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# RHEOLOGICAL PROPERTIES OF FRESH MORTARS AND CONCRETES CONTAINING HIGH CALCIUM FLY ASH

**Jacek Gołaszewski, Tomasz Ponikiewski**
The Silesian University of Technology,
Department of Building Materials and Processes Engineering
Akademicka 5, 44-100 Gliwice, Poland

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# TYPES AND PROPERTIES OF FLY ASH

**ASTM C618-93 categorizes natural pozzlans and fly ashes into the following three categories:**

**Class N:** Raw or calcined natural pozzolans such as some diatomaceous earths, opaline chert and shale, stuffs, volcanic ashes and pumice are included in this category.

***ASTM C618-93 specification (1993) for „Fly Ash and Raw or Calcined Natural Pozzolan for use as Mineral Admixture in Portland Cement Concrete"***

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**Class N:** Raw or calcined natural pozzolans such as some diatomaceous earths, opaline chert and shale, stuffs, volcanic ashes and pumice are included in this category.

**Class F:** Fly ash normally produced from burning anthracite or bituminous coal falls in this category.
This class of fly ash exhibits pozzolanic property but rarely, if any, self hardening property.

***ASTM C618-93 specification (1993) for „Fly Ash and Raw or Calcined Natural Pozzolan for use as Mineral Admixture in Portland Cement Concrete"***

# TYPES AND PROPERTIES OF FLY ASH

**ASTM C618-93 categorizes natural pozzlans and fly ashes into the following three categories:**

**Class C:** Fly ash normally produced from lignite or sub-bituminous coal is the only material included in this category. This class of fly ash has both pozzolanic and varying degree of self cementitious properties.

***ASTM C618-93 specification (1993) for „Fly Ash and Raw or Calcined Natural Pozzolan for use as Mineral Admixture in Portland Cement Concrete"***

# COMPOSITION AND CEMENT PRODUCTION METHOD

| Component | Mixed components method | | | Joint-grinding components method | | |
|---|---|---|---|---|---|---|
| | CEM II/ A-W | CEM II/ B-W | CEM IV/ B-W | CEM II/ A-W | CEM II/ B-W | CEM IV/ B-W |
| Cement | 85 | 70 | 50 | - | - | - |
| Portland cement clinkier | - | - | - | 81,1 | 67,7 | 49,2 |
| High-lime fly ash (Class C) | 15 | 30 | 50 | 14,3 | 29,0 | 49,2 |
| Siliceous fly ash (Class F) | - | - | - | - | - | - |
| Gypsum | - | - | - | 4,6 | 3,3 | 1,6 |

| Component | Mixed components method | | | Joint-grinding components method | | |
|---|---|---|---|---|---|---|
| | CEM II/A-M (V-W) | CEM II/B-M (V-W) | CEM IV/B (V-W) | CEM II/A-M (V-W) | CEM II/B-M (V-W) | CEM IV/B (V-W) |
| Cement | - | - | - | 85 | 70 | 50 |
| Portland cement clinkier | 80,5 | 66,7 | 48,1 | - | - | - |
| High-lime fly ash (Class C) | 7,1 | 14,3 | 24,0 | 7,5 | 15 | 25 |
| Siliceous fly ash (Class F) | 7,1 | 14,3 | 24,0 | 7,5 | 15 | 25 |
| Gypsum | 5,3 | 4,7 | 3,8 | - | - | - |

# COMPOSITION AND CEMENT PRODUCTION METHOD

Fly ash Portland

Fly ash Portland

Portland-pozzolan cement

| | Mixed components method | | | Joint-grinding components method | | |
|---|---|---|---|---|---|---|
| | CEM II/ A-W | CEM II/ B-W | CEM IV/ B-W | CEM II/ A-W | CEM II/ B-W | CEM IV/ B-W |
| Cement | 85 | 70 | 50 | - | - | - |
| Portland cement clinkier | - | - | - | 81,1 | 67,7 | 49,2 |
| High-lime fly ash (Class C) | 15 | 30 | 50 | 14,3 | 29,0 | 49,2 |
| Siliceous fly ash (Class F) | - | - | - | - | - | - |
| Gypsum | - | - | - | 4,6 | 3,3 | 1,6 |

Multicomponent

Multicomponent

Portland-pozzolan cement

| | Mixed components method | | | Joint-grinding components method | | |
|---|---|---|---|---|---|---|
| | CEM II/A-[illegible] | CEM II/B-[illegible] | CEM IV/B (V-W) | CEM II/A-M (V-W) | CEM II/B-M (V-W) | CEM IV/B (V-W) |
| Cement | - | - | - | 85 | 70 | 50 |
| Portland cement clinkier | 80,5 | 66,7 | 48,1 | - | - | - |
| High-lime fly ash (Class C) | 7,1 | 14,3 | 24,0 | 7,5 | 15 | 25 |
| Siliceous fly ash (Class F) | 7,1 | 14,3 | 24,0 | 7,5 | 15 | 25 |
| Gypsum | 5,3 | 4,7 | 3,8 | - | - | - |

# PHYSICAL PROPERTIES OF FLY ASH class C

| Fly ash C | | Density [g/cm3] | Fineness – rest on sieve 45 µm [%] | Blaine specific surface, [cm2/g] | Mass volume, [kg/m3] |
|---|---|---|---|---|---|
| Batch A | | | | | |
| AWG | Without grinding | 2,62 | 38,0 | 2 860 | - |
| AG10 | Grinding 10 min | 2,77 | 23,0 | 3 500 | - |
| AG20 | Grinding 28 min | 2,75 | 10,5 | 3 870 | - |
| Batch B | | | | | |
| BWG | Without grinding | 2,58 | 35,4 | 4 400 | 750 |
| BG15 | Grinding 15 min | 2,70 | 13,3 | 6 510 | - |
| Batch C | | | | | |
| CWG | Without grinding | 2,64 | 55,6 | 1900 | 1060 |
| CG20 | Grinding 20 min | 2,71 | 20,0 | 4060 | - |

# MEASURING PROCEDURE AND THE ROTARY RHEOMETER

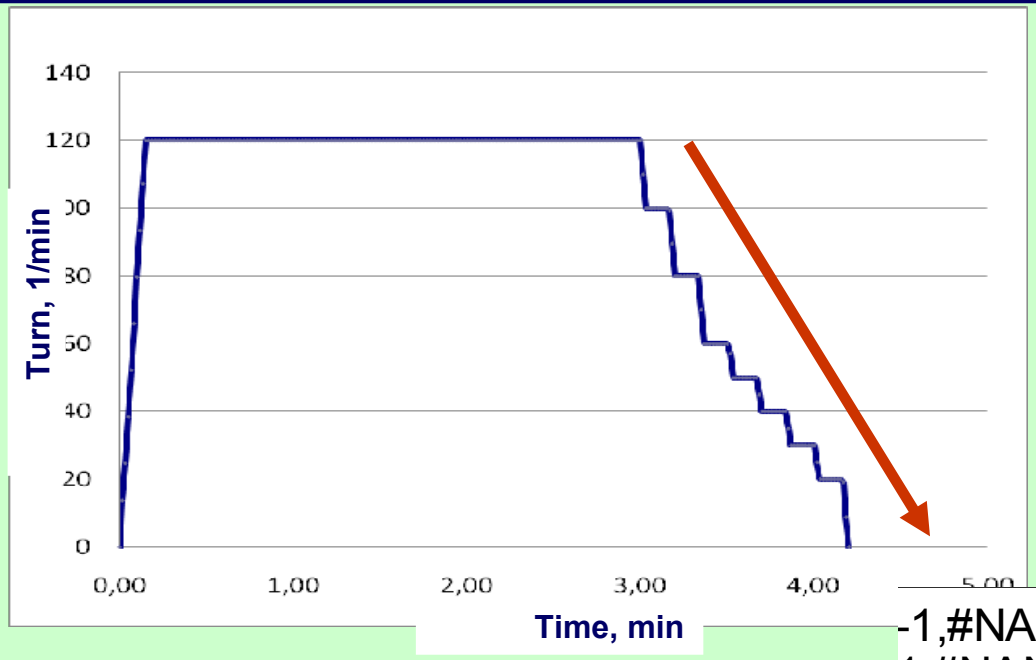
The rheological parameters

Mortars according to PN-EN 196-1

| Component | Mass [g] |
|---|---|
| *Cement* | *450* |
| *Water* | *247,5* |
| *Standard sand* | *1 350* |
| *w/c* | *0,55* |

The Admixtures effects according to PN-EN 480

# MEASURING PROCEDURE AND THE ROTARY RHEOMETER



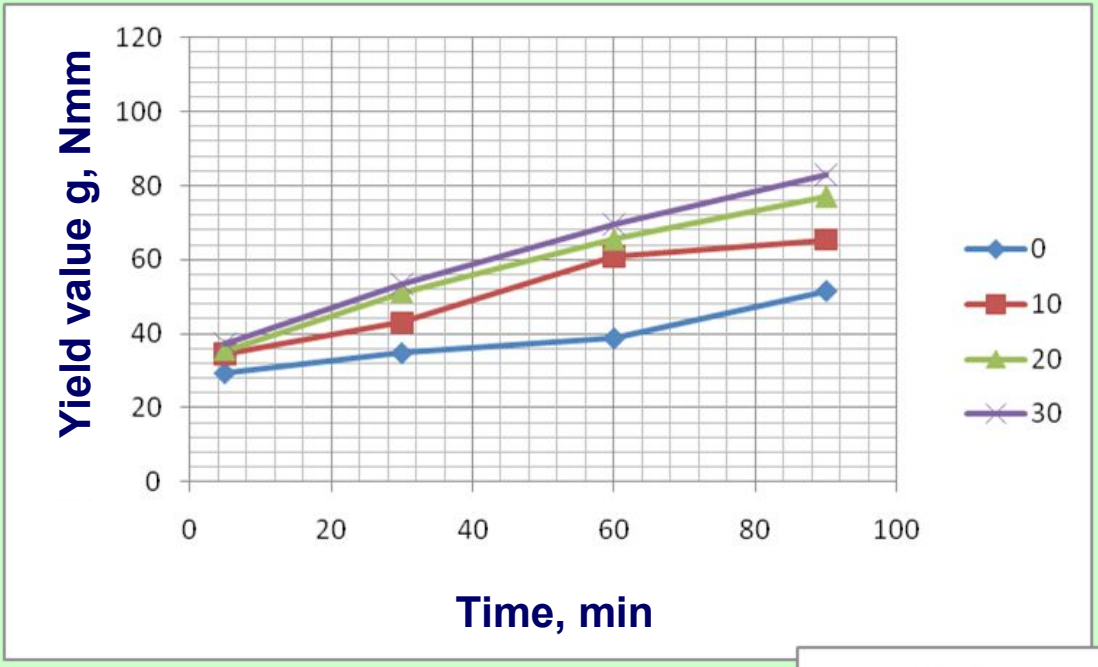

-1,#NANx
1,#NAN

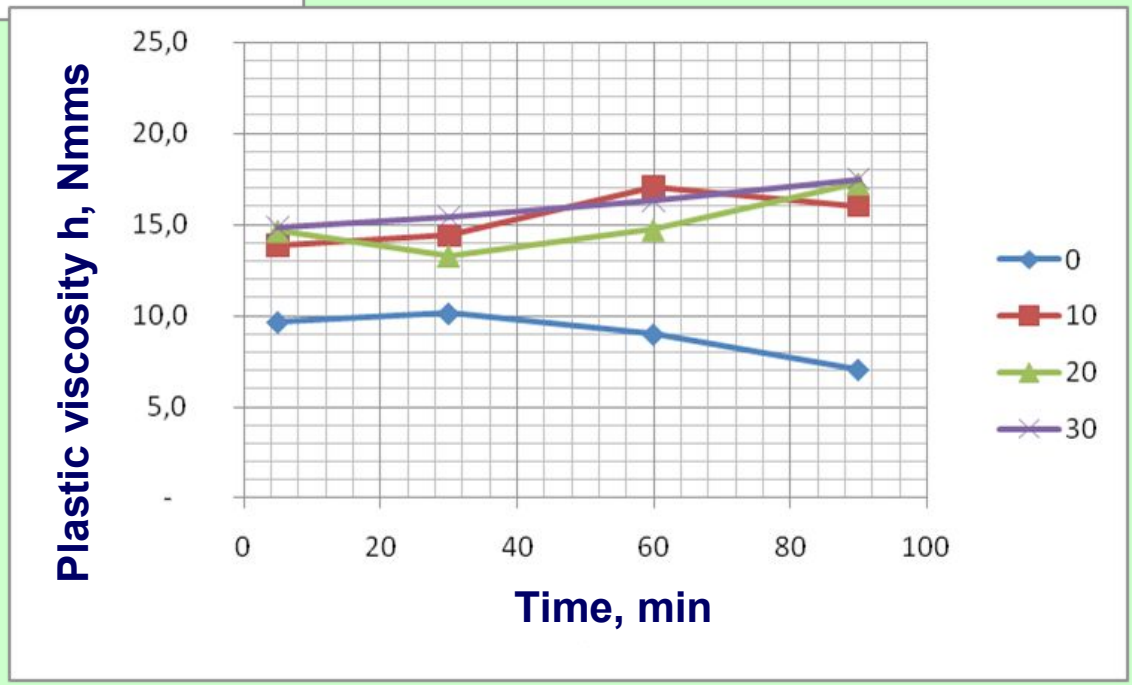
g = 44,13 [Nmm]
h = 0,13 [Nmmmin]
r = 0,975

80

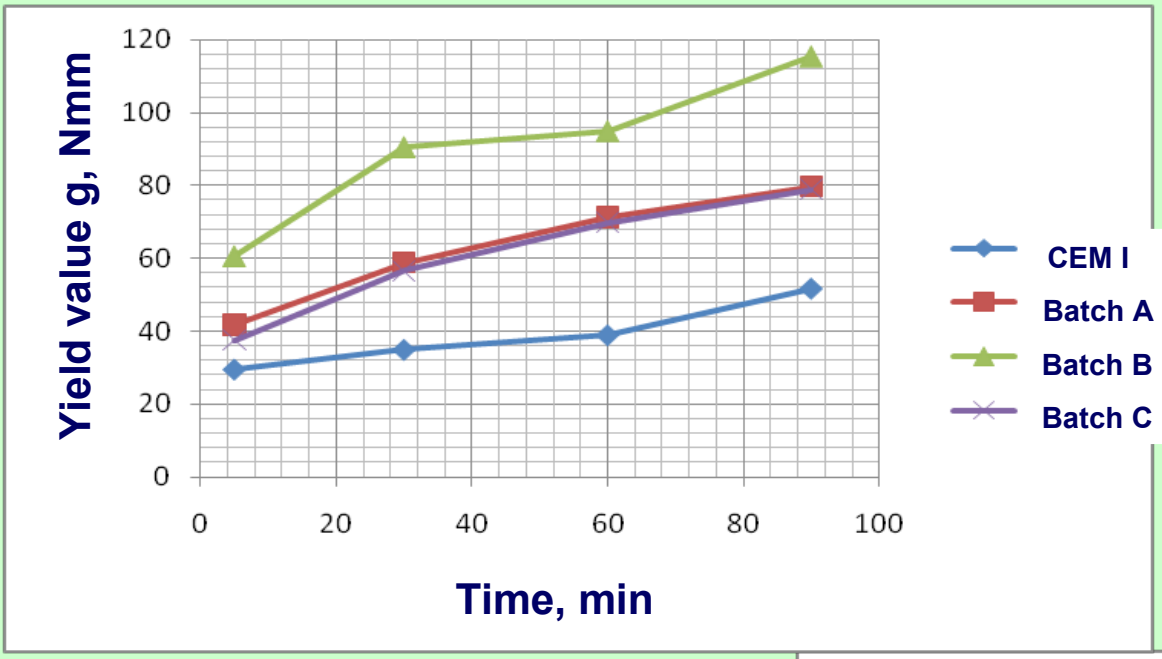
60

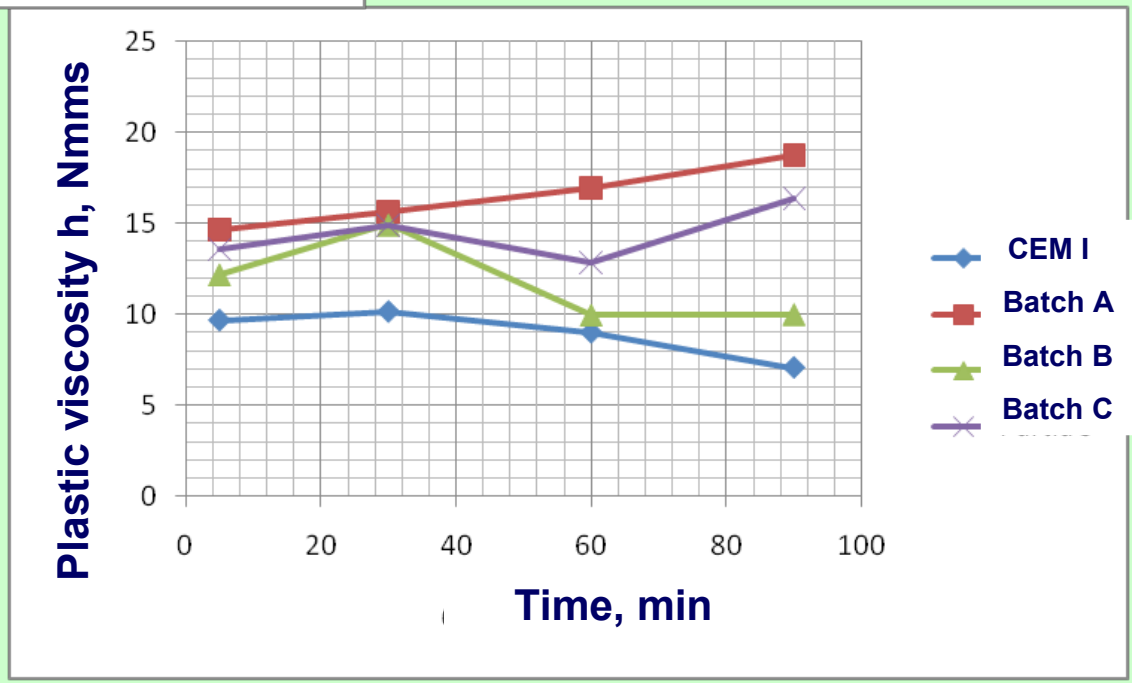
# INFLUENCE OF HIGH - LIME FLY ASH AMOUNT



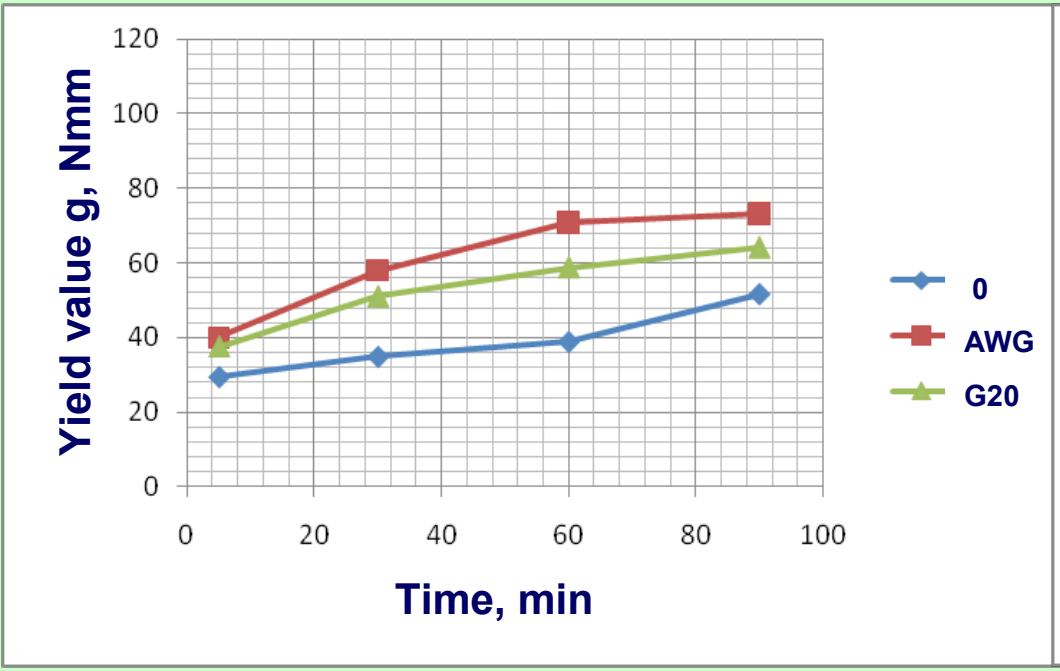



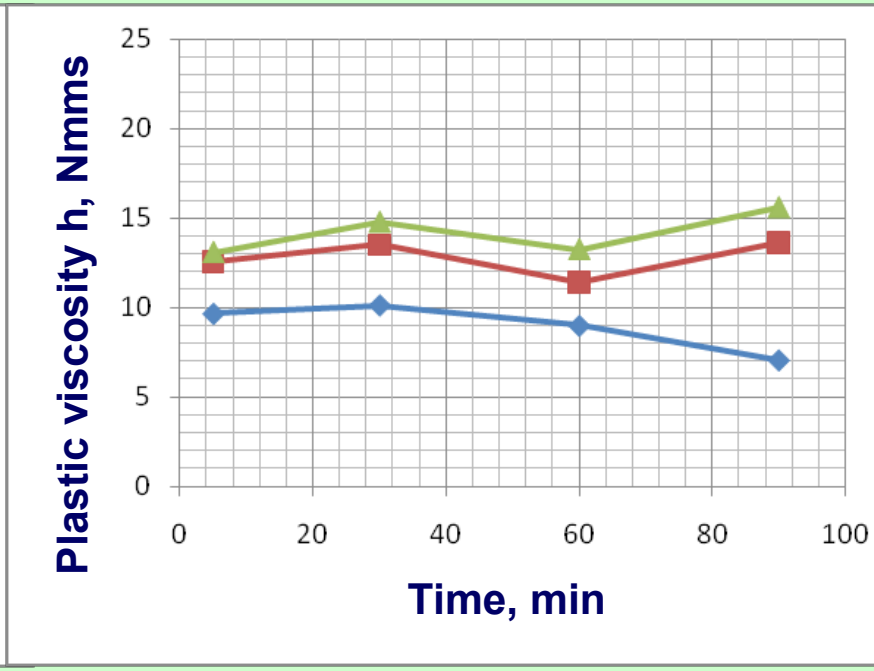
# INFLUENCE OF 10% HIGH - LIME FLY ASH KIND



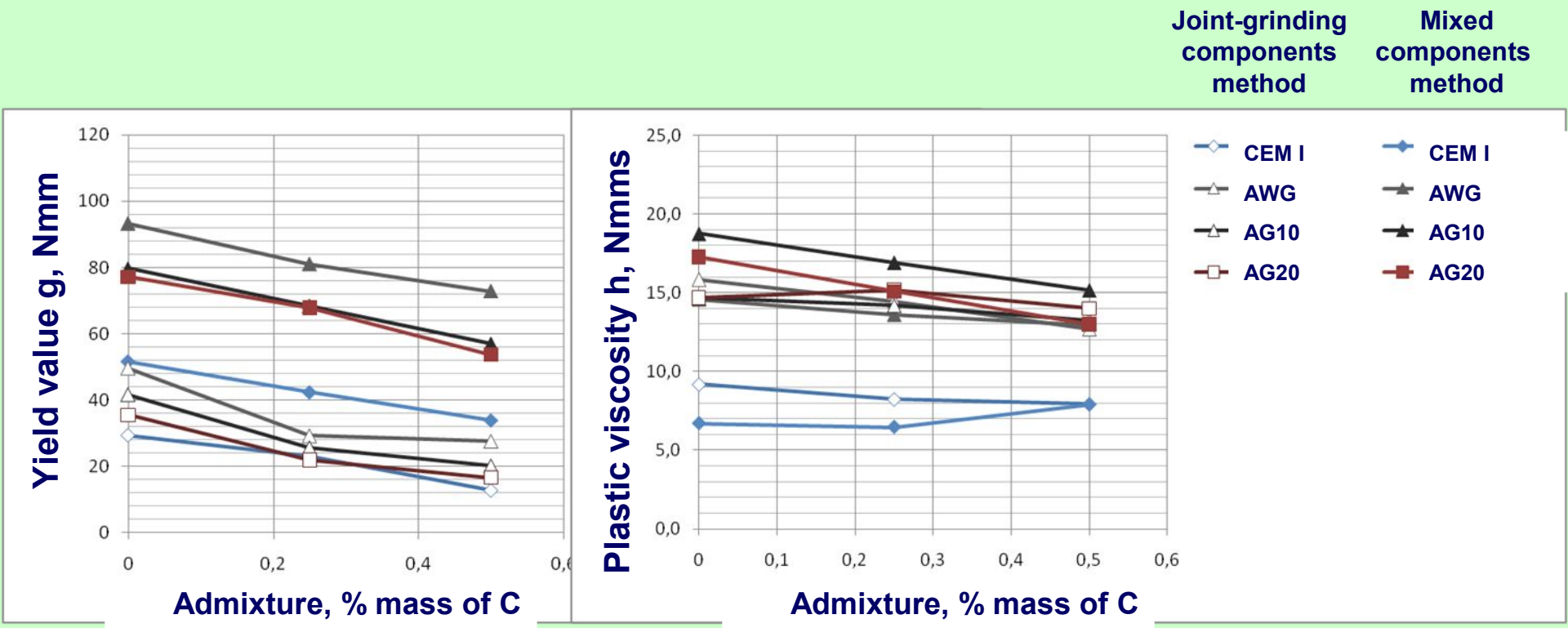



# INFLUENCE OF GRINDING 10% FLY ASH C

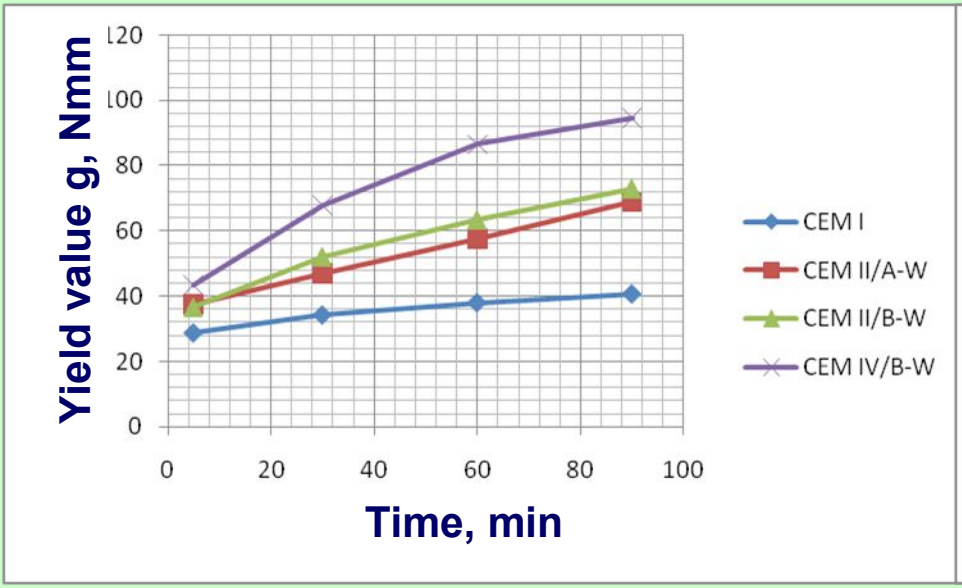


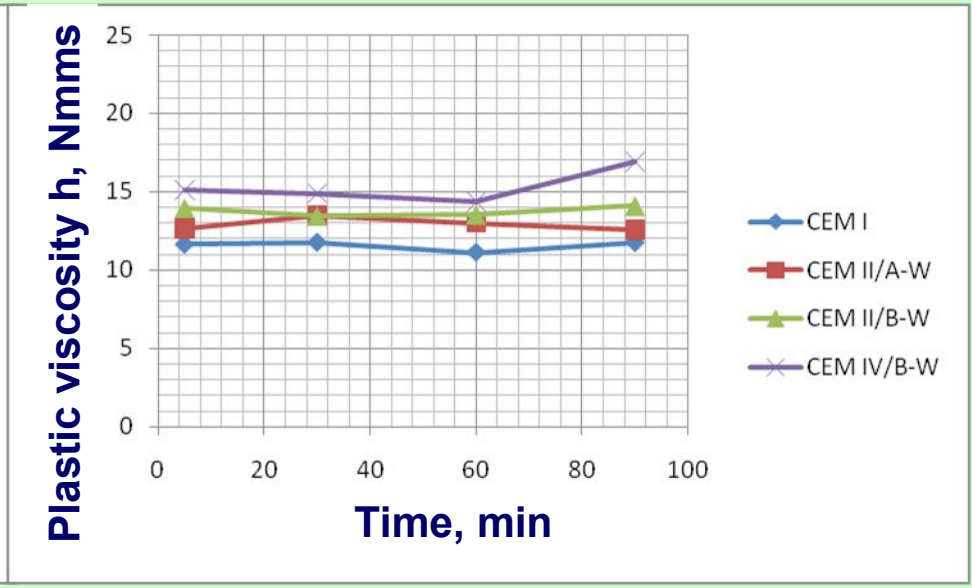



# INFLUENCE OF 20% HIGH - LIME FLY ASH AND PLASTICIZER



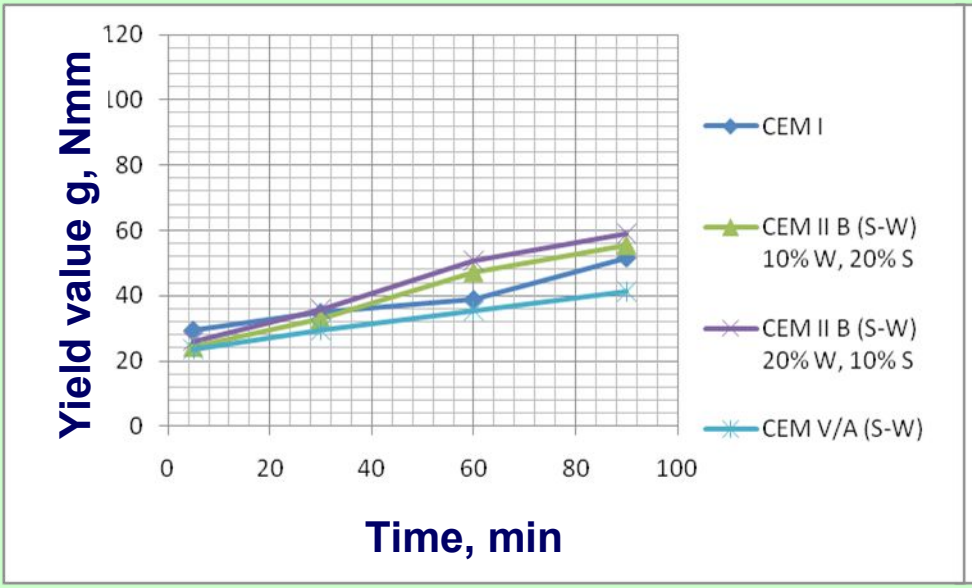
# INFLUENCE OF CEMENT WITH HIGH - LIME FLY ASH

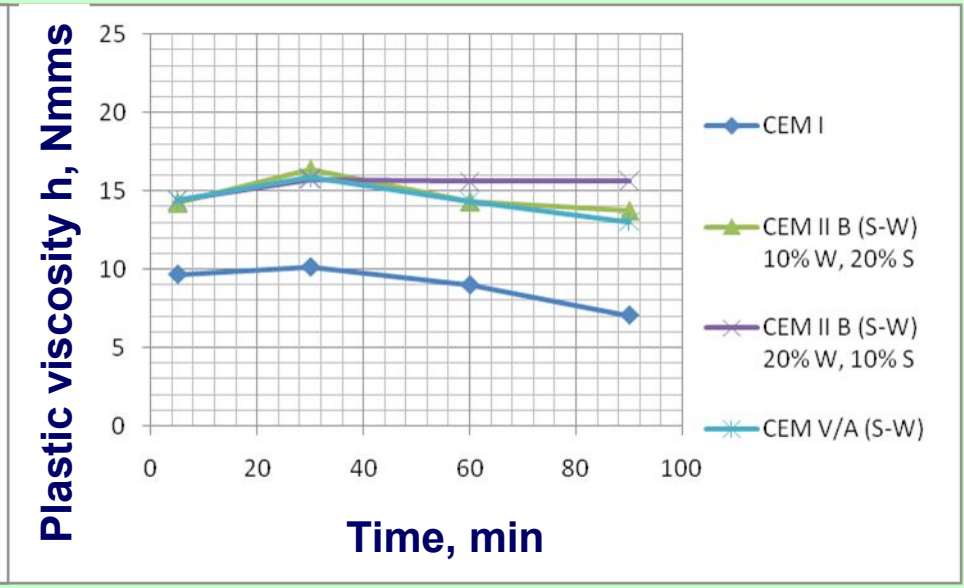



***Joint-grinding Blast Furnace Slag Cement CEM II and Portland –Pozzolan cement CEM IV with fly ash C***
***amount of fly ash – 15, 30, 50%***

# INFLUENCE OF CEMENT WITH HIGH - LIME FLY ASH



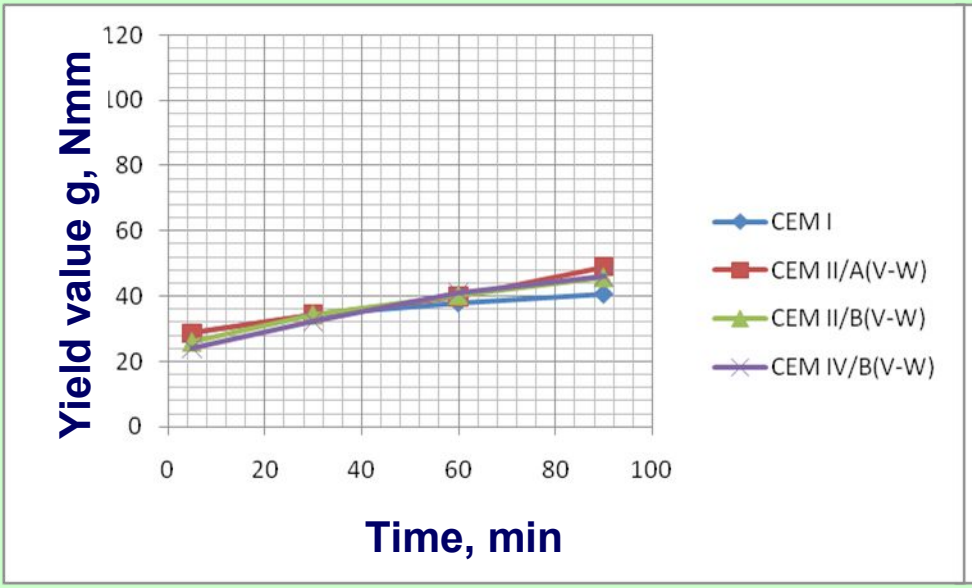

***Joint-grinding Blast Furnace Slag Cement CEM II and Multicomponent Portland cement CEM V***

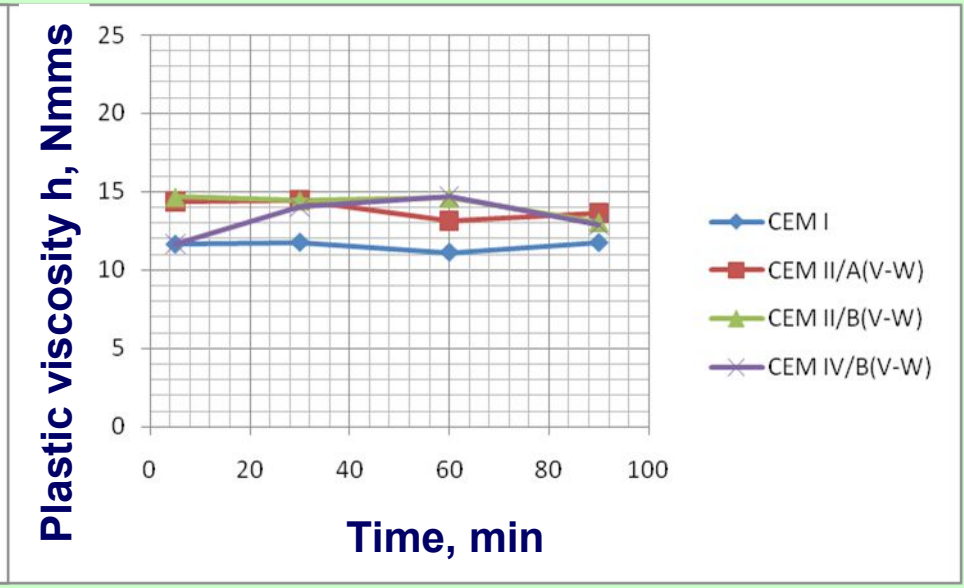
***CEM II B (S-W) 20%S (slag), 10%W (fly ash C)***

***CEM II B (S-W) 20%W (fly ash C), 10%S (slag)***

***CEM V/A (S-W)***

# INFLUENCE OF CEMENT WITH HIGH - LIME FLY ASH

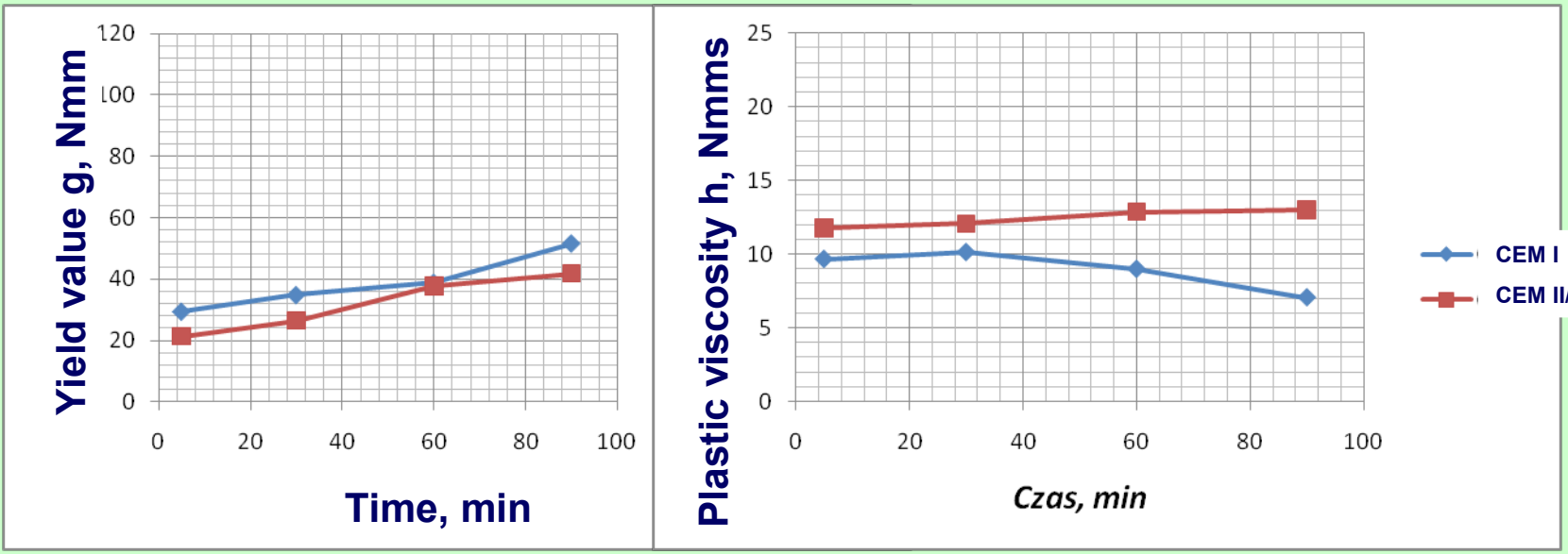



***Joint-grinding Blast Furnace Slag Cement CEM II and Portland –Pozzolan cement CEM IV with fly ashes***

**Siliceous fly ash (Class F) : High-lime fly ash (Class C) = (1:1)**

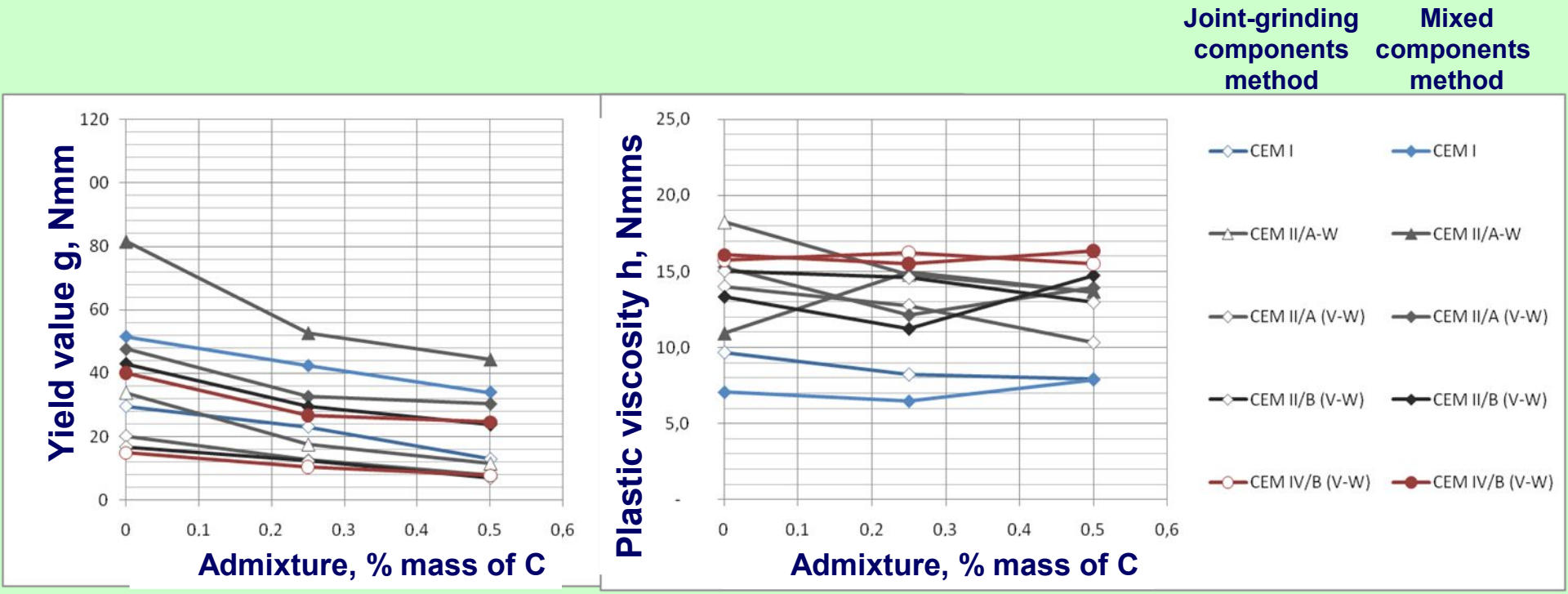
# INFLUENCE OF CEMENT WITH HIGH - LIME FLY ASH




***Joint-grinding Limestone Portland cement CEM II/B (LL-W)***

***LL – grinding limestone, W – fly ash C ; (1:1)***

# ADMIXTURE EFFICIENCY CORRELATION

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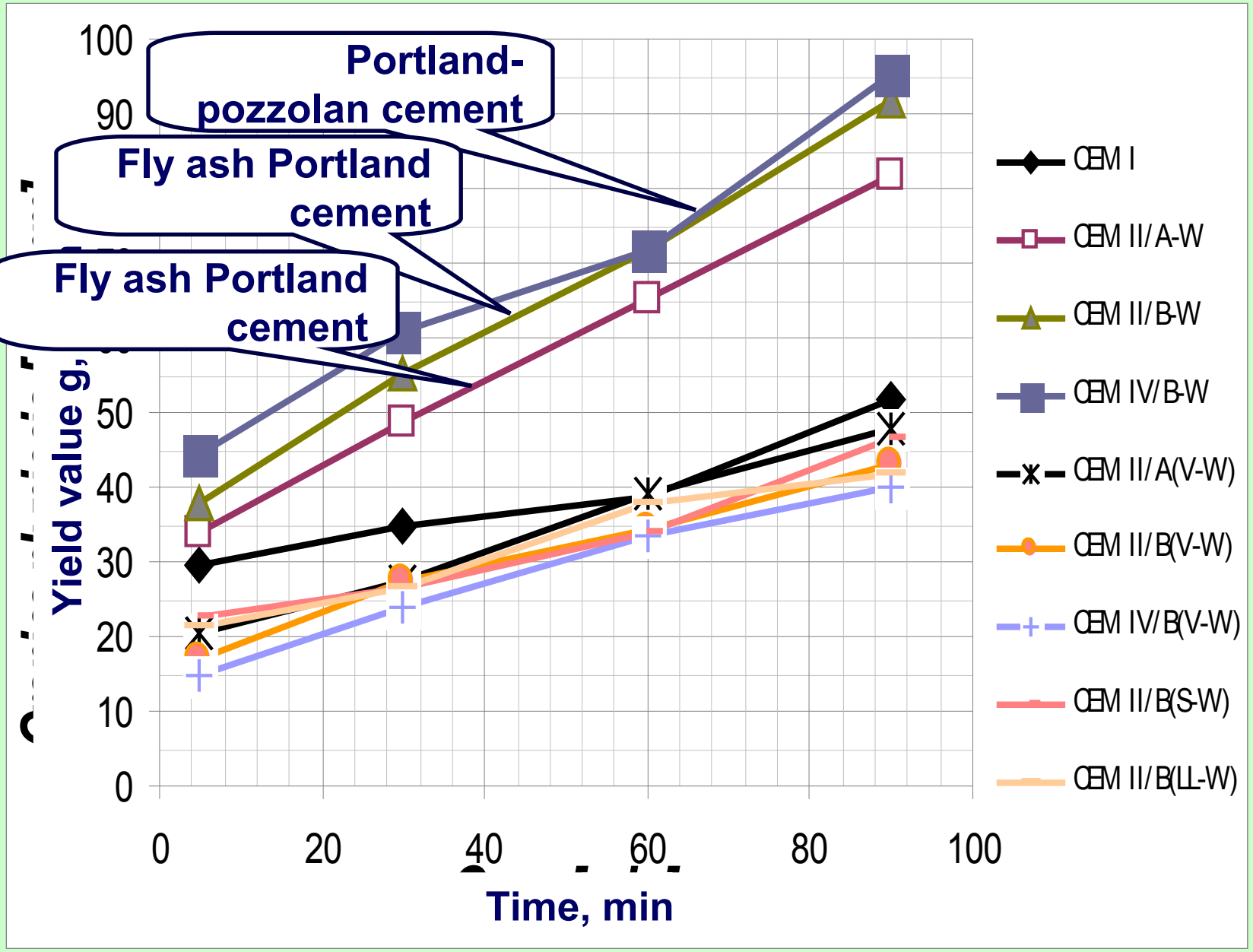
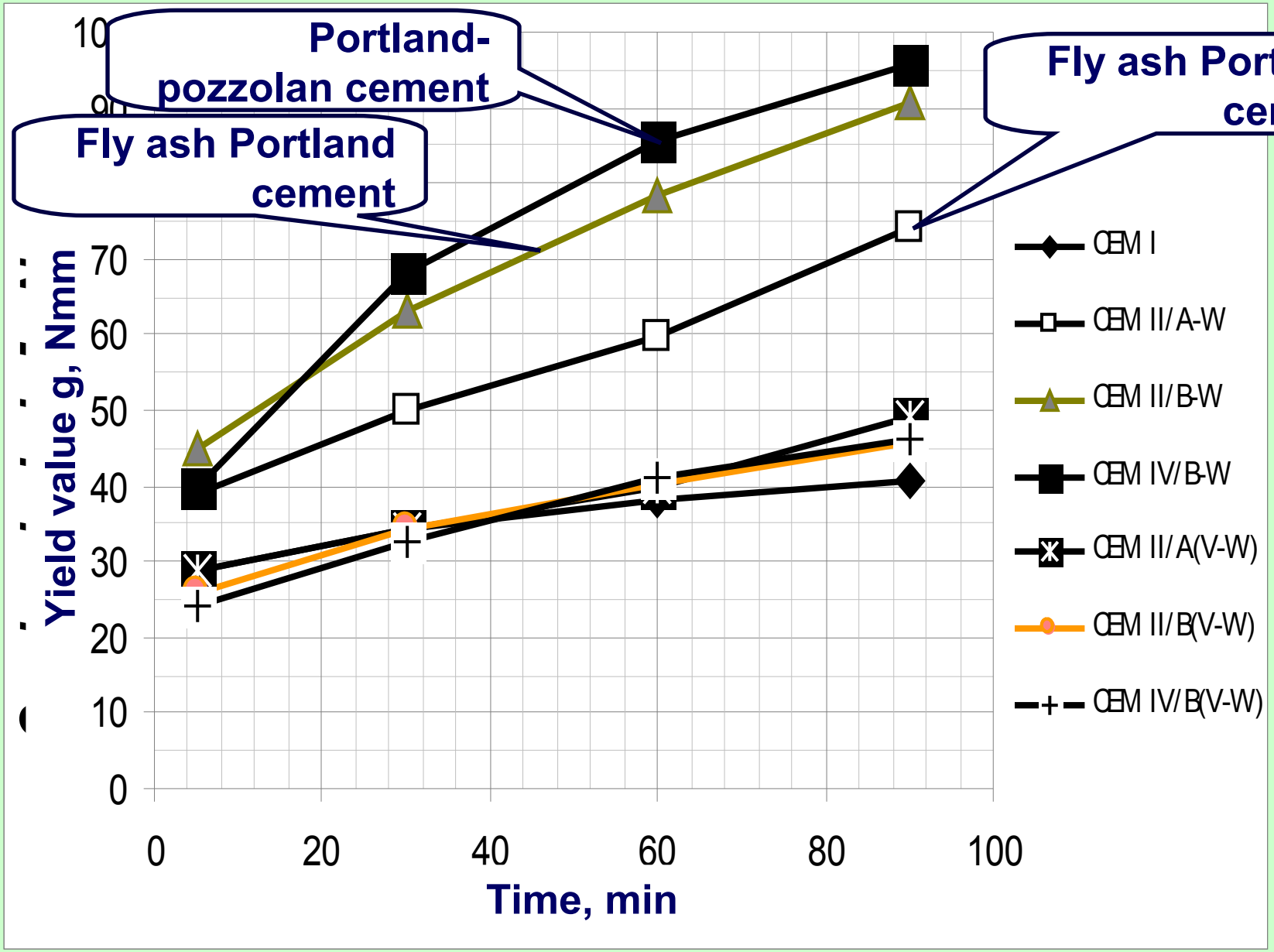
# MIXED CEMENT RHEOLOGICAL PROPERTIES



# JOINT-GRINDING CEMENT RHEOLOGICAL PROPERTIES



# CONCLUSIONS - 1

***The rheological properties of cements with high-lime fly ash from workability point of view are worsen***

***The workability of cement with milling high-lime fly ash are better***

# CONCLUSIONS - 2

***Adding high-lime fly ash to cement, the CEM I workability received, especially for multicomponent cements***

# CONCLUSIONS - 3

***Worsen efficiency admixtures in high-lime fly ash presence are wasn't found***

# THANK YOU FOR ATTENTION

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