

Doctoriales

EOLE

1<sup>ÈRE</sup> Edition

# RHEOLOGIE DES BETONS AUTOPLAÇANTS

Mr TALEB Omar

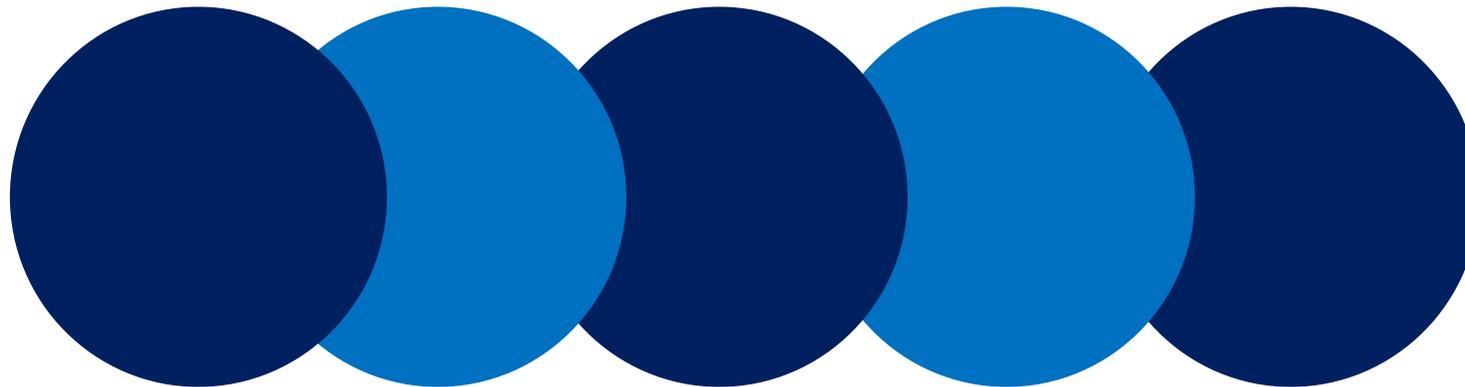
Encadreur :

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Dr BOUKLI HACENE Mohamed El Amine

Paramètres  
influent

Résultats

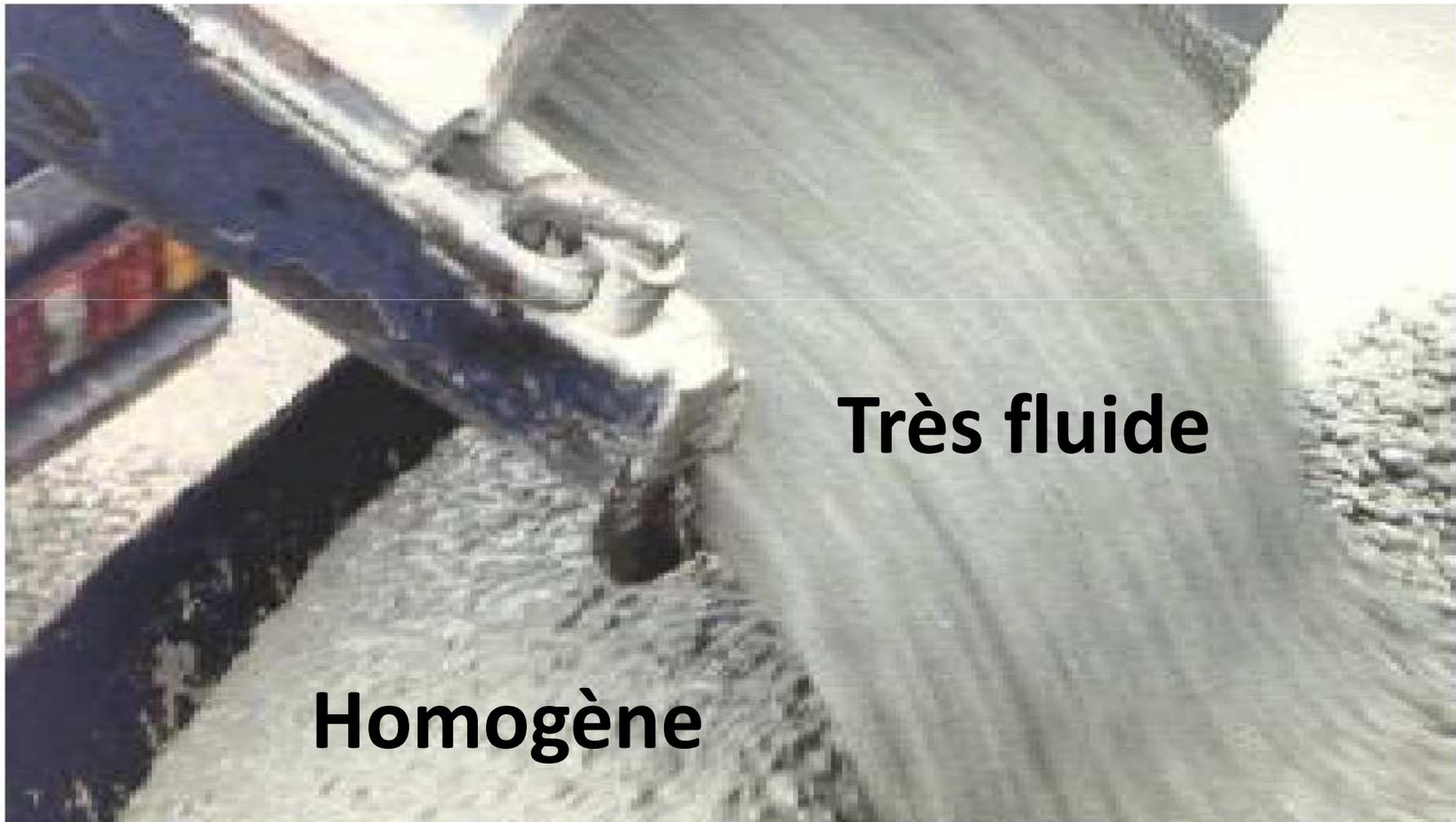


Introduction & Problématique  
Démarc

Méthodologique

Conclusion

# **I**ntroduction



**Très fluide**

**Homogène**

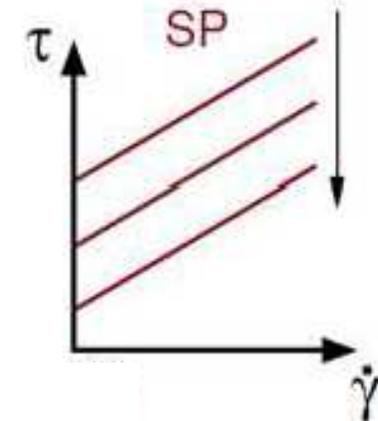
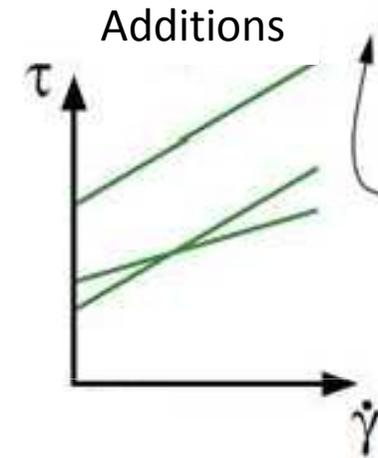
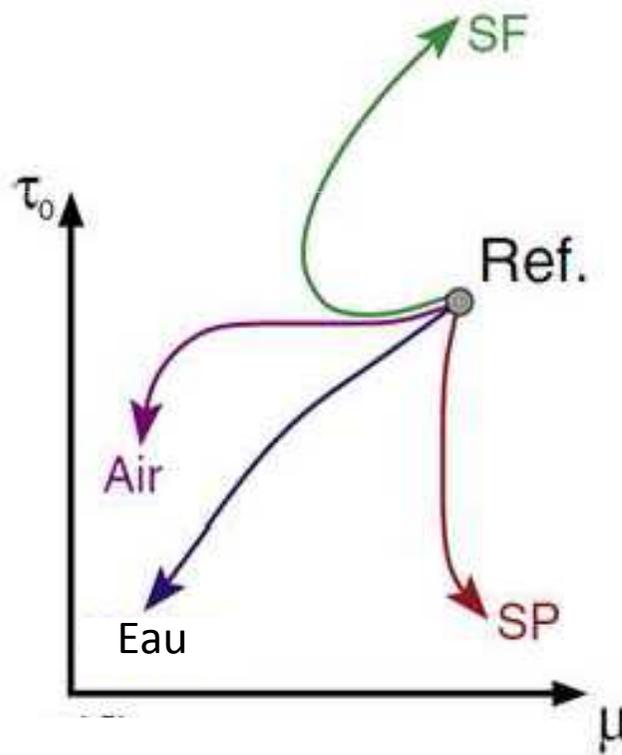
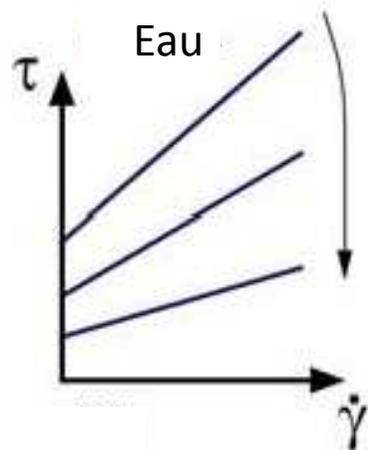
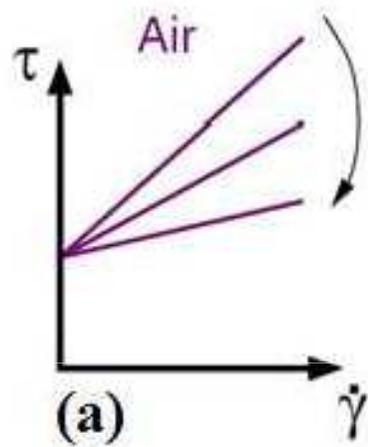


# Problématique



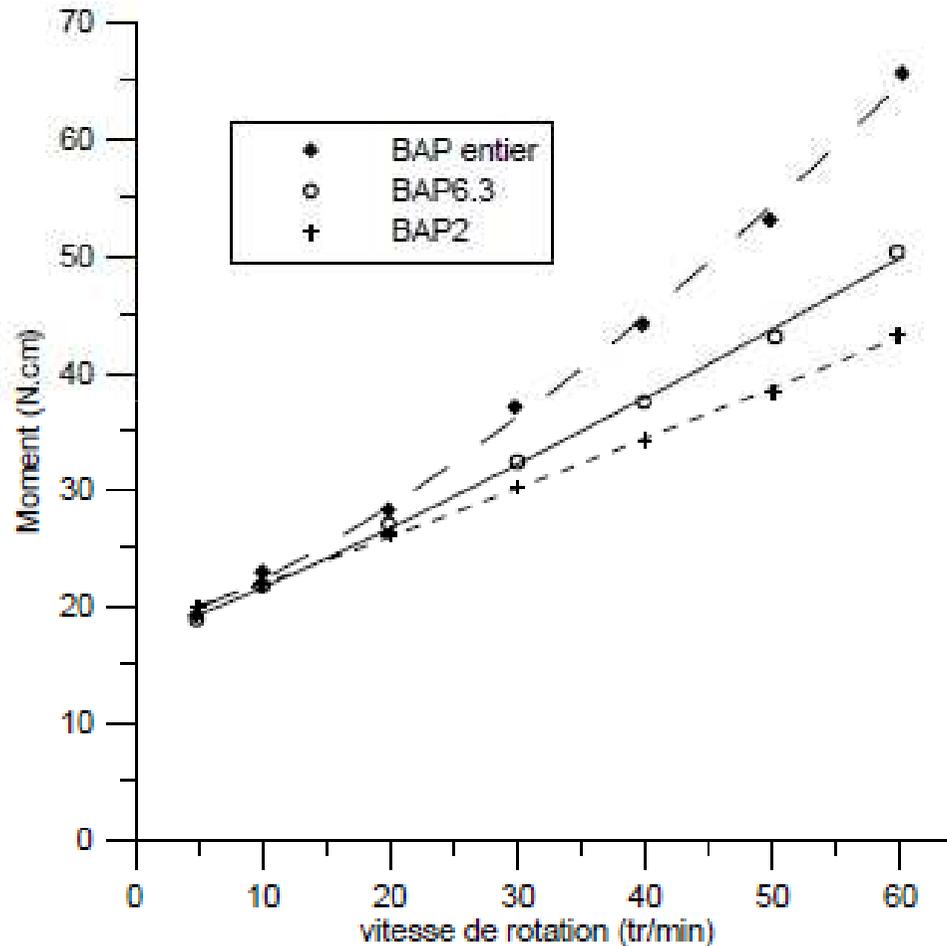
- **Proposition d'une nouvelle approche de formulation (Durabilité, EN 206-1)**
- **Connaître les caractéristiques rhéologiques ainsi que les effets rhéologiques que peut induire toute augmentation des quantités des différents constituants.**
- **Optimiser la formulation en fonction des caractéristiques rhéologiques ciblées (mise en place, pompage)**

# P Paramètres influents



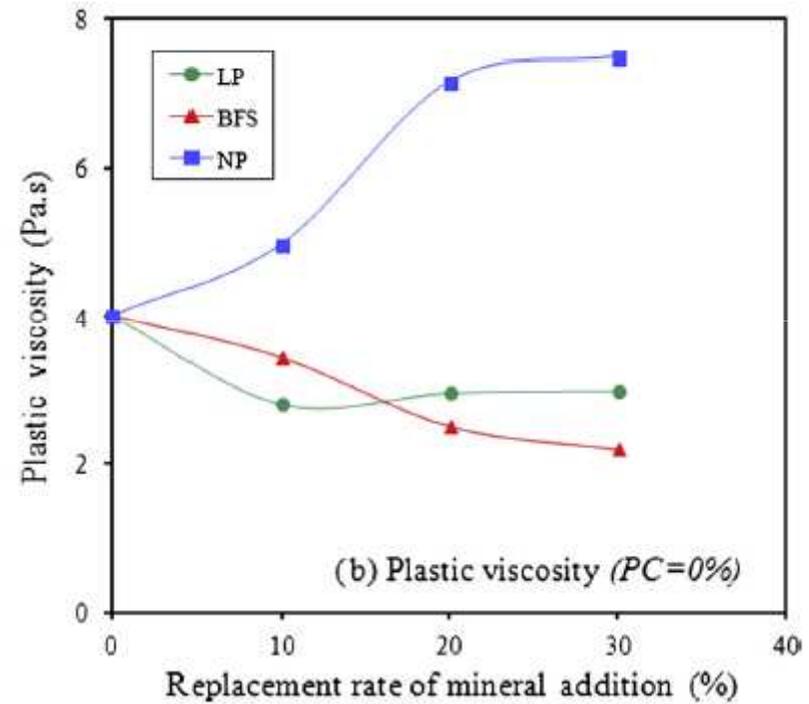
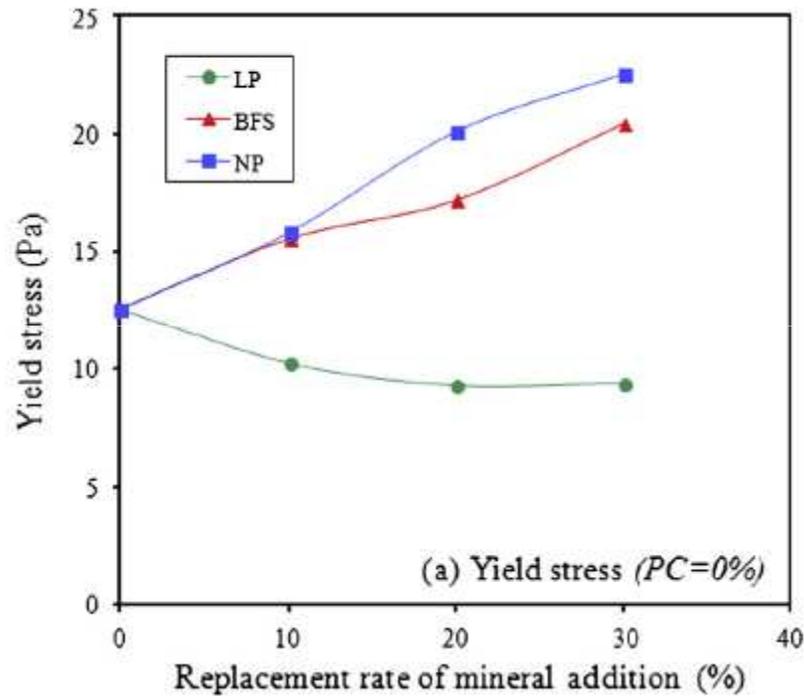
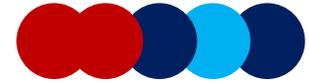
Rhéographe du béton

# P Paramètres influents



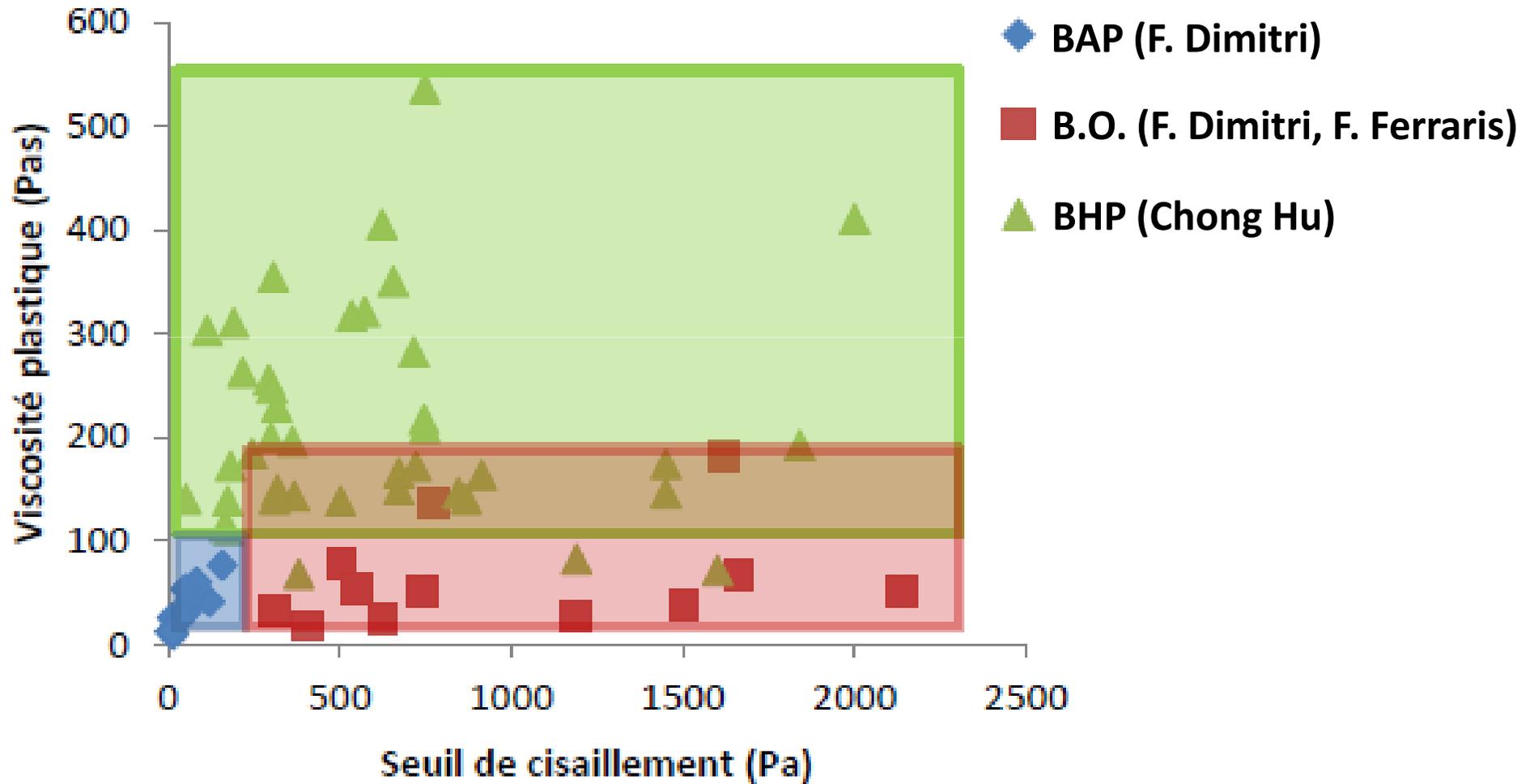
Influence de la quantité de pâte (NAADIA, 2014)

# P Paramètres influents



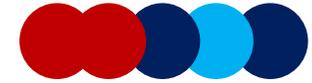
Type d'additions (Adjoudj, 2014)

# P Paramètres influents



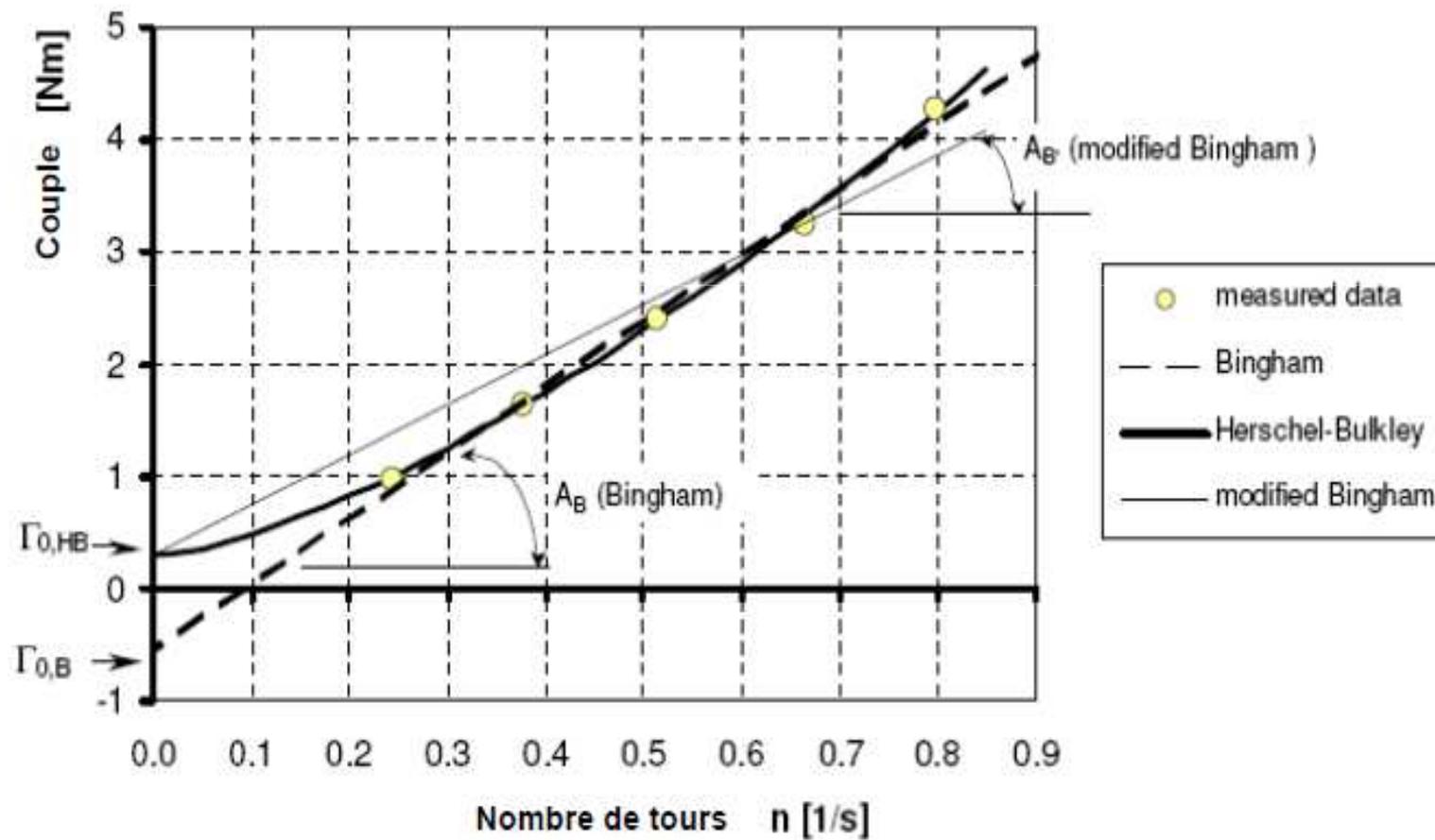
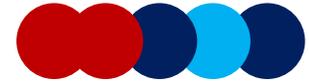
Rhéologie des différentes familles de béton

# P paramètres influents

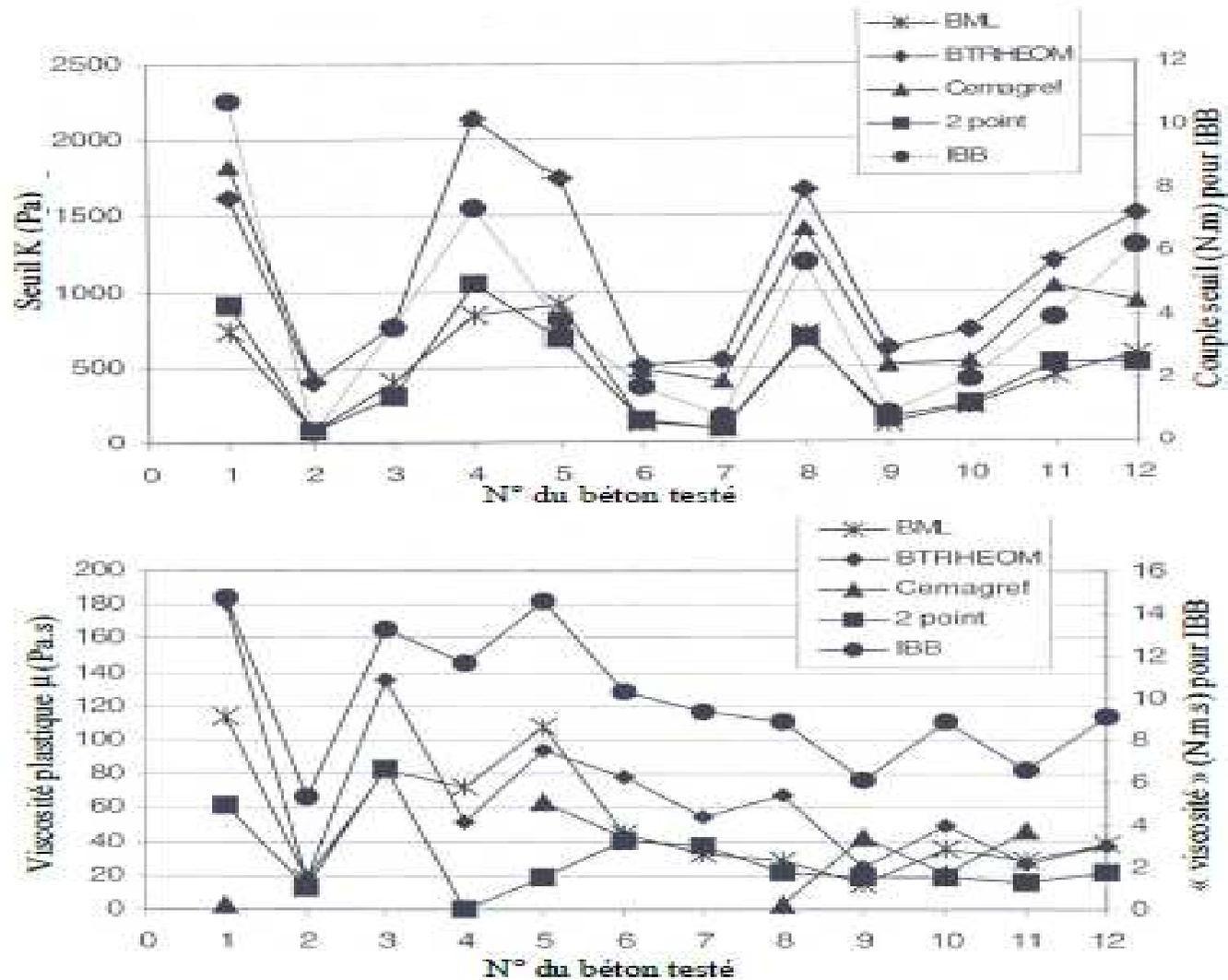


Model	Equation
Newtonian	$\sigma = \eta_0 \dot{\gamma}$
Bingham	$\sigma = \sigma_0 + \eta_0 \dot{\gamma}$
Casson	$\sigma^{1/2} = \sigma_0^{1/2} + \eta_0^{1/2} \dot{\gamma}^{1/2}$
Power Law	$\sigma = K \dot{\gamma}^c$
Herschel Bulkley	$\sigma = \sigma_0 + K \dot{\gamma}^c$
Sisko	$\eta = \eta_\infty + K \dot{\gamma}^{n-1}$
Williamson	$\eta = \eta_0 / (1 + (\dot{\gamma} / \dot{\gamma}_0)^c)$
Cross	$(\eta - \eta_\infty) / (\eta_0 - \eta_\infty) = 1 / (1 + (\dot{\gamma} / \dot{\gamma}_0)^d)$
Ellis	$(\eta - \eta_\infty) / (\eta_0 - \eta_\infty) = 1 / (1 + (\sigma / \sigma_0)^d)$
Carreau	$(\eta - \eta_\infty) / (\eta_0 - \eta_\infty) = 1 / (1 + (\dot{\gamma} / \dot{\gamma}_0)^2)^{d/2}$

# P Paramètres influents

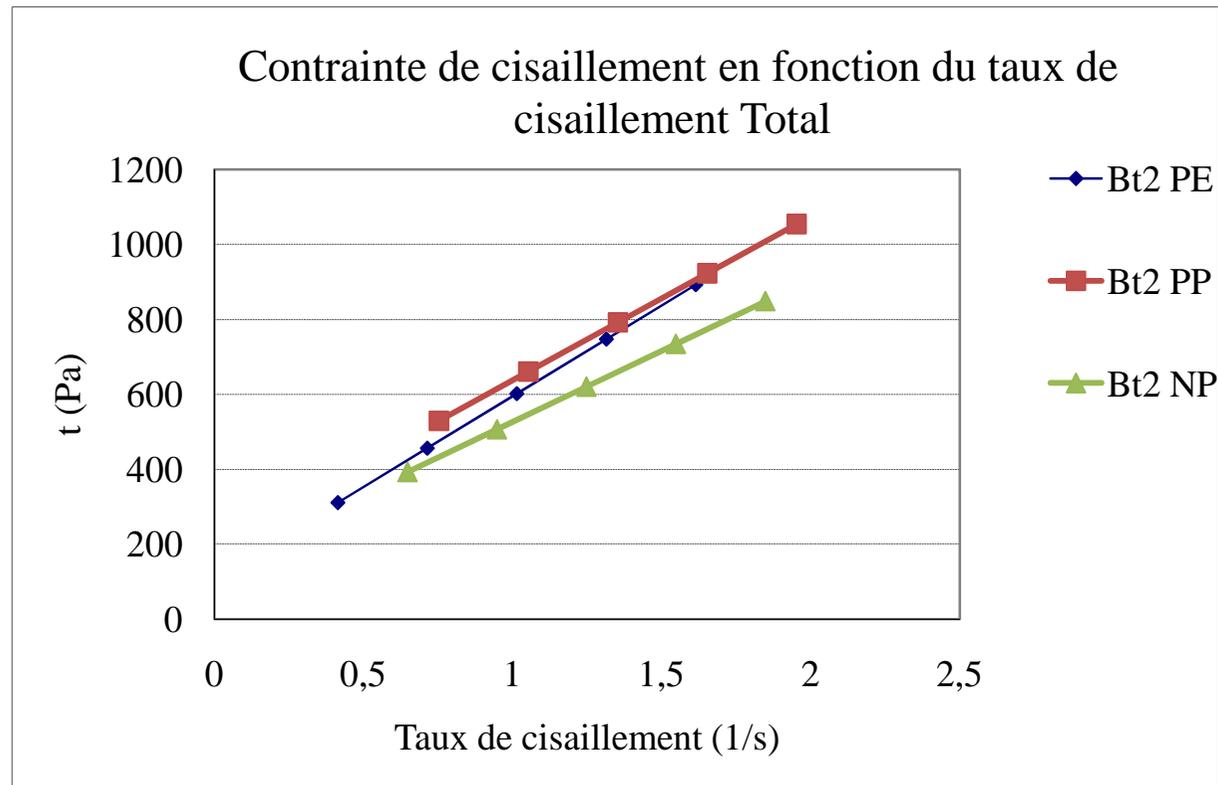


# Difficultés

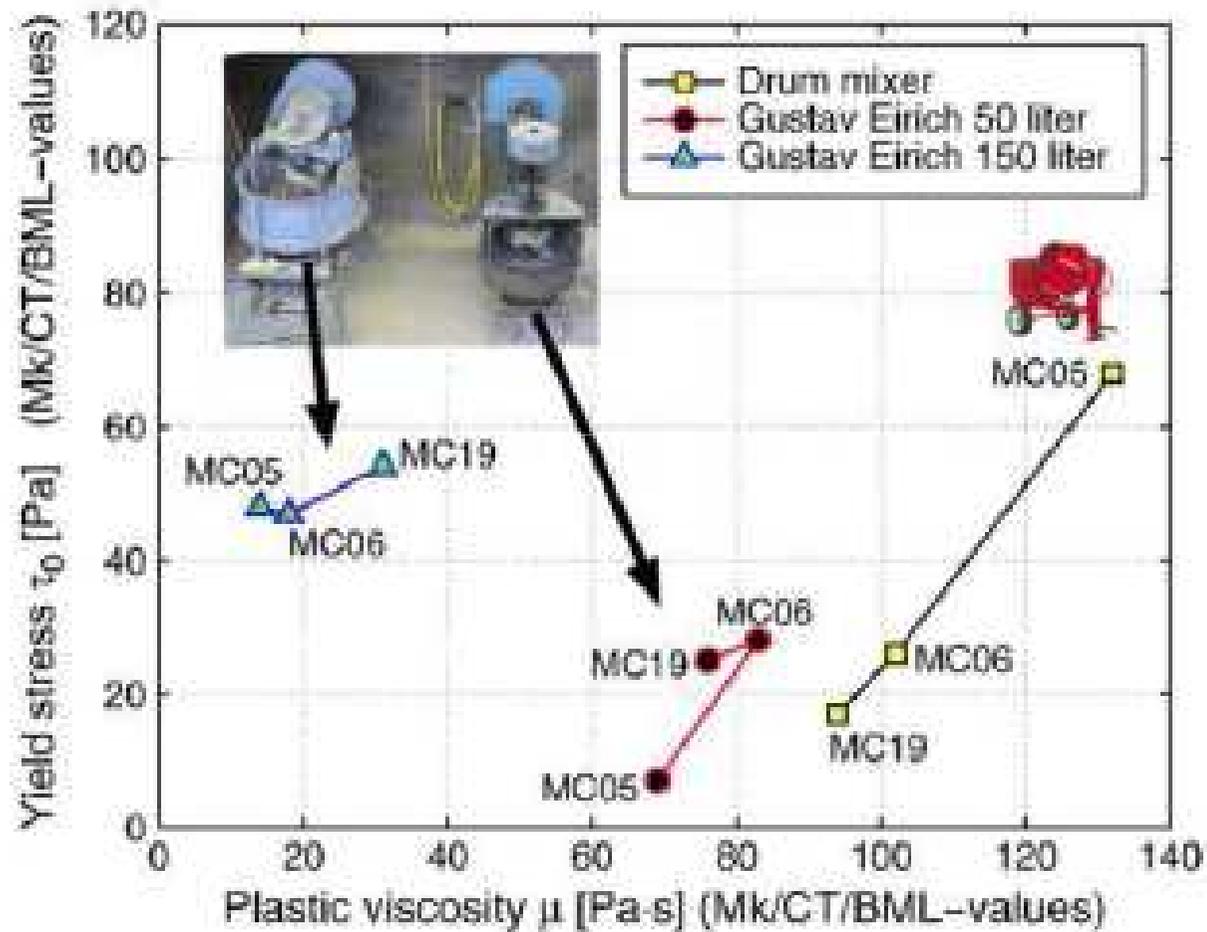
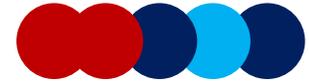


(Nist 2001)

# Difficultés

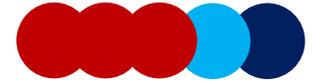


# Difficultés

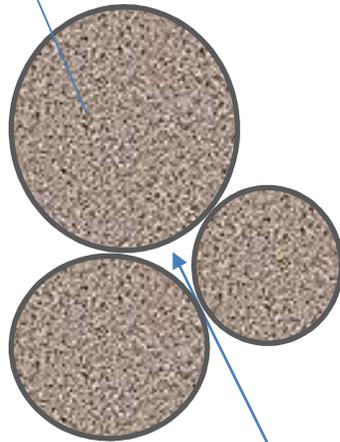


(Wallevik, 2011)

# Démarches Méthodologiques



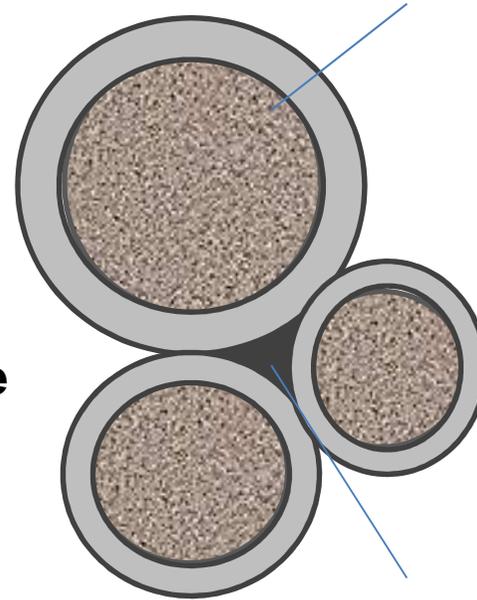
**Granulat**



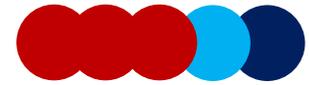
**Vide**



**Ajout de pâte**



# Démarches Méthodologiques



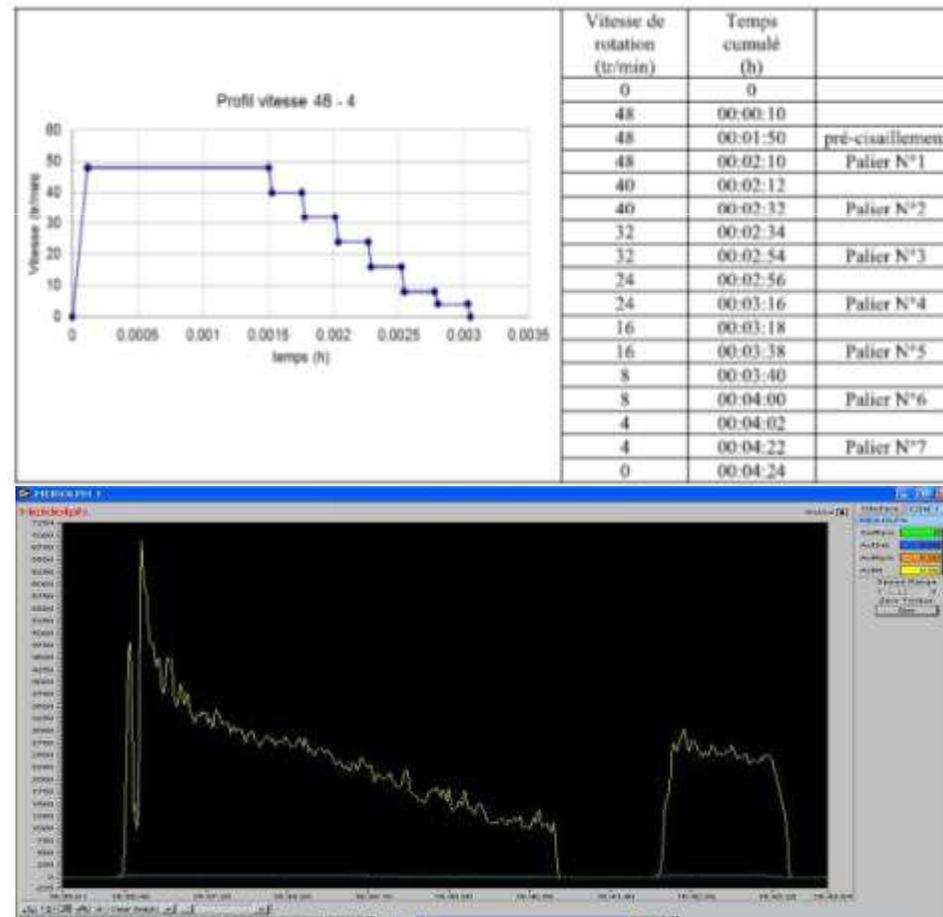
# Démarches Méthodologiques



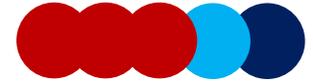
- Equations de Lanos et Estelle (2009)
- Equations de Reiner Rivlin



(Soualhi et col, 2014)



# Démarches Méthodologiques



# Résultats



Détermination de PF

$$PF = \frac{\rho_{\text{après}}}{\rho_{\text{avant}}}$$

# Résultats



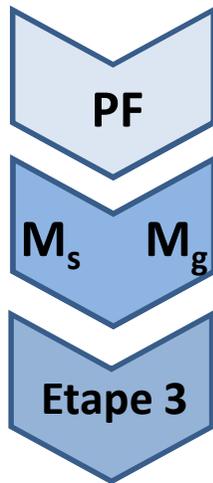
Détermination de PF

Calcul du dosage en granulats

$$M_{\text{gg}} = \text{PF} \times \rho_{\text{gg}} \times \left( 1 - \frac{S}{S + G} \right)$$

$$M_{\text{s}} = \text{PF} \times \rho_{\text{s}} \times \left( \frac{S}{S + G} \right)$$

# Résultats



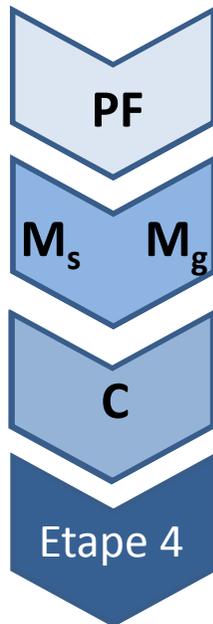
Détermination de PF

Calcul du dosage en granulats

Calcul du dosage en ciment

*En fonction du critère de la durabilité (EN 206 – 1)*

# Résultats



Détermination de PF

Calcul du dosage en granulats

Calcul du dosage en ciment

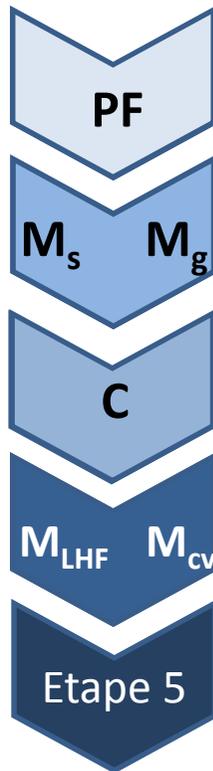
Calcul du dosage en additions

$$V_{PCV} + V_{PLHF} = 1 - \frac{M_g}{1000 \times G_g} - \frac{M_s}{1000 \times G_s} - \frac{C}{1000 \times G_c} - \frac{E_c}{1000 \times G_E} - V_a$$

$$V_{PCV} + V_{PLHF} = \left(1 + \frac{E}{CV}\right) \times A\% \times \frac{M_{pm}}{1000 \times G_{CV}} + \left(1 + \frac{E}{LHF}\right) \times B\% \times \frac{M_{pm}}{1000 \times G_{LHF}}$$

$$M_{CV} = A\% \times M_{pm} \quad M_{LHF} = B\% \times M_{pm}$$

# Résultats



Détermination de PF

Calcul du dosage en granulats

Calcul du dosage en ciment

Calcul du dosage en additions

Calcul du dosage en superplastifiant (SP)

$$SP = n\% (C + M_{CV} + M_{LHF})$$

# Résultats



Détermination de PF

Calcul du dosage en granulats

Calcul du dosage en ciment

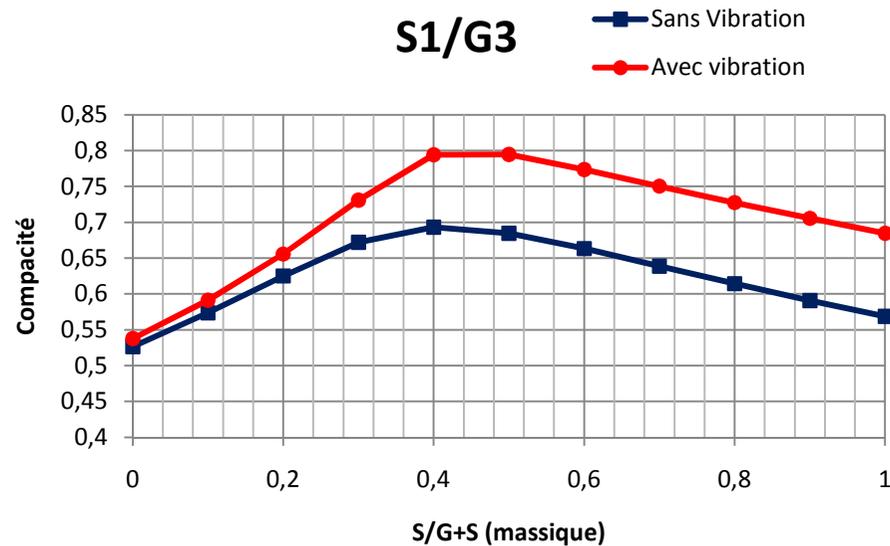
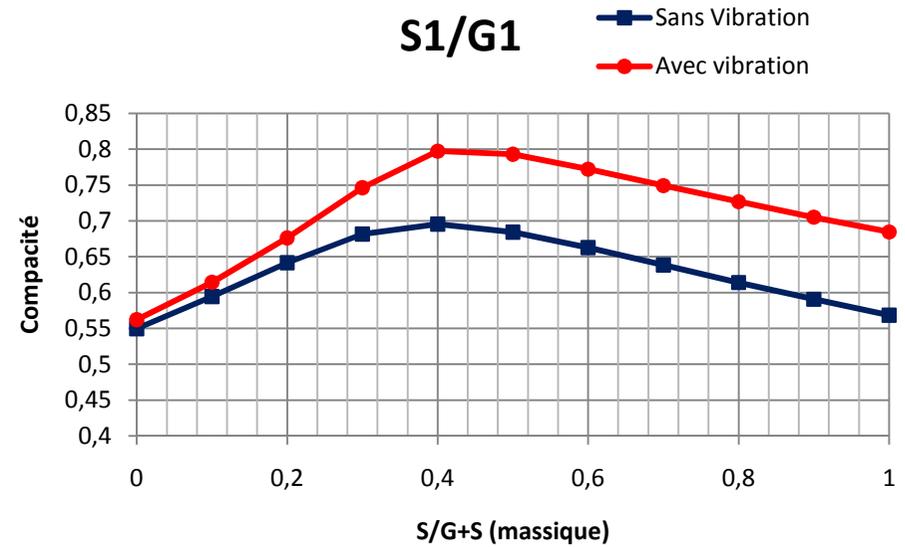
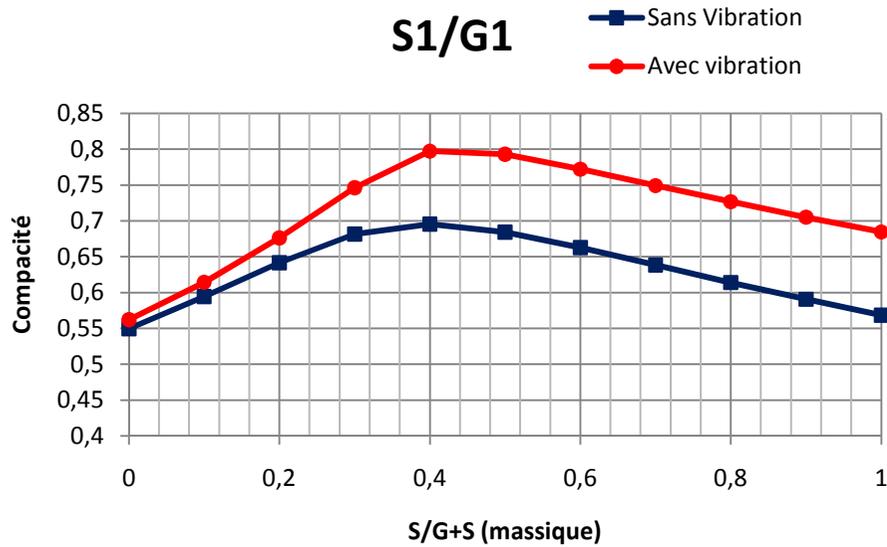
Calcul du dosage en additions

Calcul du dosage en superplastifiant (SP)

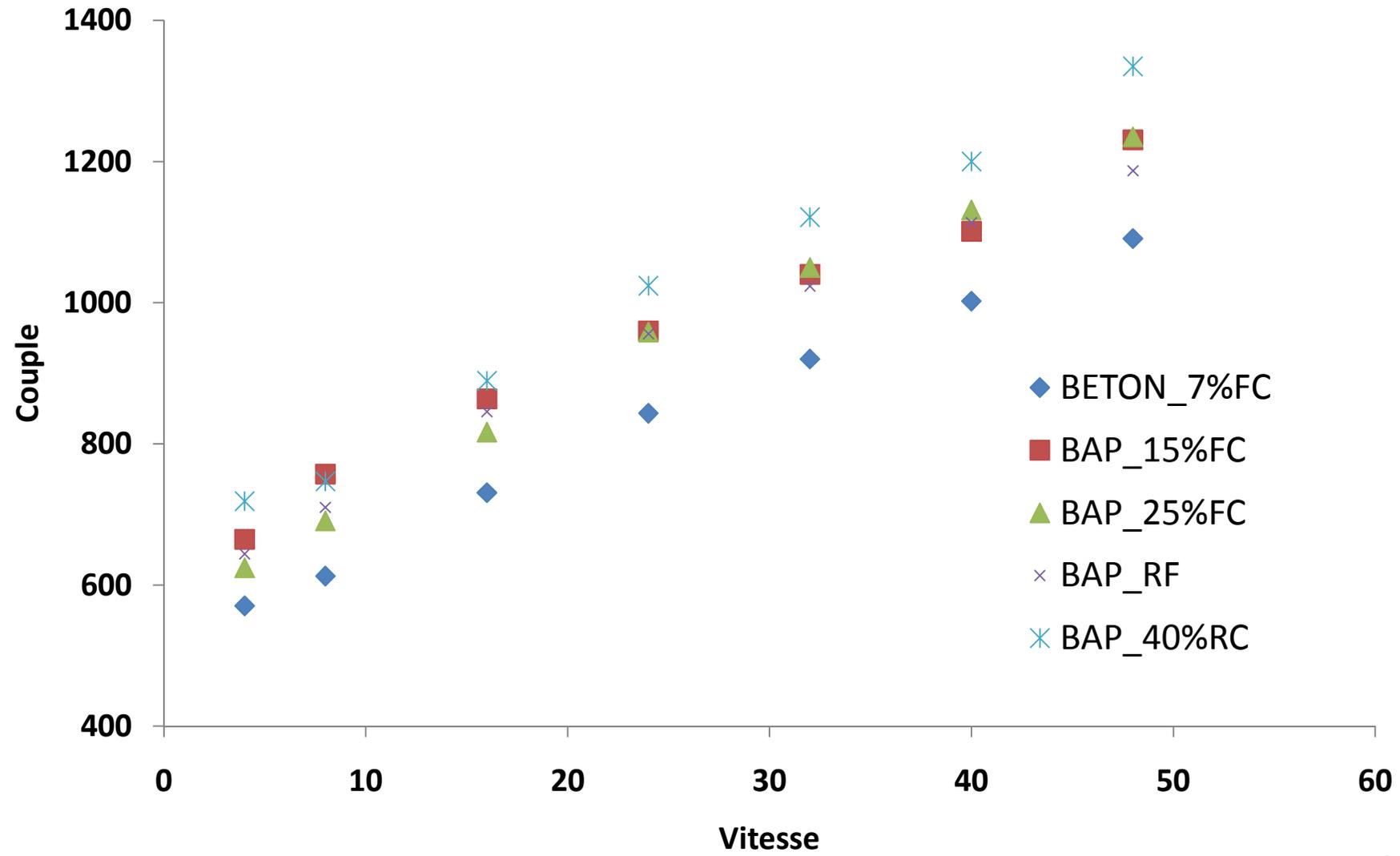
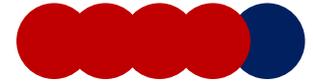
Calcul du dosage en eau

$$E = E_C + E_{CV} + E_{LHF} - E_g - E_s - E_{SP}$$

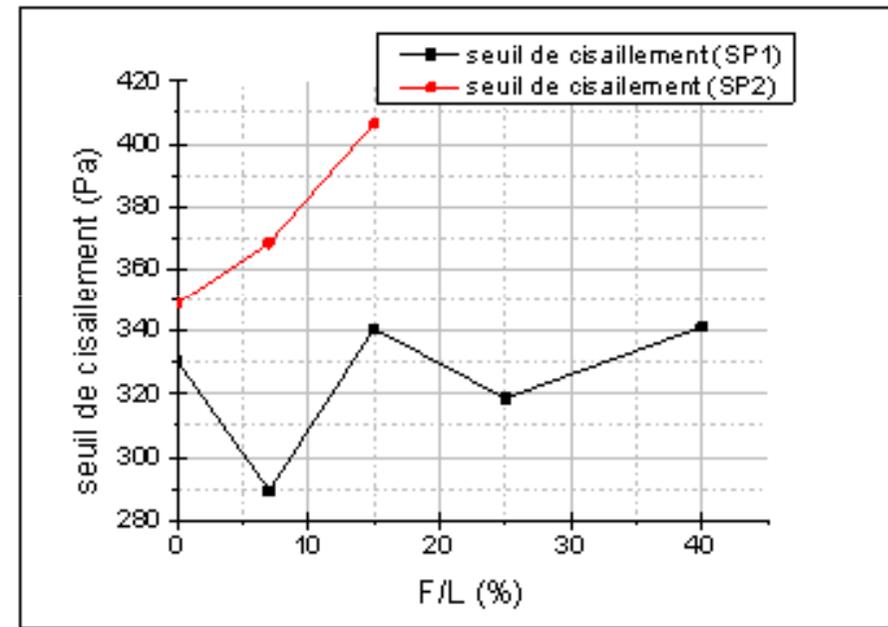
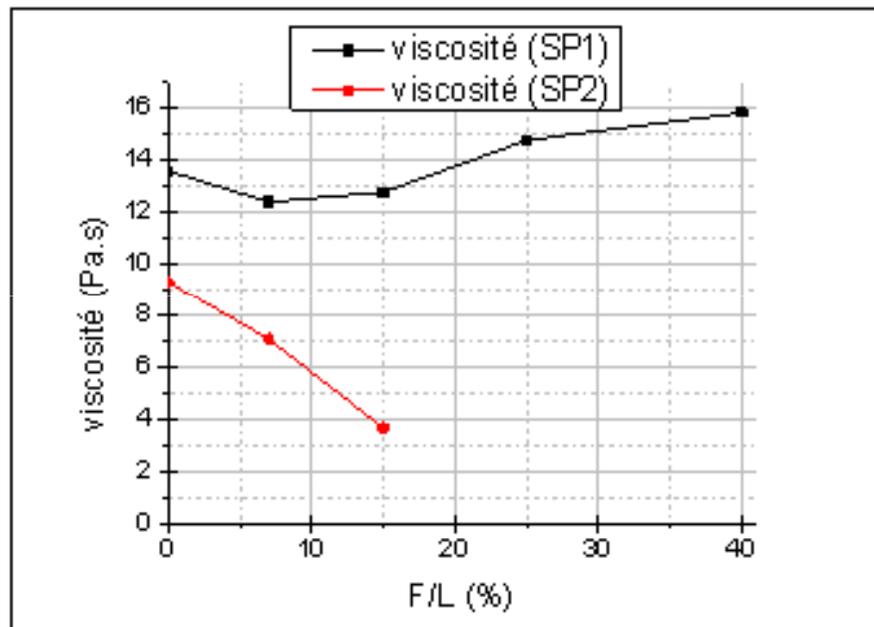
# Résultats



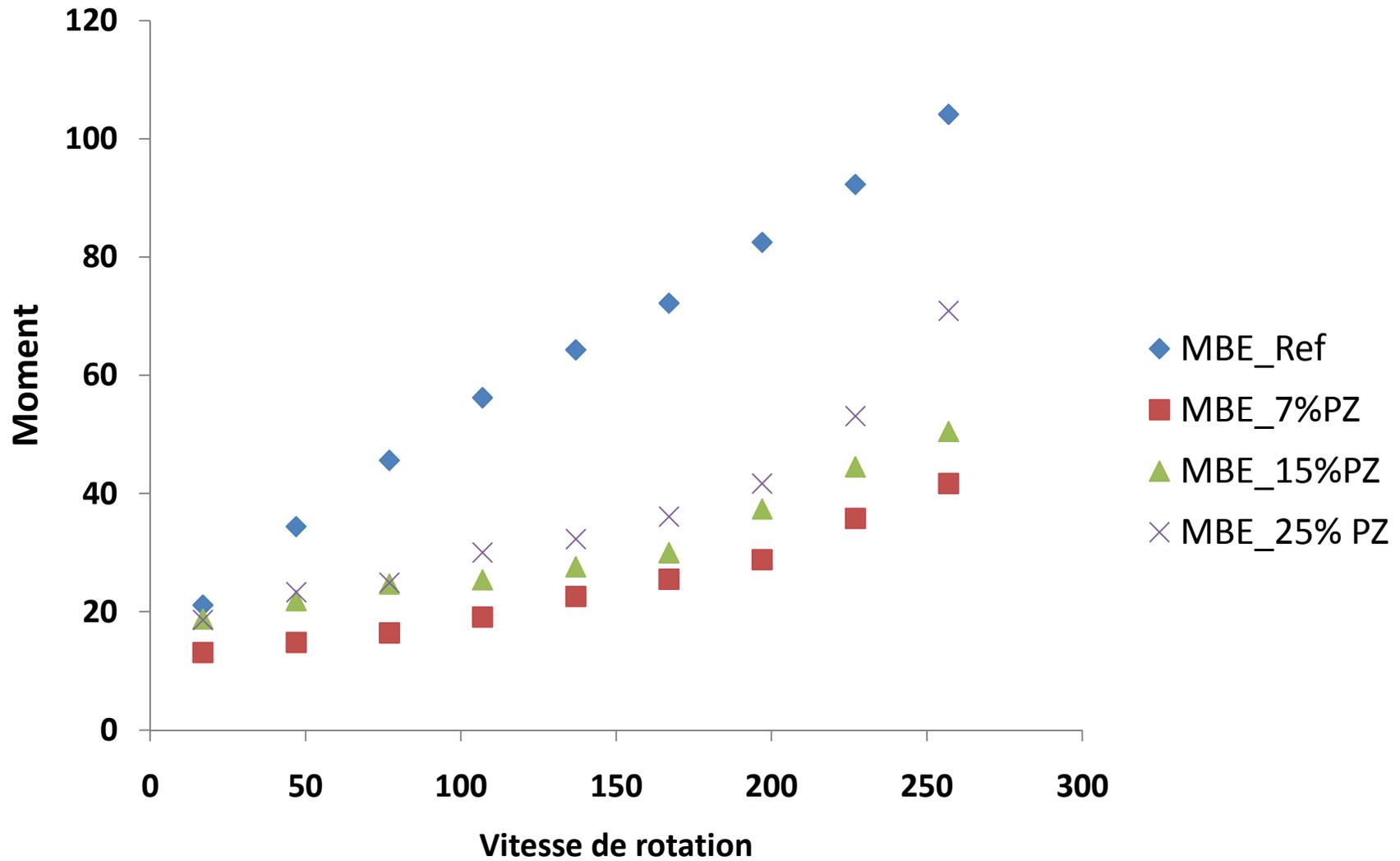
# Résultats



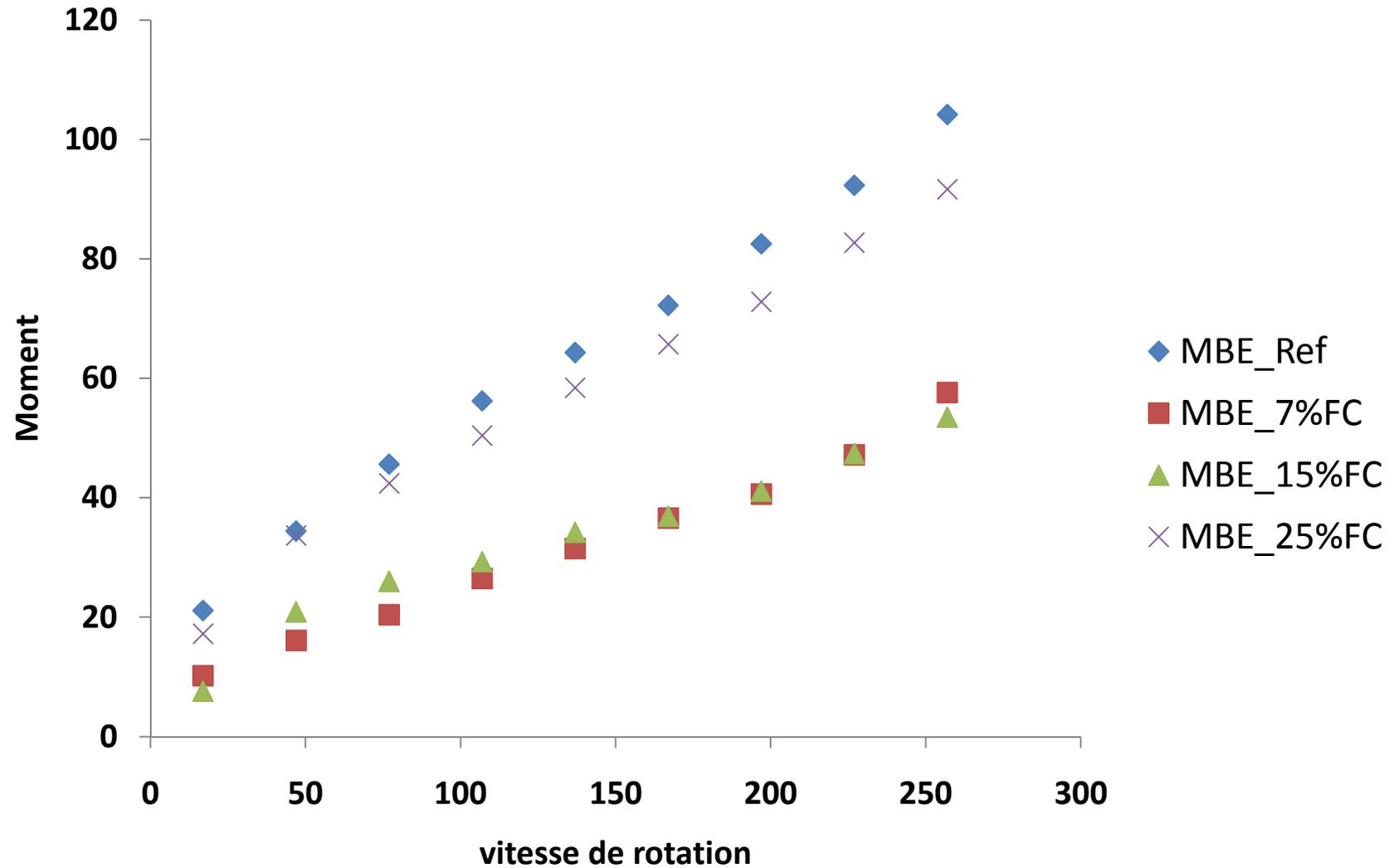
# Résultats



# Résultats



# Résultats



# Conclusion

- **Efficacité de la méthode développée**
- **l'intérêt de substituer le ciment par des additions de type calcaires sur le plan rhéologique.**
- **Les BAP se comportent comme un fluide Binghamien**
- **Les MBE ont un comportement de type Hershel Bulkley (rhéoépaississant)**