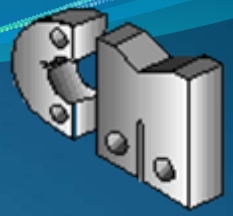

GRC's impact behavior

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2. GRC production and tests
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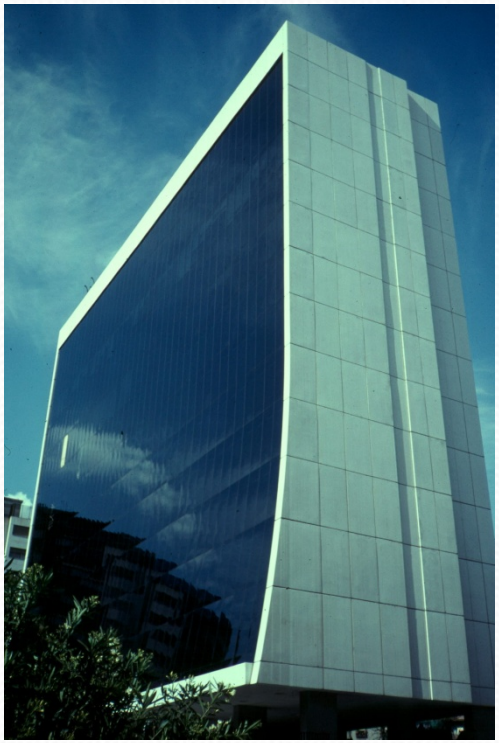
Introduction

What is GRC?

¿What does GRC stand for?

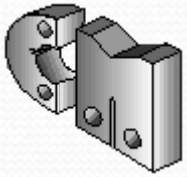
GRC stands for Glass Fiber Reinforced Cement. This material is produced by spraying chopped glass fibers simultaneously with cement mortar.



What is GRC?

Why are glass fibers added to cement mortar?

Glass fibers increase cement mortar's ductility and prevent cracking caused by shrinkening.



GRC's mechanical properties

GRC static mechanical properties

Density	1.900 – 2.250 Kg/m^3
Compressive strength	48 – 83 MPa.
Young modulus	10 – 20 GPa.
Flexural strength -First cracking -Rupture	 6 – 10 MPa. 17 – 25 MPa.
Tensile strength -First cracking -Rupture	 4,8 – 7 MPa. 7 – 11 MPa
Failure strain	0,6 – 1,2 %

GRC's mechanical properties

What about GRC's behavior under high strain rates?

Strain rates over 10^1 s^{-1} have not been studied.

GRC production and tests

Material production

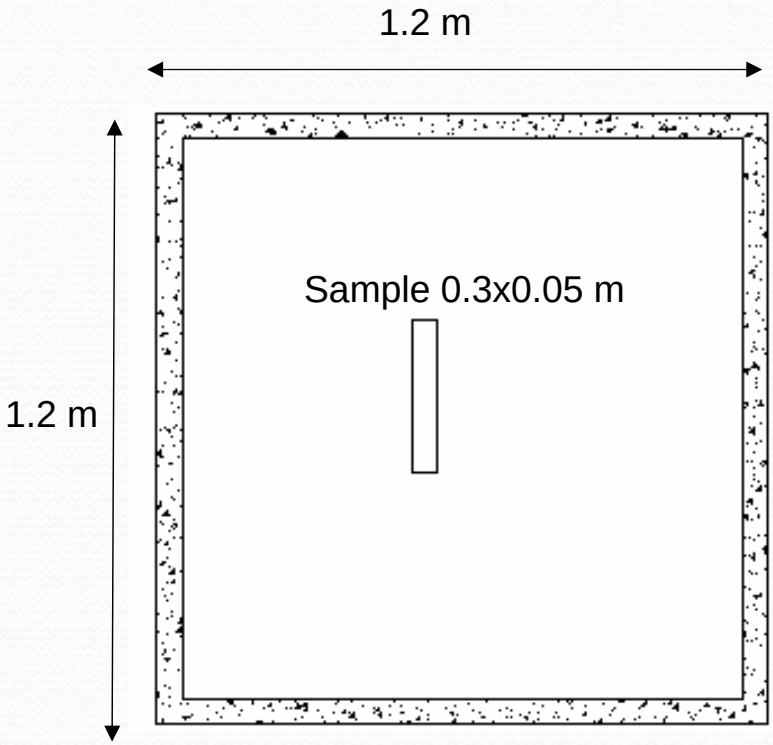
GRC was produced using a 10% metakolin addition.

Cement	Sand	Water	Plasticizer	Metakaolin
50 Kg.	50 Kg.	22 l.	0.5 liters	5 Kg.

Material production

GRC tensile tested samples were cut from 1.2x1.2m test boards

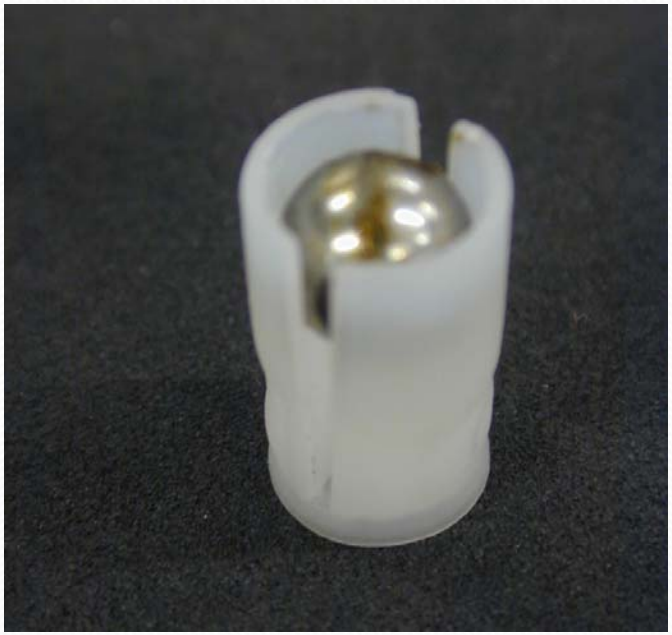
Samples dimensions were 0.3x0.05 m.



Test set up

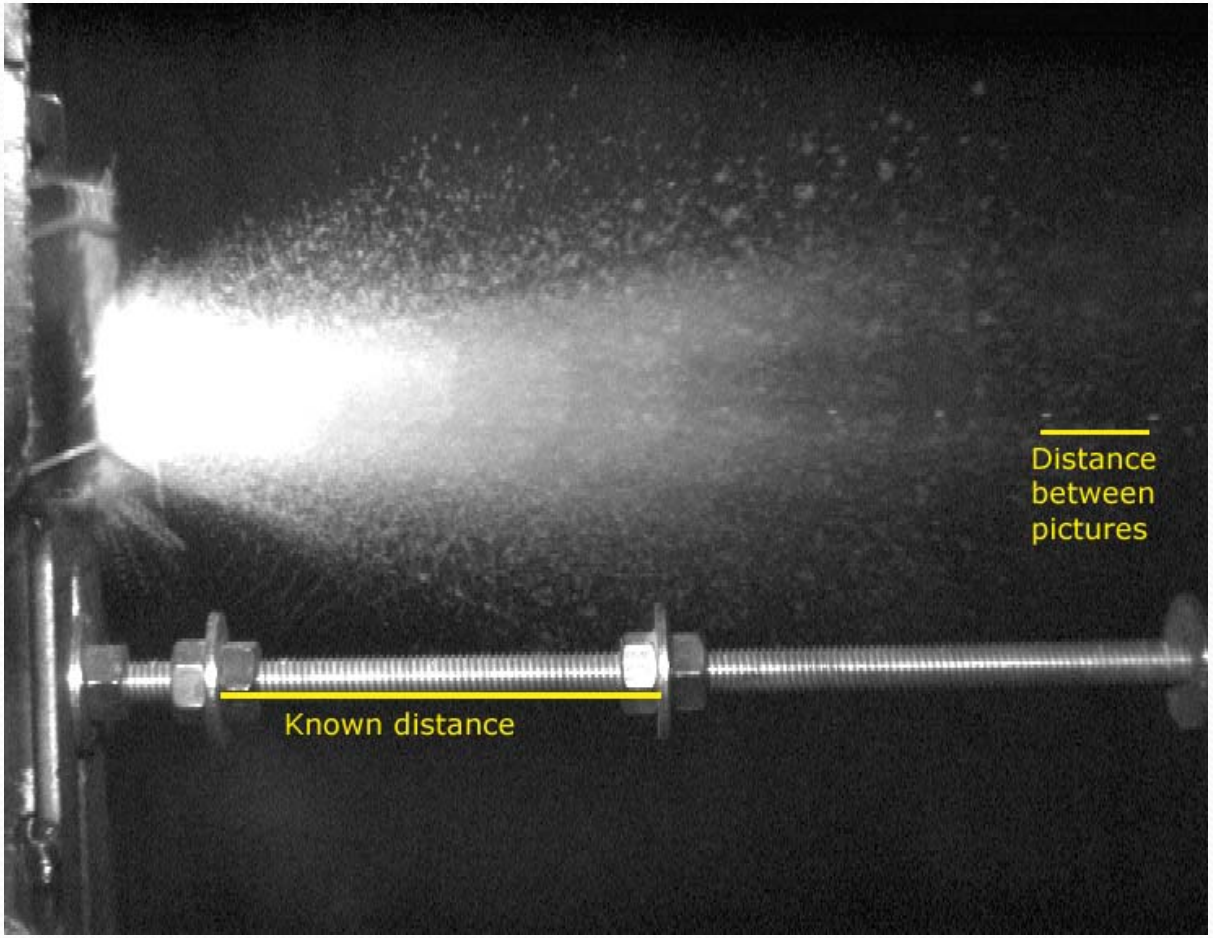
Gas gun

5.5 mm diameter steel spheres and sabot



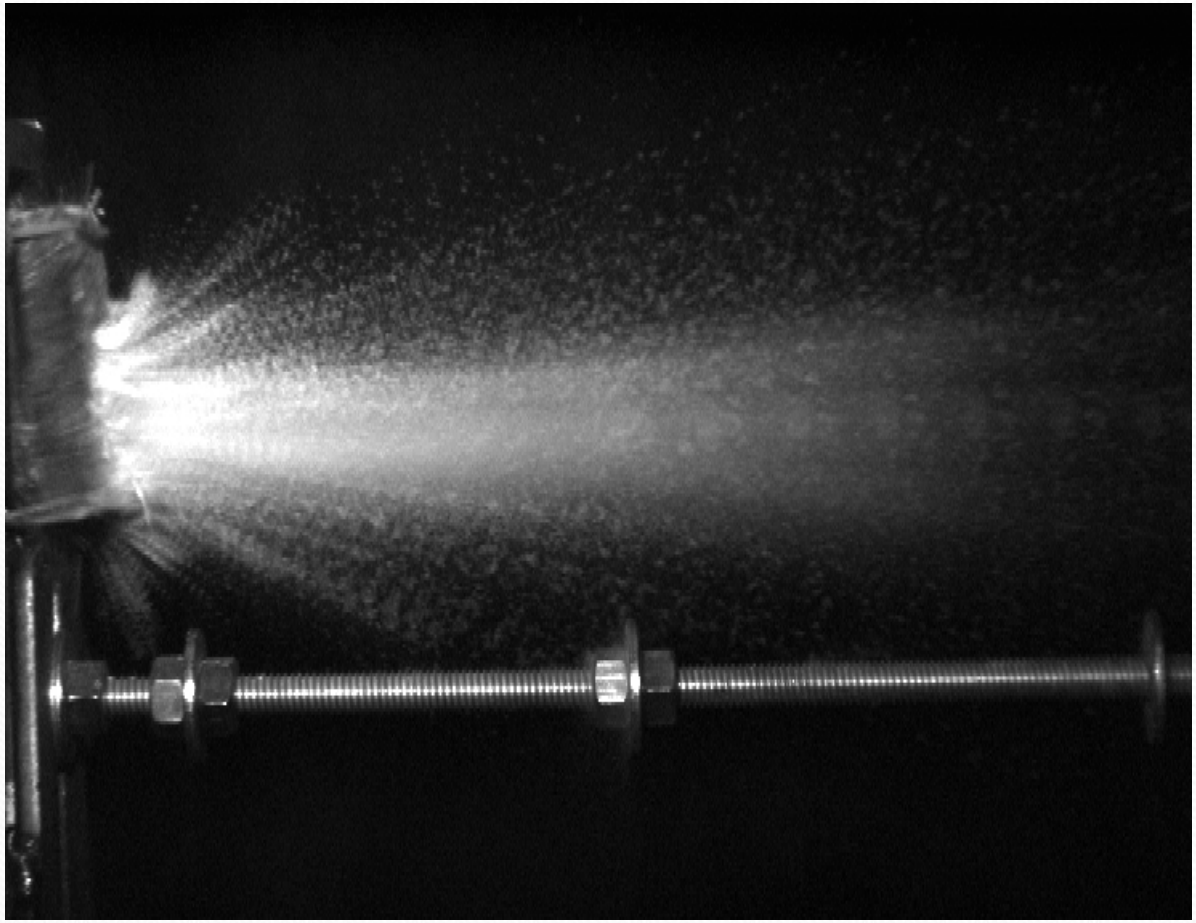
Velocity measuring systems

High speed rate pictures for high speeds (>400 m/s)

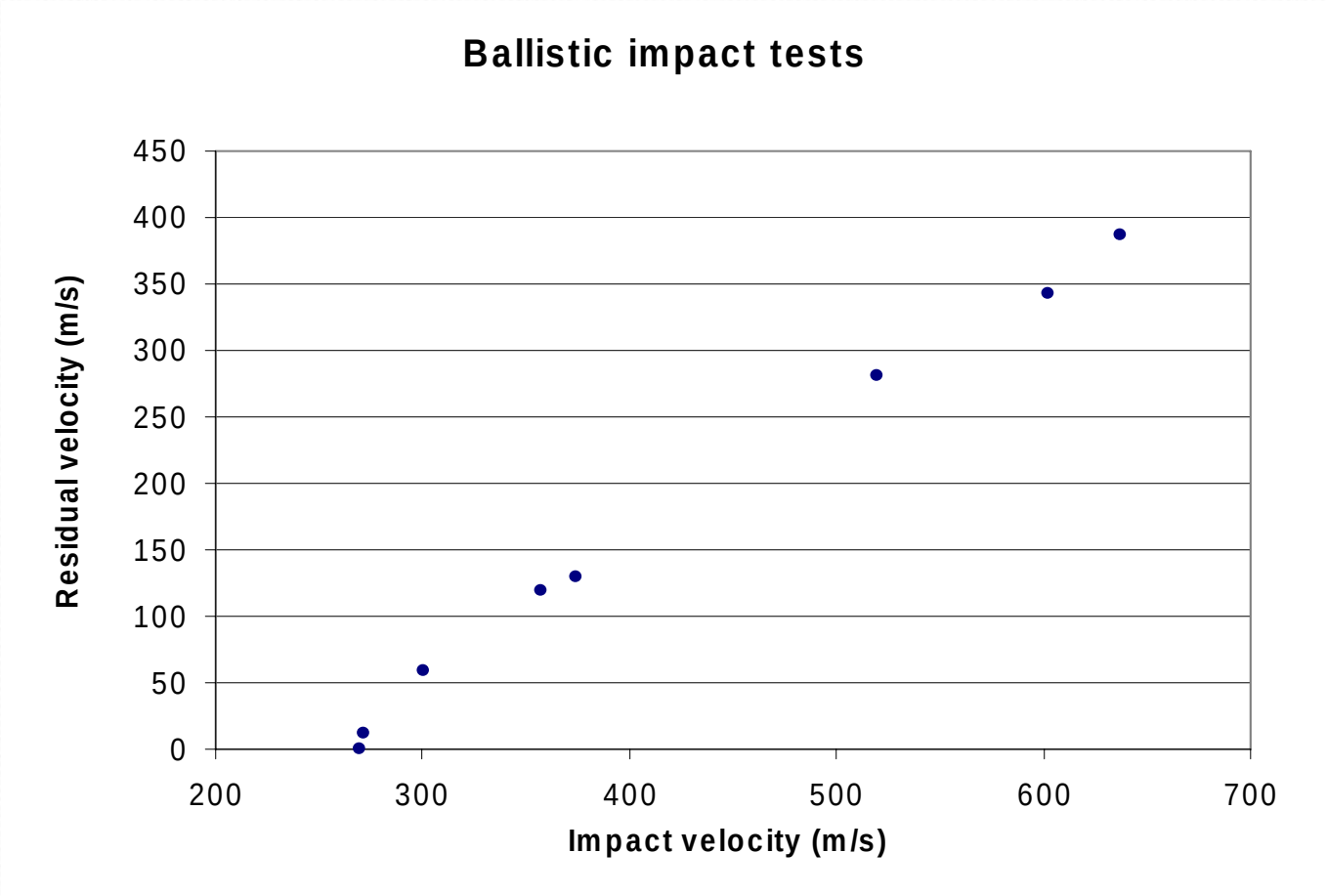


Velocity measuring systems

For low speeds a calibrated molding clay was used (< 400 m/s)



Test results



Numerical simulations

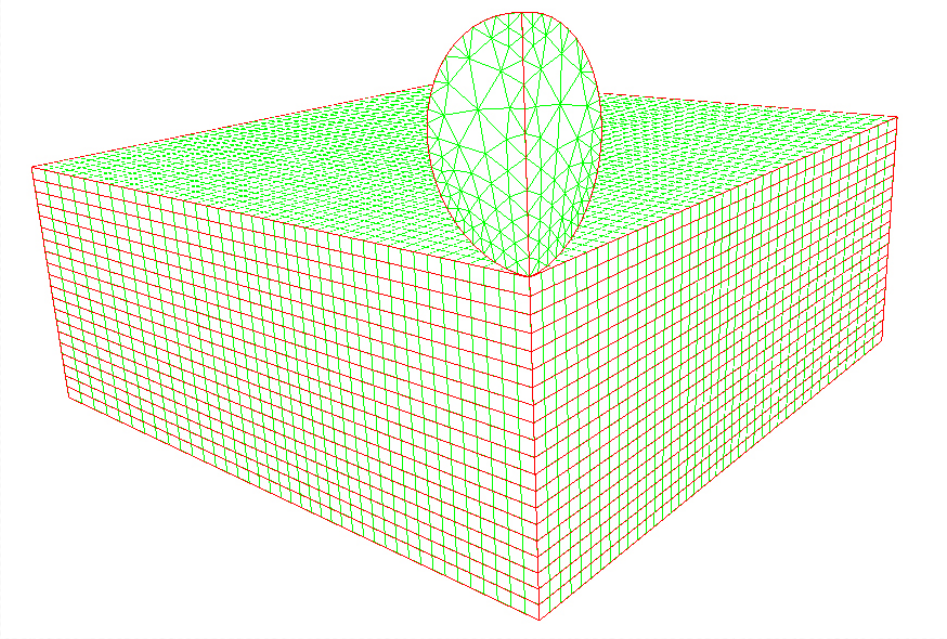
Autodyn v6 was used for calculations

GRC samples idealized as 10 mm thick plates

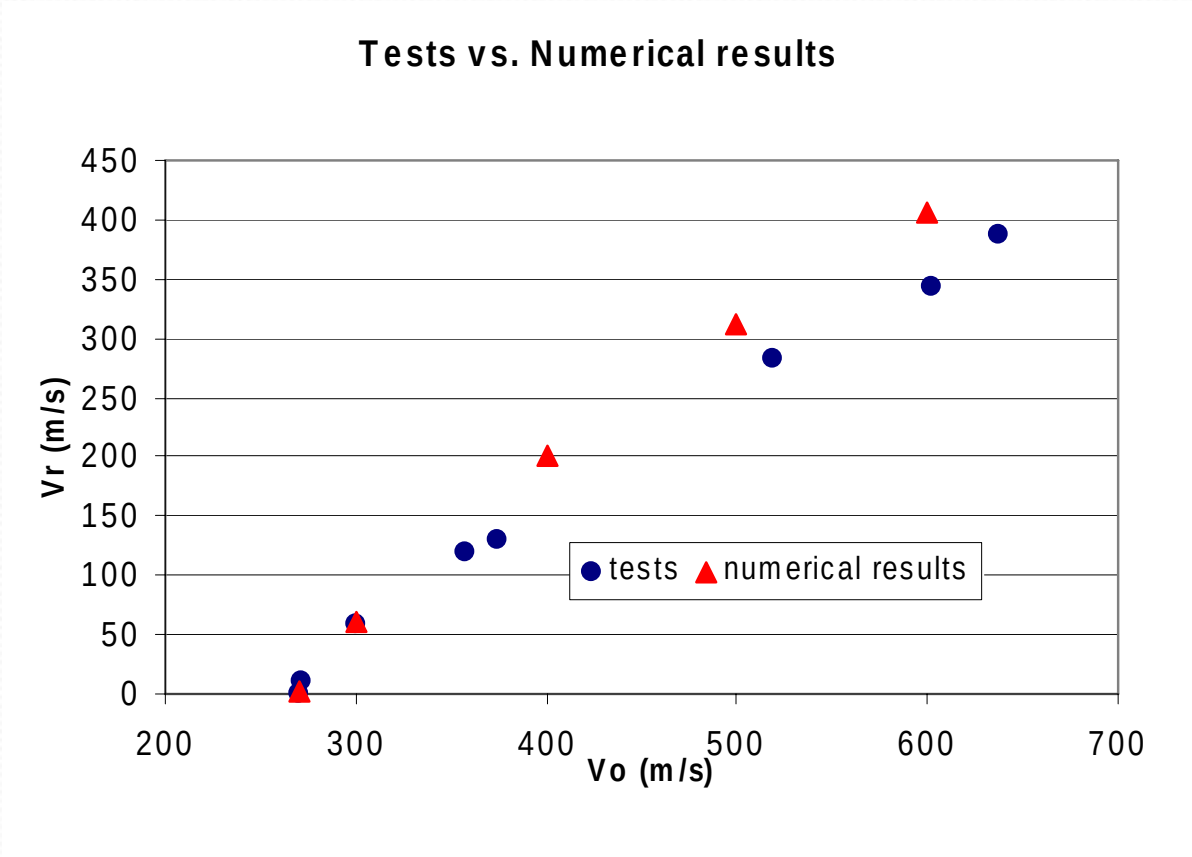
Cement simulated as Concrete-L Autodyn library material

Glass fibers introduced in the model as membrane layers between cement ones

Spheres simulated as a rigid body



Testing vs. Numerical simulations

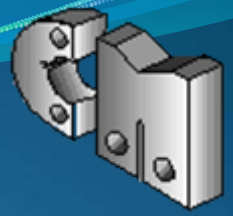


Conclusions

1. A complete residual velocity vs. impact velocity curve for GRC panels has been achieved.

2. Velocity measurement through high velocity photographs and indirect measurement using molding clay have been proved to be consistent.

3. Numerical simulations using Autodyn 3-D v6. are able to predict GRC's impact behavior accurately.



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