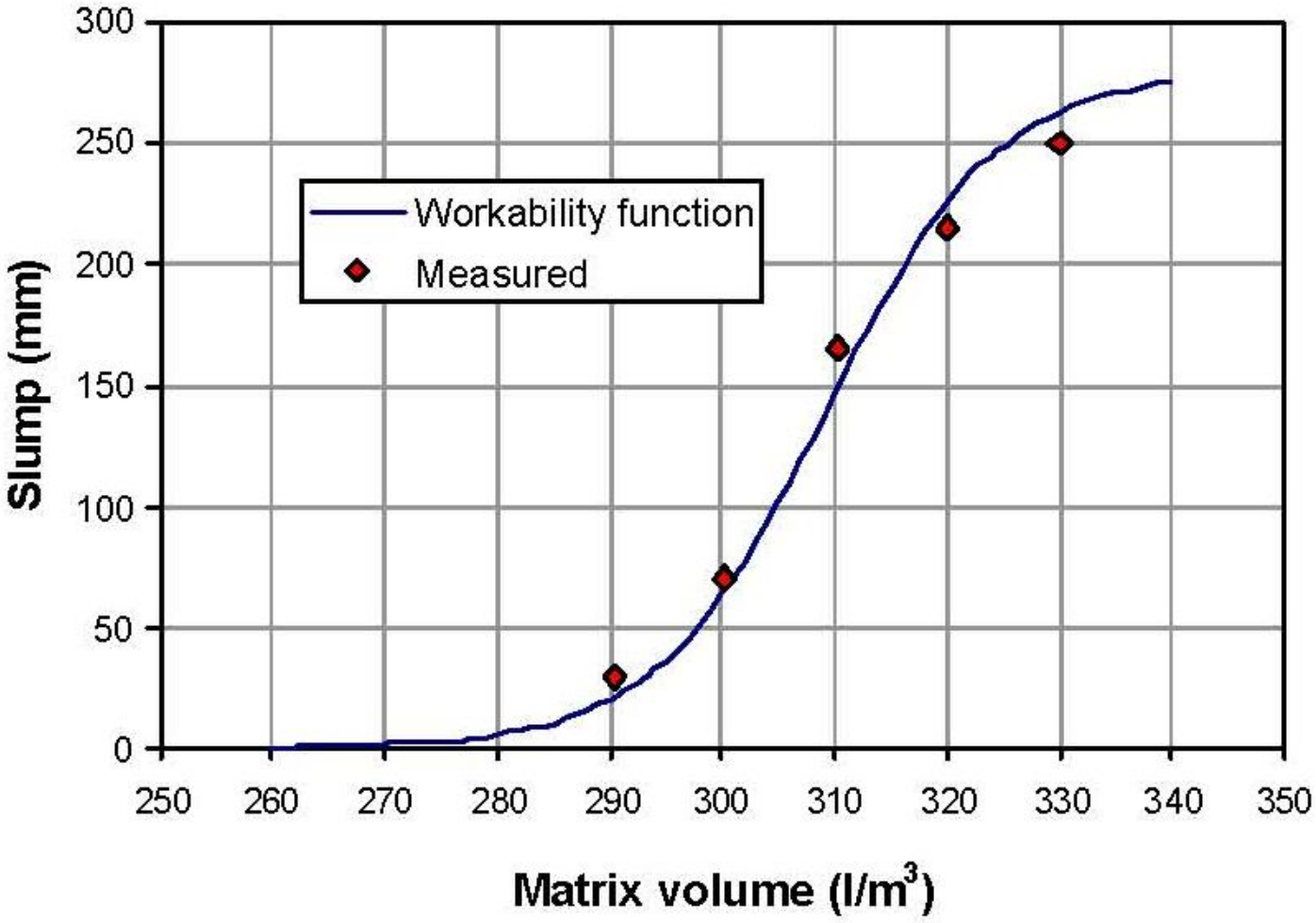
Matrix properties

(filler modified cement paste)

Particle properties

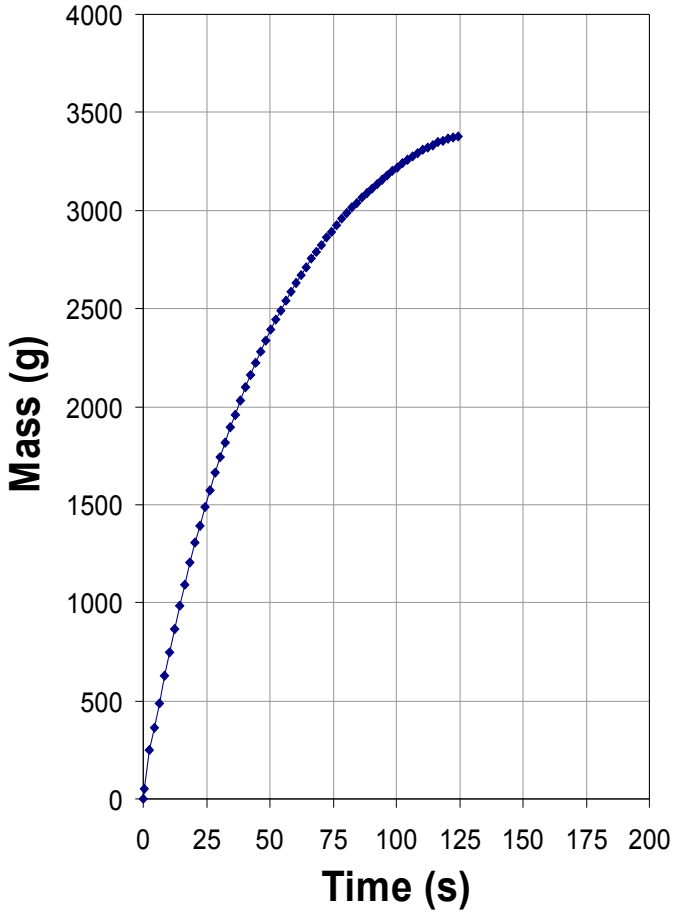
(particles >125μm)

Workability function

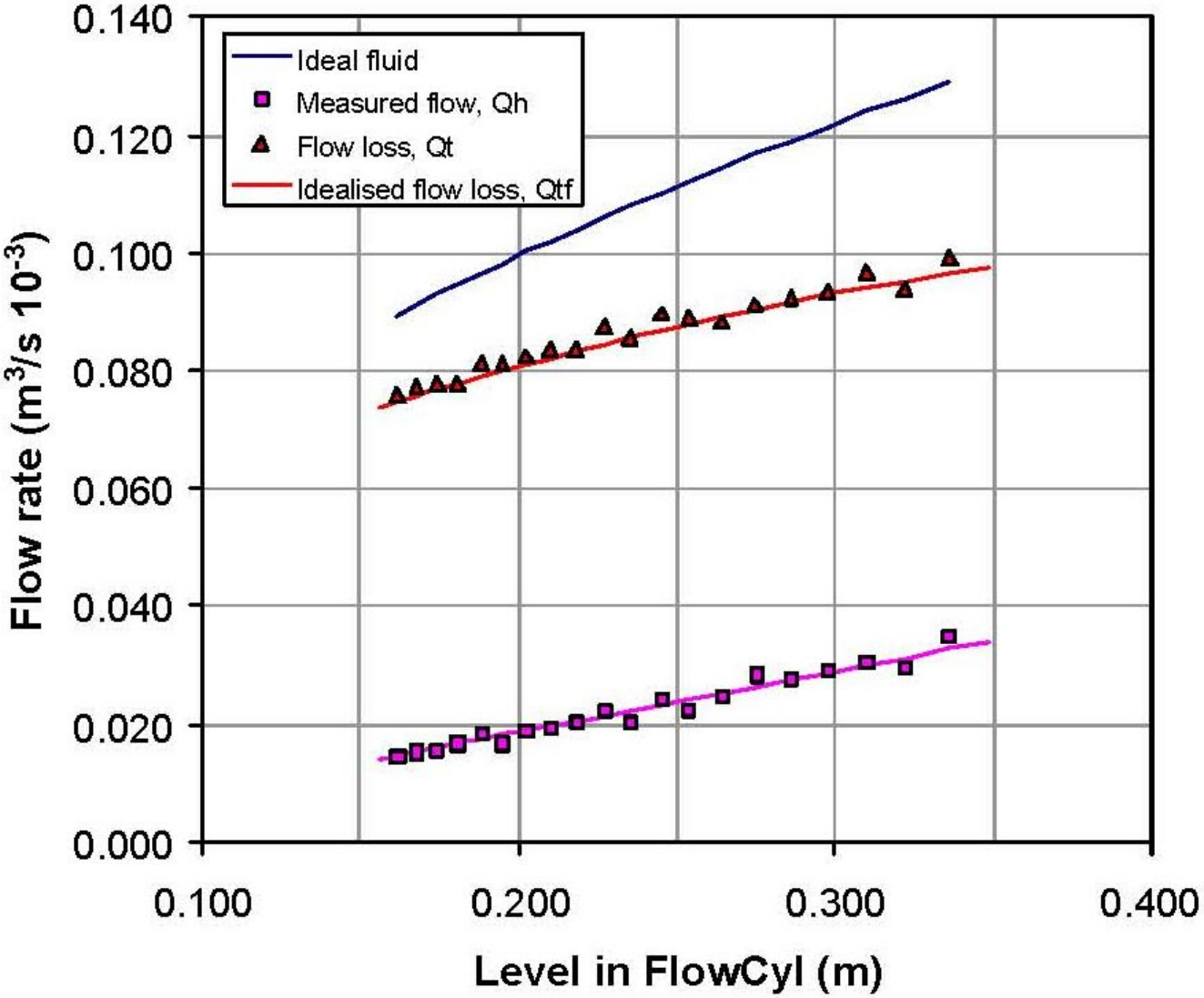


Matrix properties

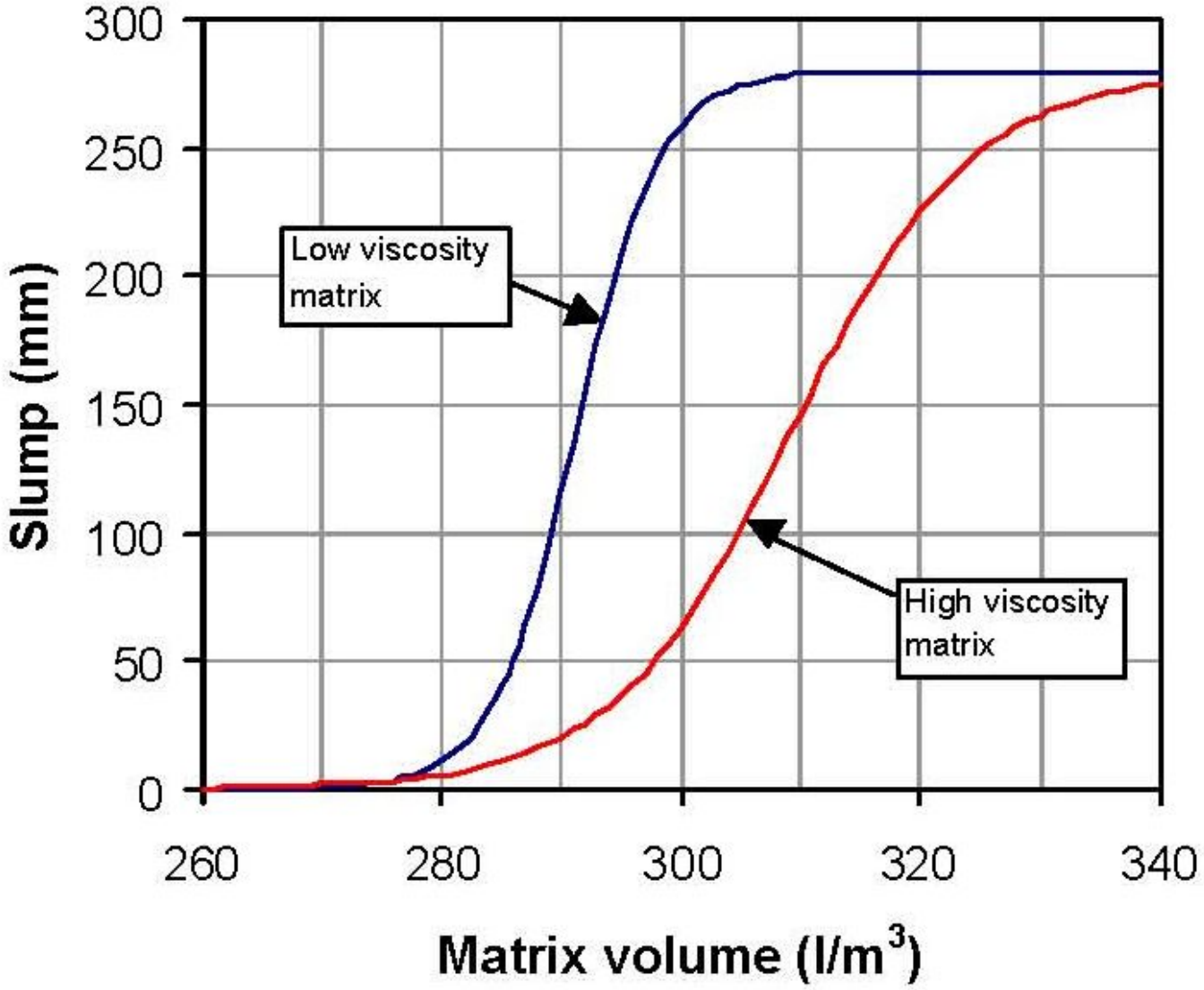
FlowCyl determines the *flow resistance*, **λQ**
of the matrix material which is closely related to viscosity



Flow resistance



Flow resistance



Experiments

- Testing pure cement pastes with w/c = 0.35 with 0 – 15 % air content
- Testing the influence of increasing the air content from 3 – 13 %

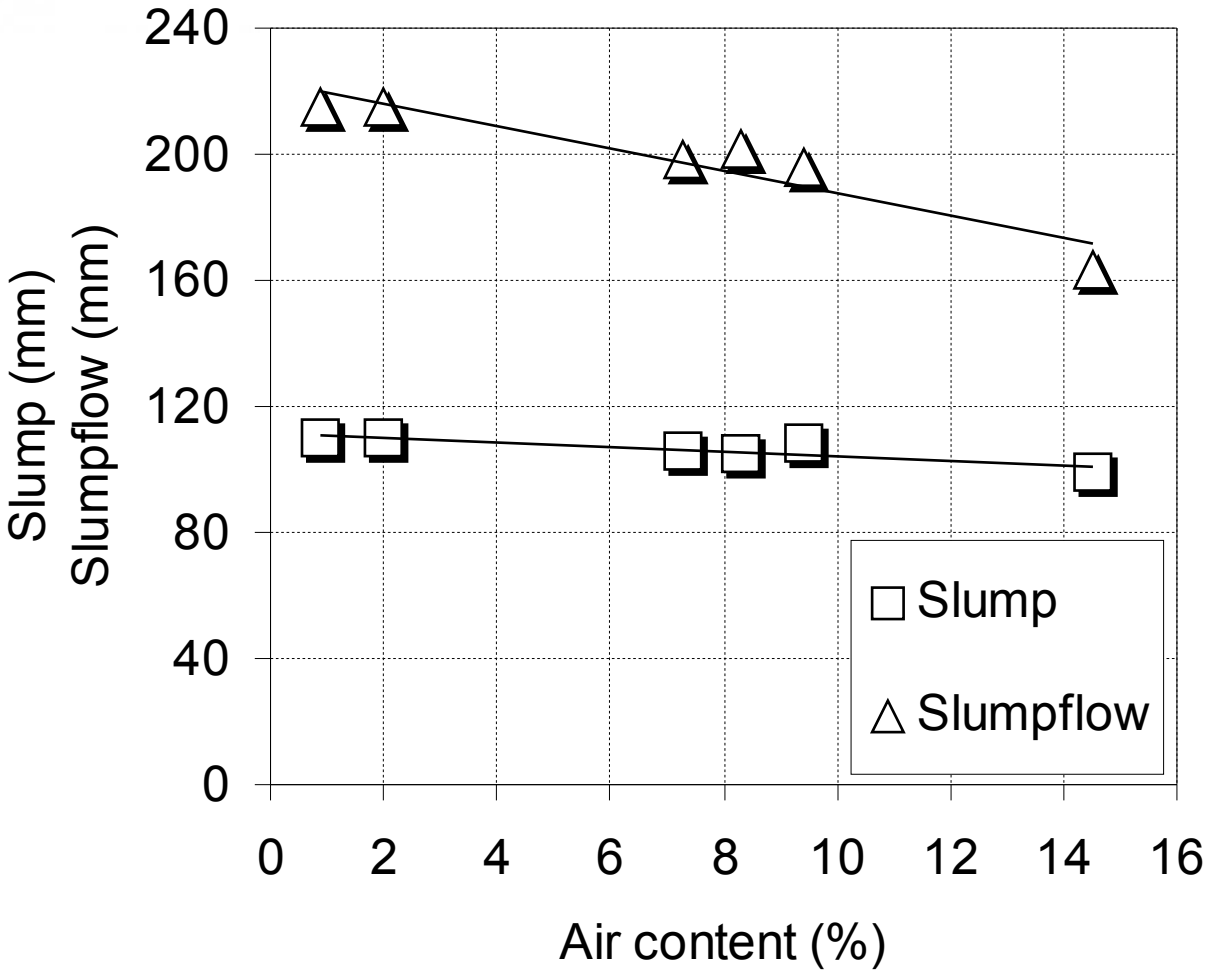
  in mortars with w/c = 0.50
- Testing the influence of increasing the matrix content with 7 % in mortars with 3 % air

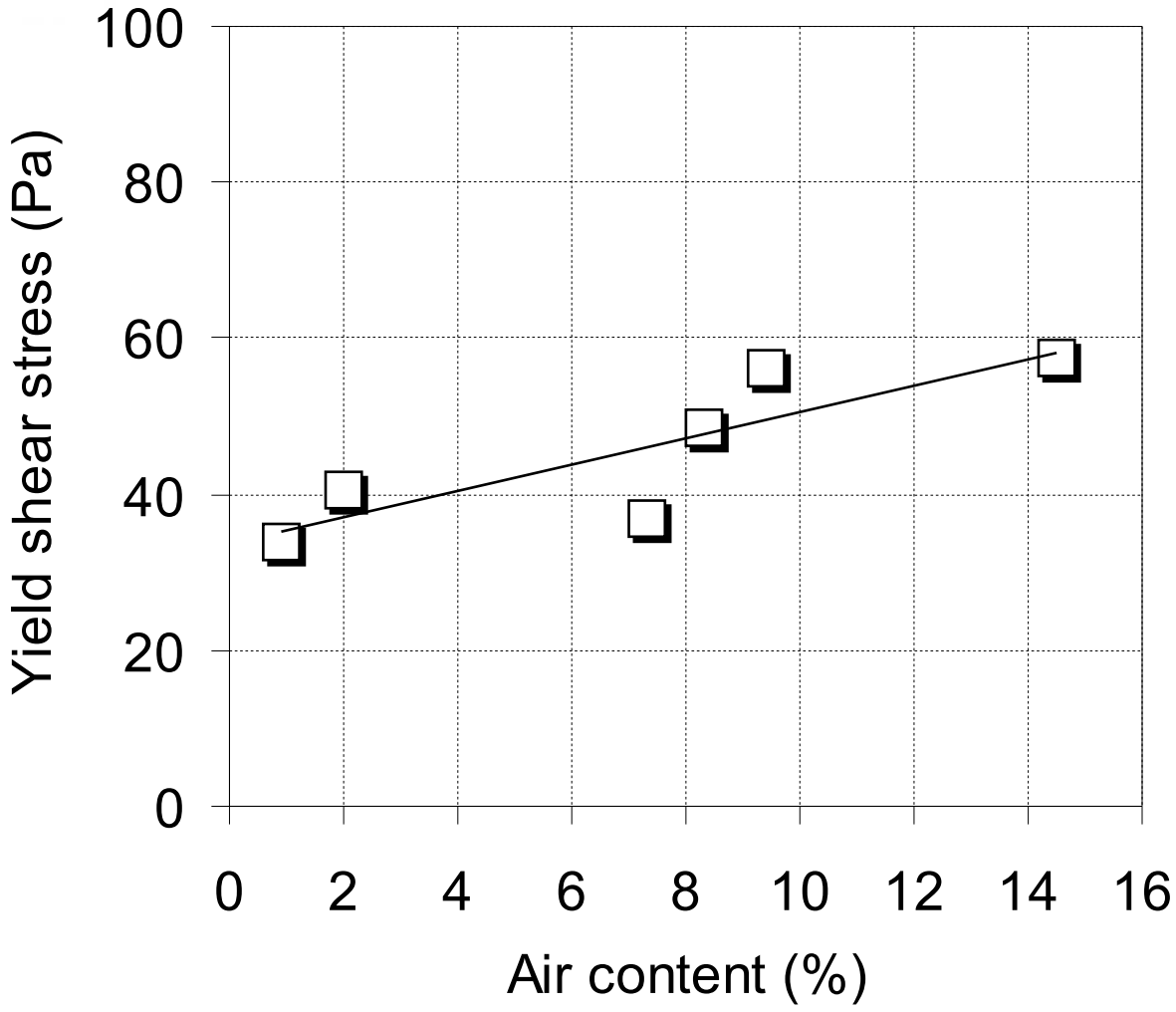
Experiments

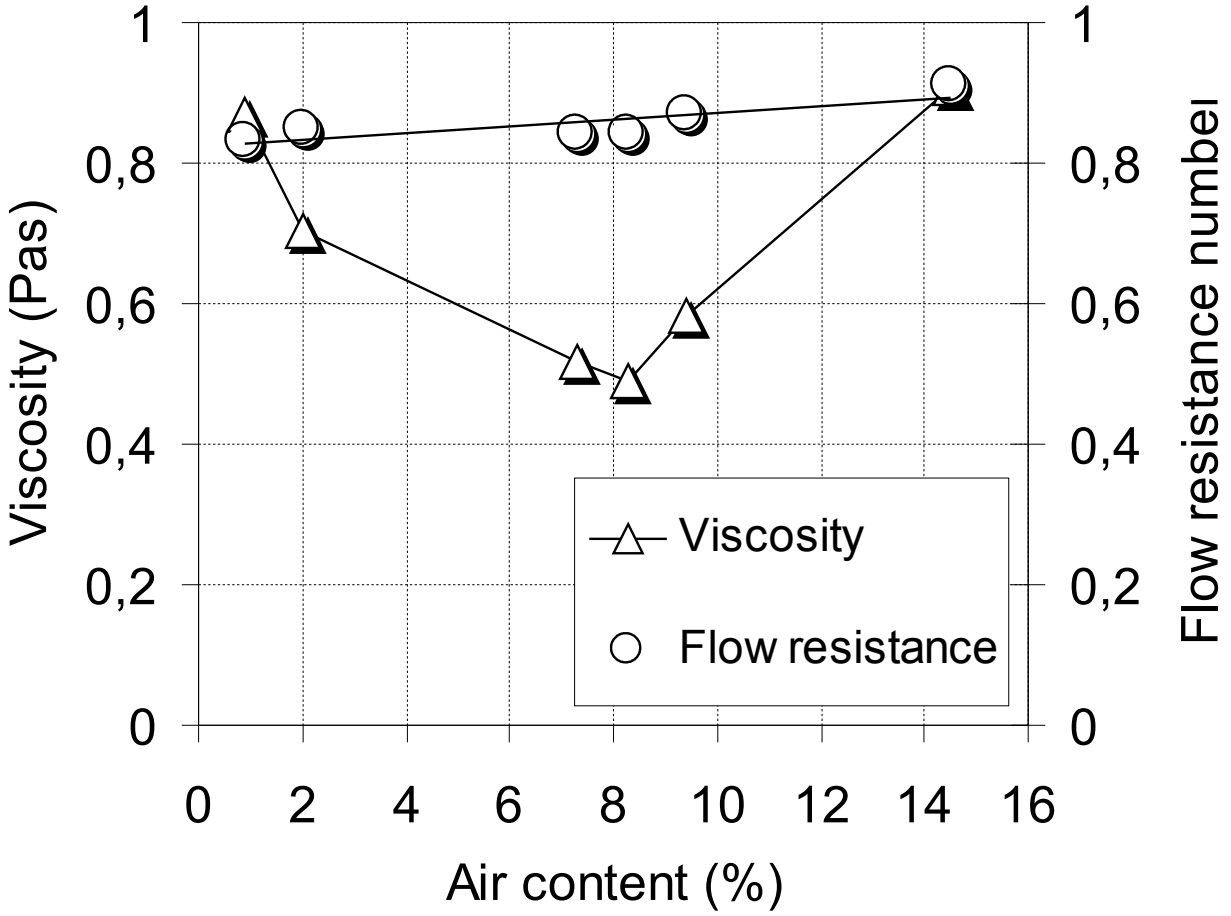
- Slump and slumpflow (120 mm and 300 mm cone)
- Flow resistance number (FlowCyl)
- Viscosity and yield shear stress (ConTec 4 Rheometer)


Con Tec

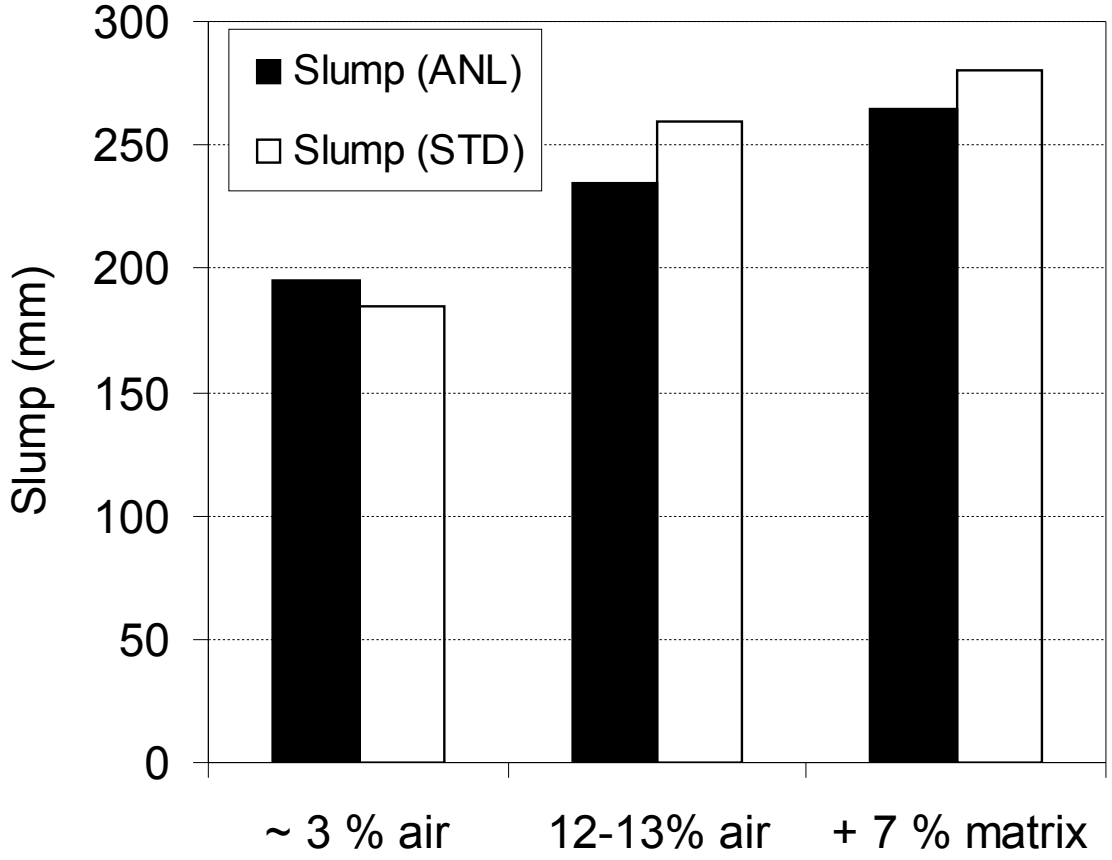
Cement paste

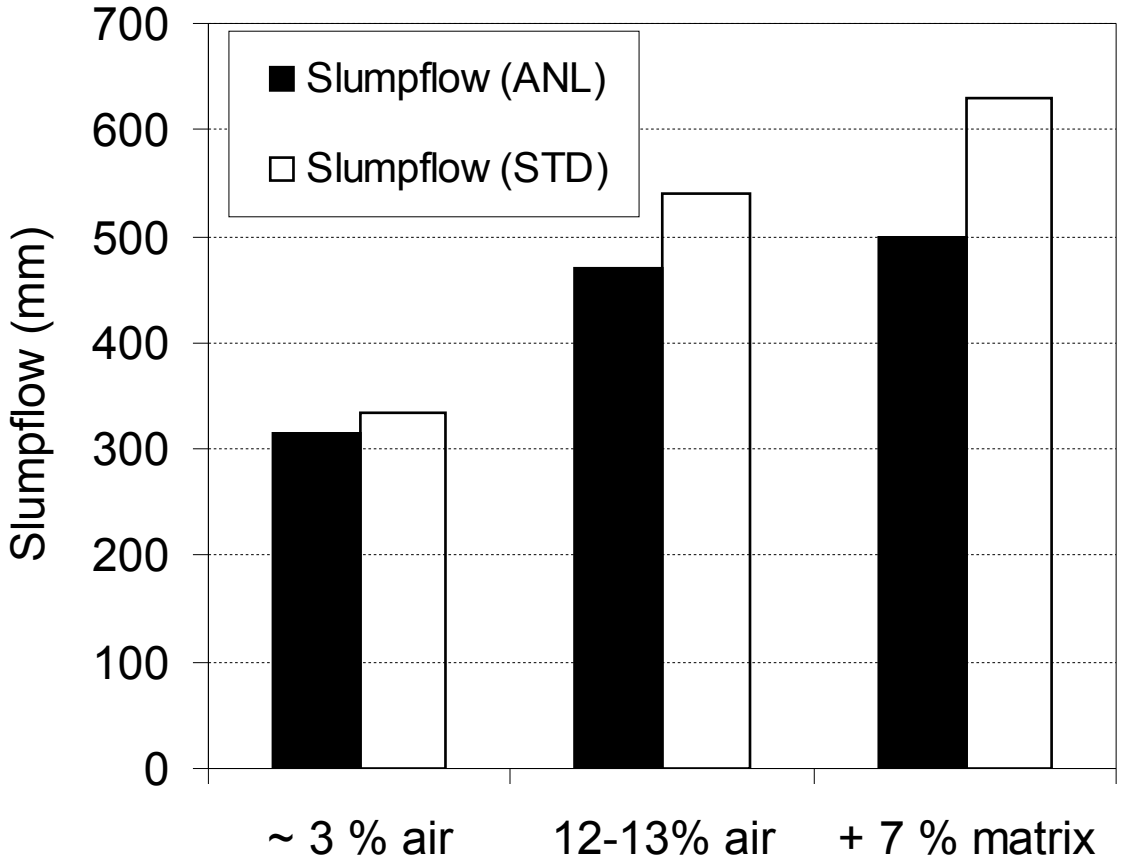

240
200
160
120
80
40
0
Slump (mm)
Slumpflow (mm)
0
2
4
6
8
10
12
14
16
Air content (%)
Slump
Slumpflow

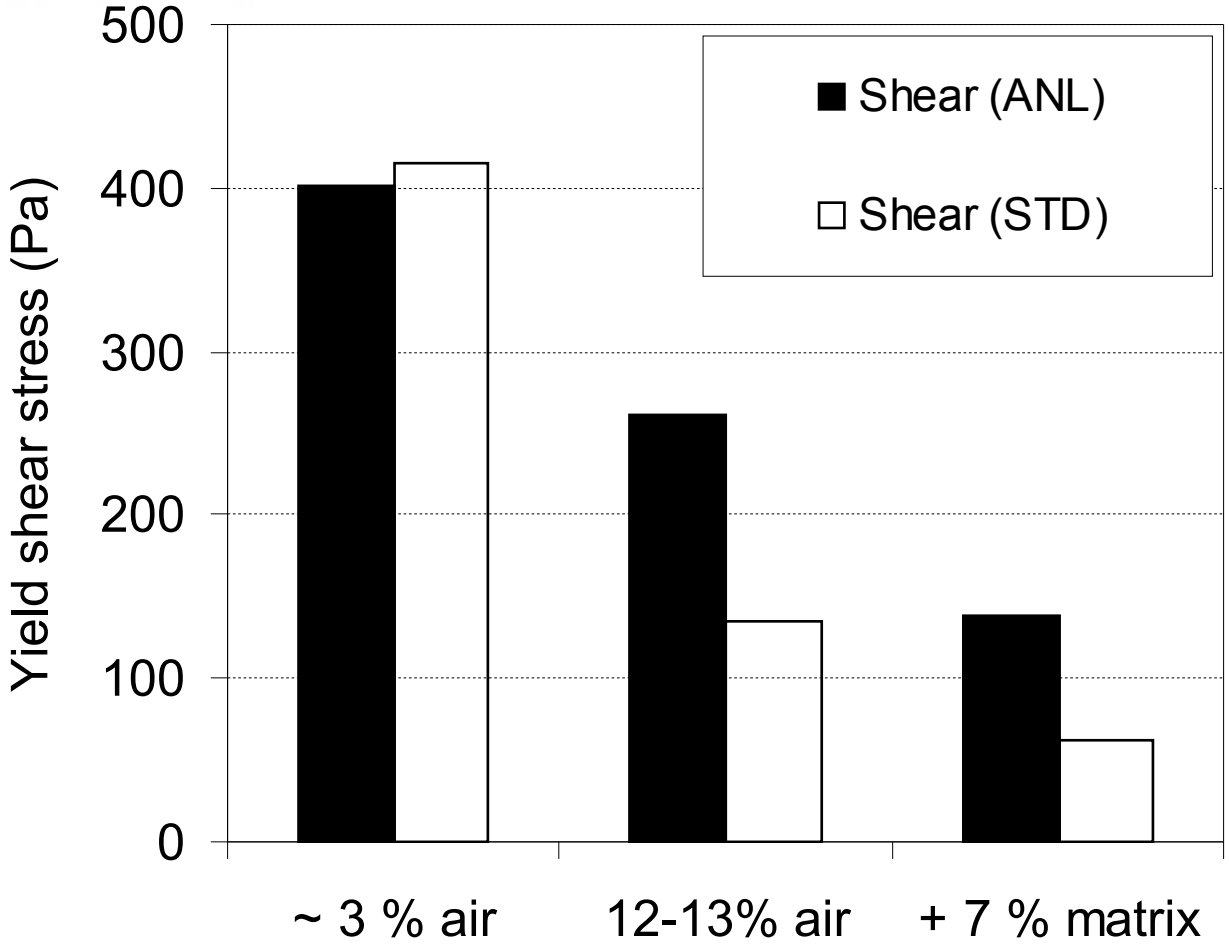

Yield shear stress (Pa)
100
80
60
40
20
0
0
2
4
6
8
10
12
14
16
Air content (%)

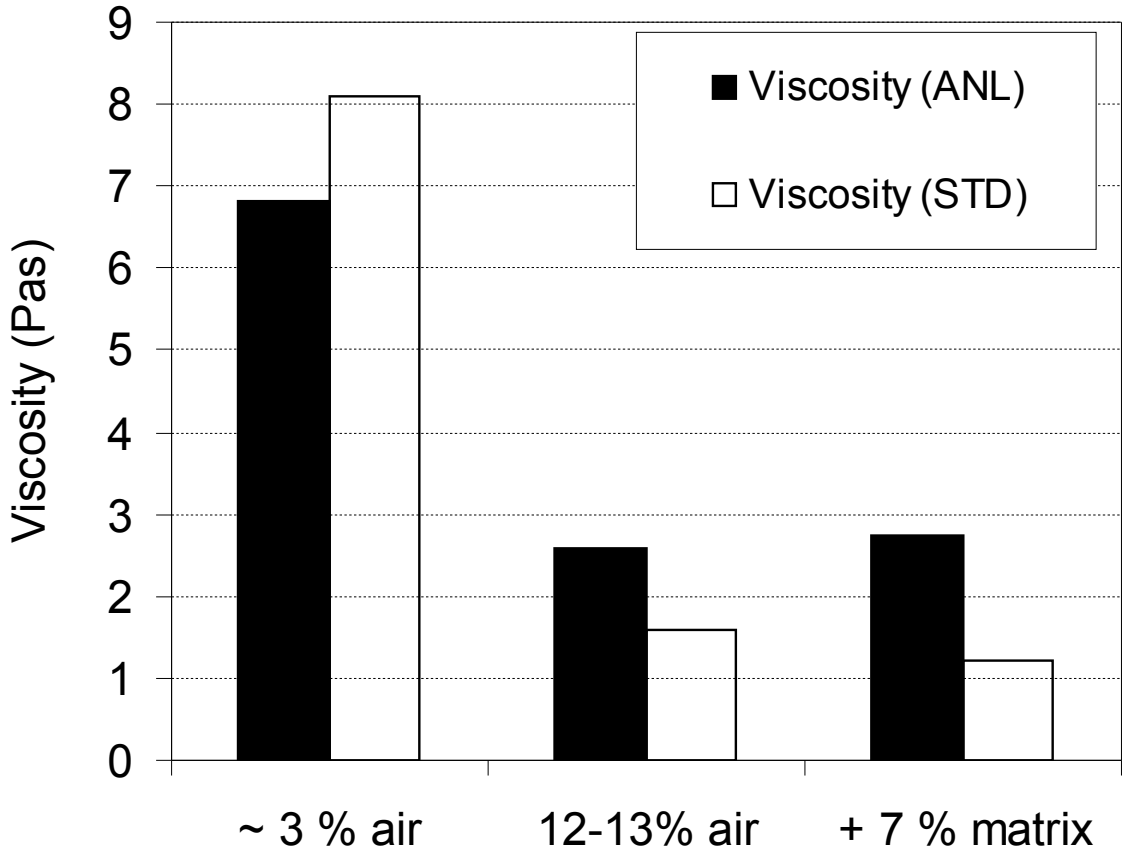

1
0,8
0,6
0,4
0,2
0
Viscosity (Pas)
1
0,8
0,6
0,4
0,2
0
Flow resistance number
0
2
4
6
8
10
12
14
16
Air content (%)
Viscosity
Flow resistance

Mortar


300
250
200
150
100
50
0
Slump (mm)
Slump (ANL)
Slump (STD)
~ 3 % air
12-13% air
+ 7 % matrix


700
600
500
400
300
200
100
0
Slumpflow (mm)
Slumpflow (ANL)
Slumpflow (STD)
~ 3 % air
12-13% air
+ 7 % matrix


500
400
300
200
100
0
Yield shear stress (Pa)
Shear (ANL)
Shear (STD)
~ 3 % air
12-13% air
+ 7 % matrix


9
8
7
6
5
4
3
2
1
0
Viscosity (Pas)
Viscosity (ANL)
Viscosity (STD)
~ 3 % air
12-13% air
+ 7 % matrix

Conclusion

EA reduces slightly consistency of cement paste.
Nevertheless, it contributes to increased consistency of mortars, because of increased paste(matrix)-aggregate ratio.

EA may be considered as part of ”matrix” in the PMM, but with an ”efficiency factor” less than 1