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Abu Dhabi University

Low Cement Concrete Mixes with PET plastic fibres in Reinforced Concrete Beams

11th Undergraduate Research & Innovation Competition, Abu Dhabi University, Khalifa City Campus.

Afeefa Muhammad Iliyas, Ashraf Shahbaaz and ***Aashish Jain***

4th year Civil Engineering Student, School of Energy, Geoscience, Infrastructure and Society, Heriot-Watt University, Dubai

Supervisor

Dr. Mustafa Batikha

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Concrete

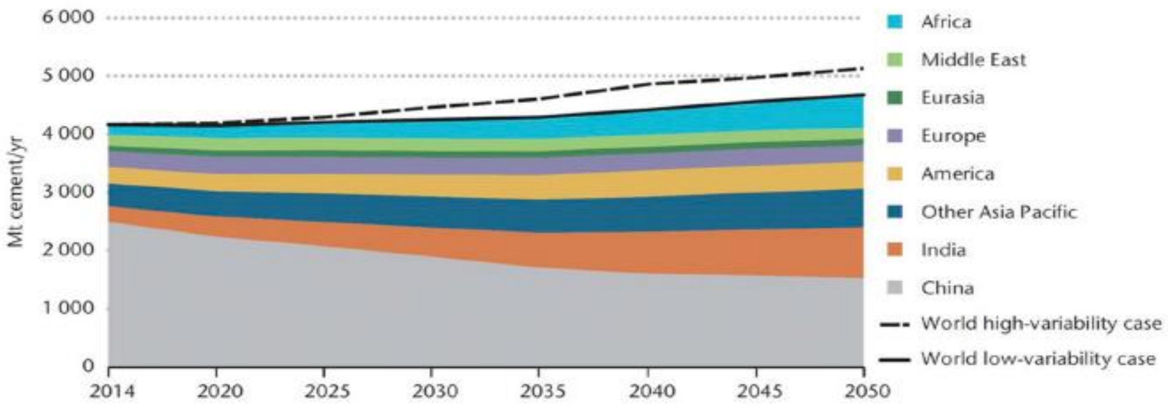
Cheap construction material, Low maintenance cost, Easy to shape, Less skilled labor and Fire and weather durable.

Second consumed material after water (**20 billion tons** annual production)

Cement Production

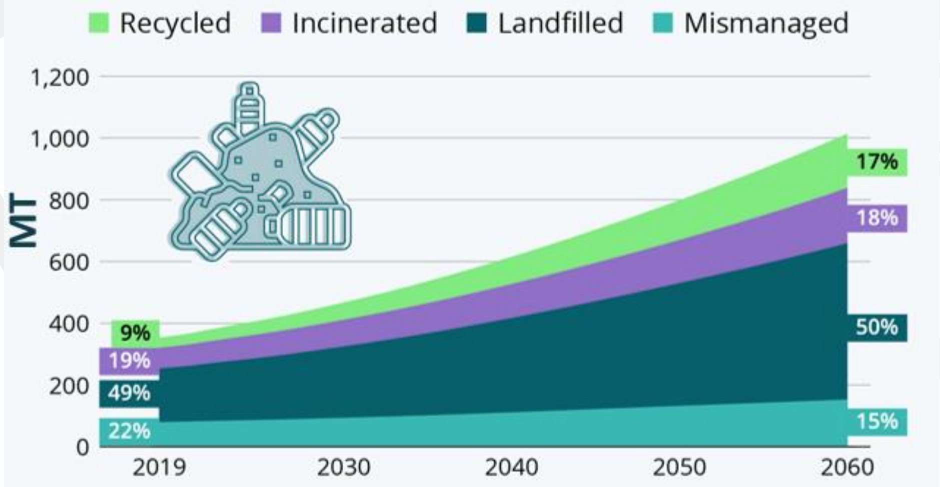
550 to 1000 kgCO_2/ton

7% of the Global CO_2 emissions



Plastic

Low cost; easily shaped; lightweight; resistant to corrosion; transparent; Poor heat and electricity conductor.



12 billion tons of plastic waste will be landfilled by 2050

This Research Solution

~~Cement~~+Natural Aggregates+ Water = Non-Eco-Friendly Concrete

50% GGBS

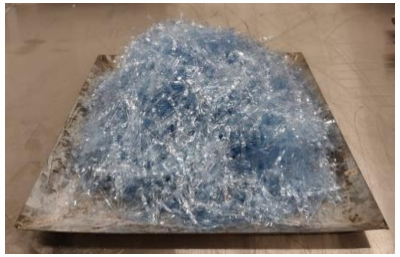
+

10% SF

+

10% CWP

+



25mm PET fibre length
1% volume fraction

=

Eco-Friendly Concrete

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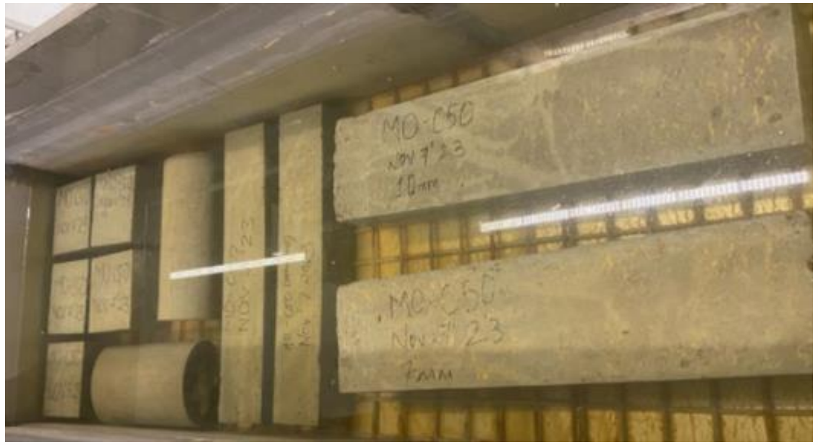
The aims and objectives of the project

- ✓ Reduction of plastic waste in landfills
- ✓ Providing a cost-effective solution
- ✓ Reduction of CO_2 emissions

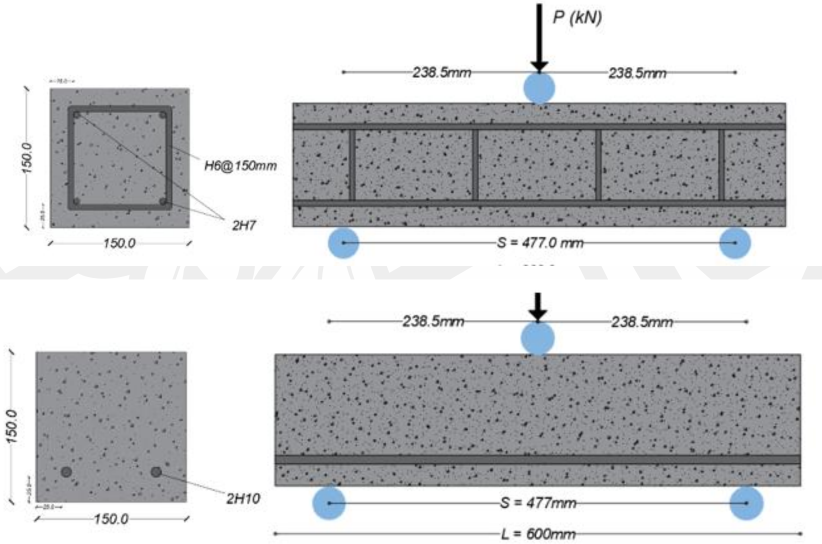
Experimental Procedure and Tests

Mix-code	Mix description
M0	**100% Cement**-N.F.A.-N.C.A.-Water-Plasticizer
MGS	40% Cement-**50% GGBS-10%SF**-N.F.A.-N.C.A.-Water-Plasticizer
MGSCW10	30% Cement-**50% GGBS-10%SF-10% CWP**-N.F.A.-N.C.A.-Water-Plasticizer
M0-P	100% Cement-N.F.A.-N.C.A.-Water-Plasticizer-**1%PET fibres**
MGS-P	30% Cement-50% GGBS-10%SF-N.F.A.-N.C.A.-Water-Plasticizer-**1%PET fibres**
MGSCW10-P	30% Cement-50% GGBS-10%SF-10% CWP-N.F.A.-N.C.A.-Water-Plasticizer-**1%PET fibres**

C40 Mix grade
W/C=0.42



Total of 60 Concrete Samples
+
12 Reinforced Concrete beams



Experimental Procedure and Tests-Continued

Slump Test

Compressive Test

Shrinkage Test

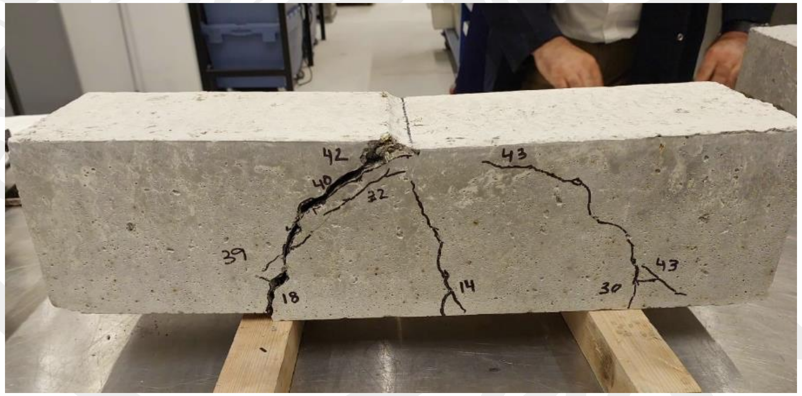
Modulus of Elasticity Test

Tensile strength and crack opening

Cubes: 7, 28 and 60 days
Cylinders, prisms and RC beams: 60 days
Shrinkage: weekly reading

RC beam-No Stirrups

RC beam-With Stirrups



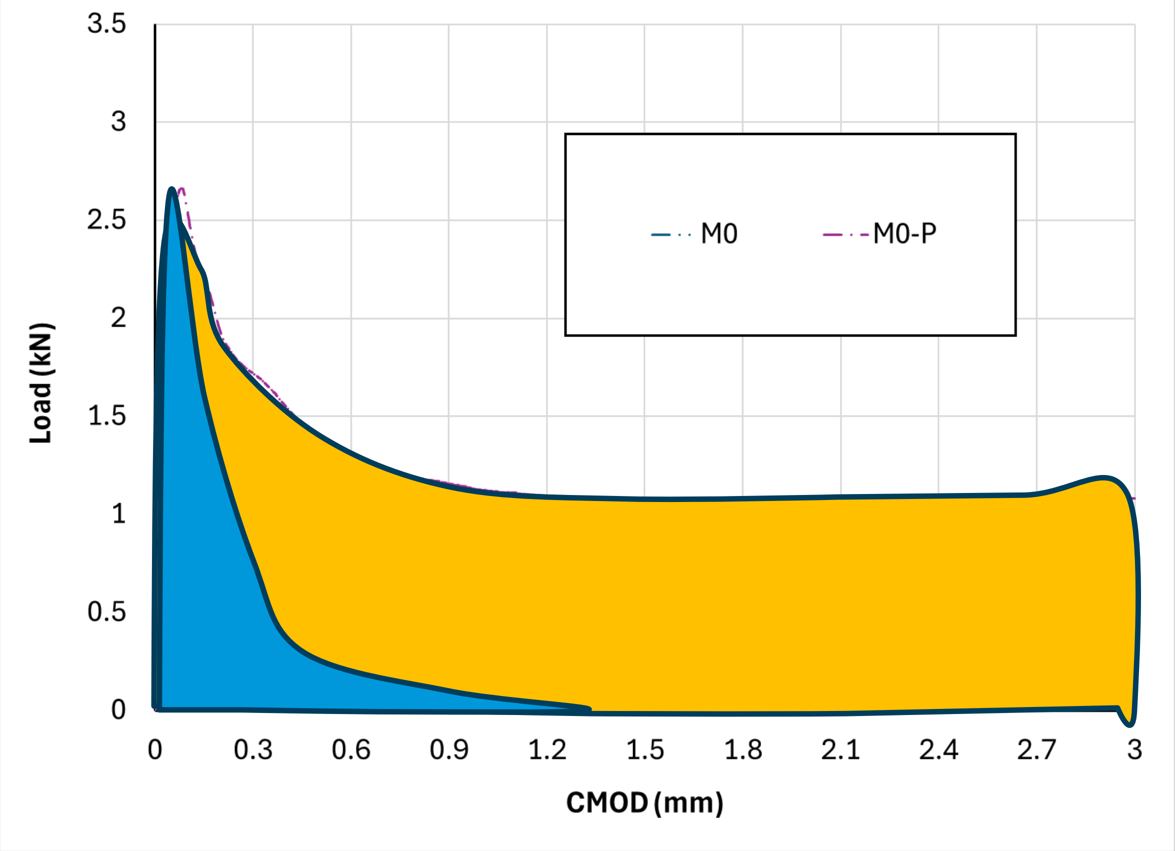
Results-Mechanical Properties

Mix-Code	*Slump (mm)*	*Density (kg/m³)*	$f_{cu,60}$ (MPa)	E_{60} (GPa)	$f_{ct,60}$ (MPa)	*Total post-crack energy (N.mm)*	*Cost (AED)*	*CO_2 Emissions (KgCO2/m3)*
M0	270	2351	47	25	3.2	546	196	438
MGS	240	2385	53	26	3.45	624	210	287
MGSCW10	245	2210	46	24	3.2	281	200	259
M0-P	100	2287	43	25	3	3248	196	438
MGS-P	130	2233	42	25	4.1	2955	210	287
MGSCW10-P	120	2202	41	26	3.35	2820	200	259

Material	*OPC*	*GGBS*	*SF*	*CWP*	*NCA 20mm*	*NCA 10mm*	*Black sand*	*Dune sand*	Water	*Plasticizer*
Unit price in AED/kg or AED/liter	0.265	0.25	0.7	0.0018	0.037	0.038	0.033	0.018	0.007	6

With transportation

Material	*OPC*	*GGBS*	*SF*	*CWP*	*NCA 20mm*	*NCA 10mm*	*Black sand*	*Dune sand*	Water	*Plasticizer*
KgCO2/Kg	0.745	0.121	0.096	0.04	0.082	0.082	0.05	0.05	0.036	2



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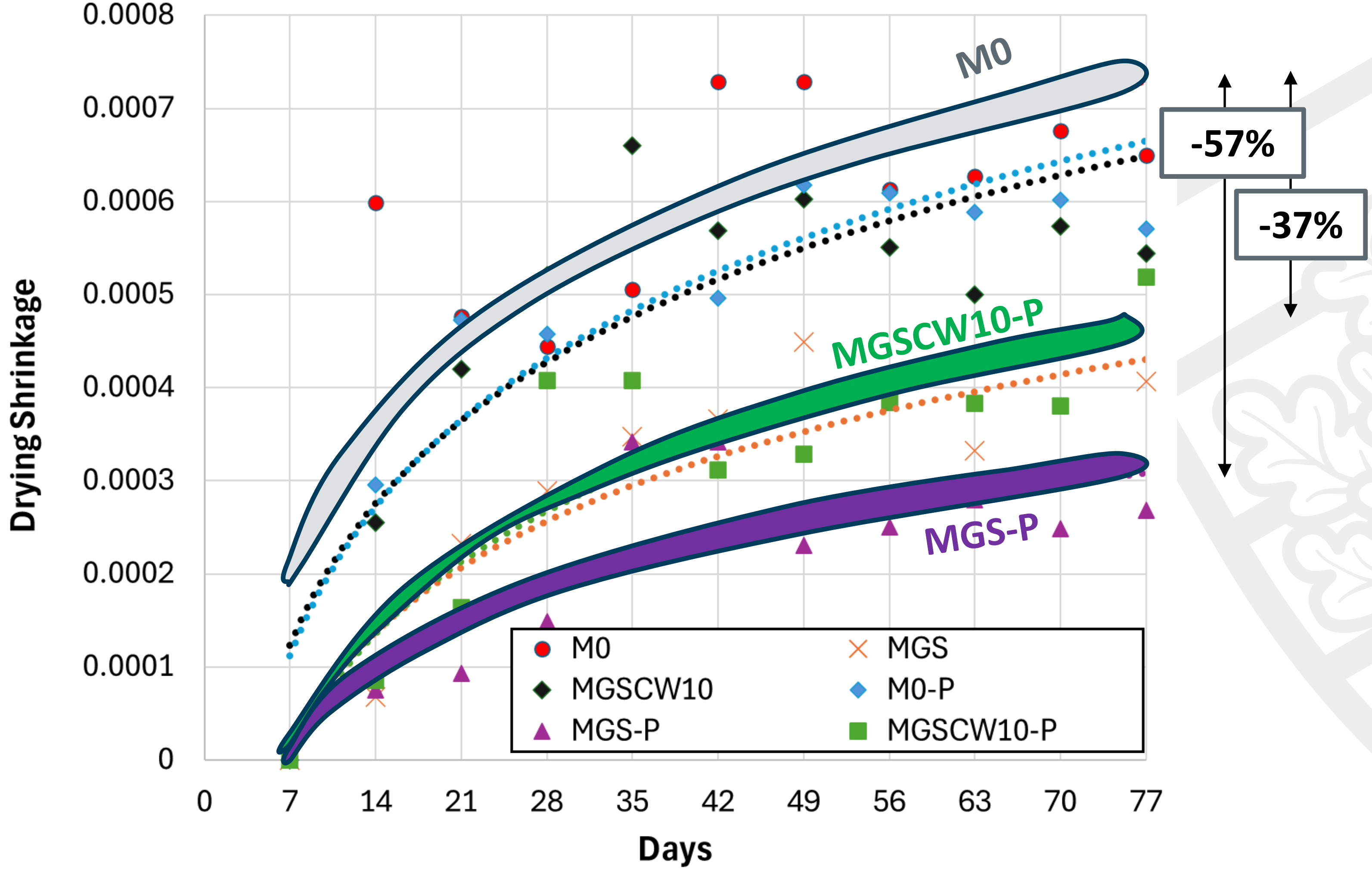
Results-Shrinkage



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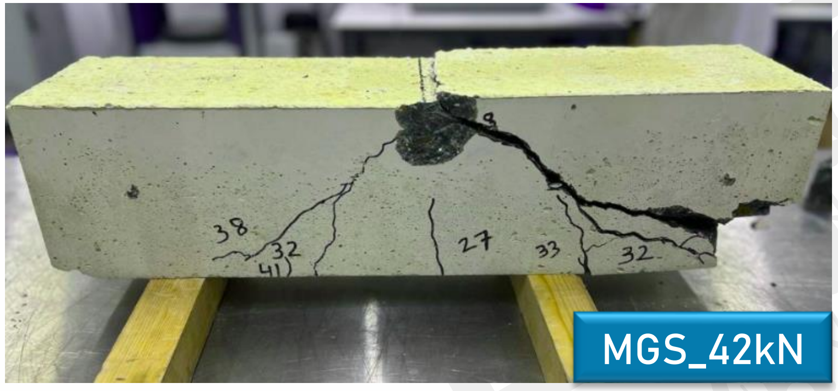
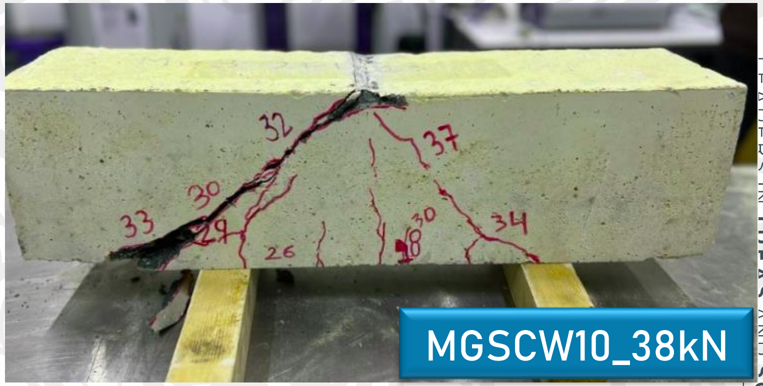
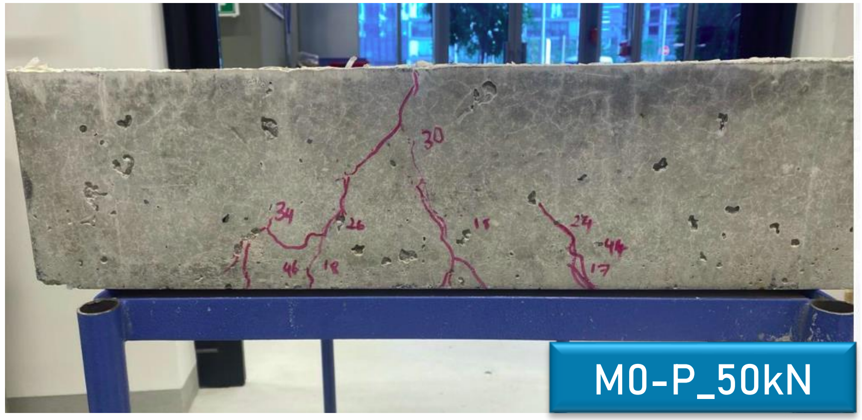
Results-RC Beams-No Stirrups

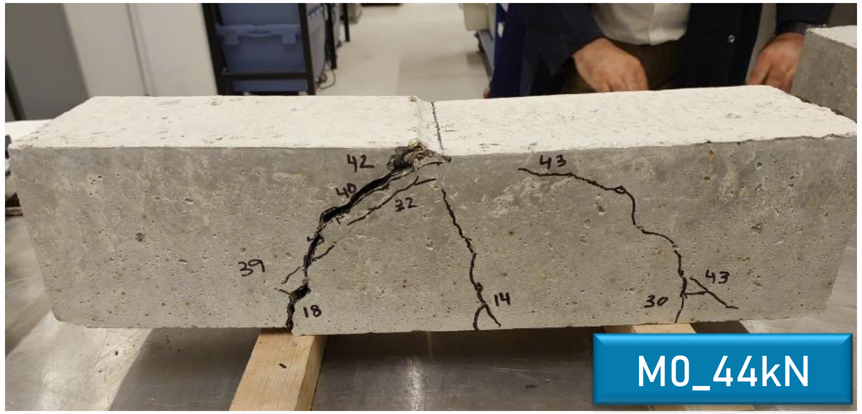


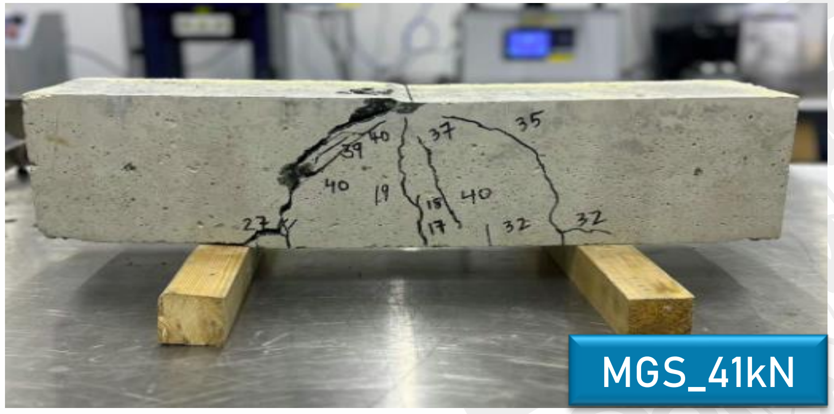


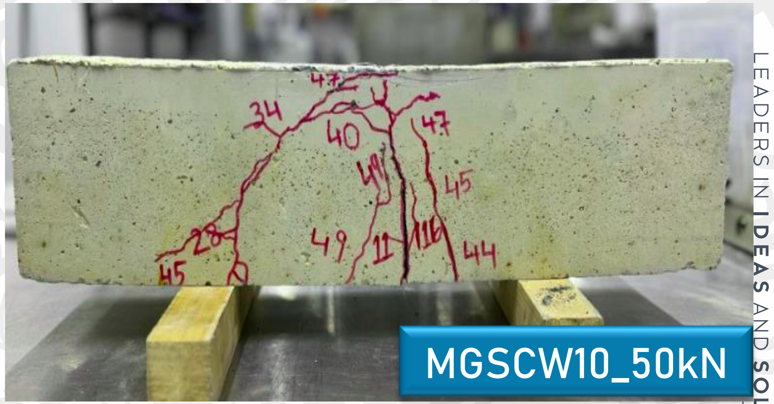


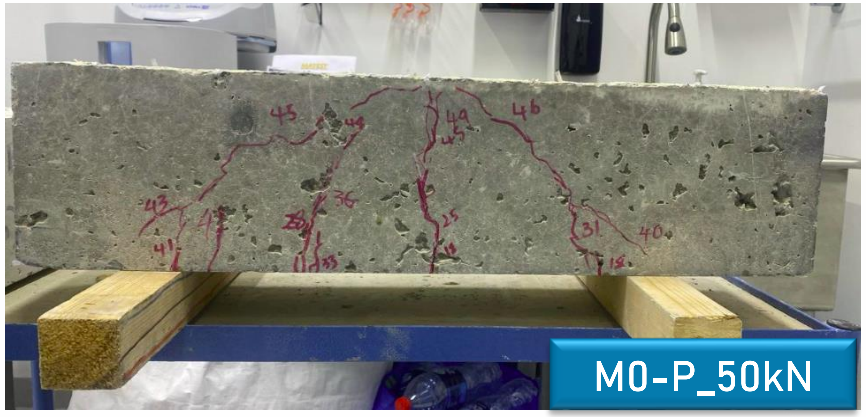
+33% than M0

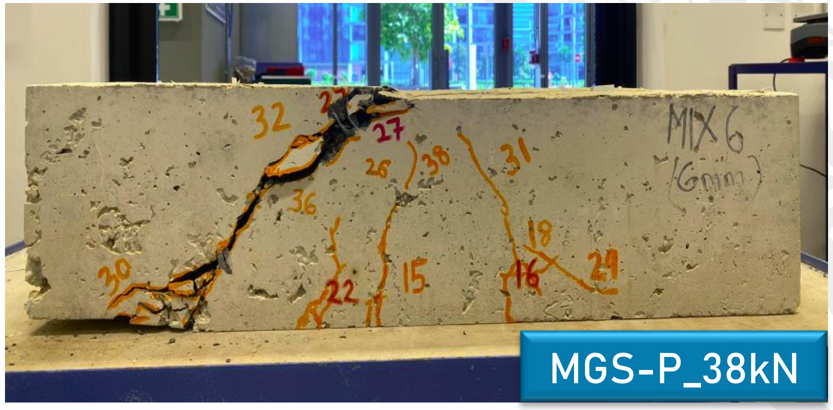
Results-RC Beams-With Stirrups

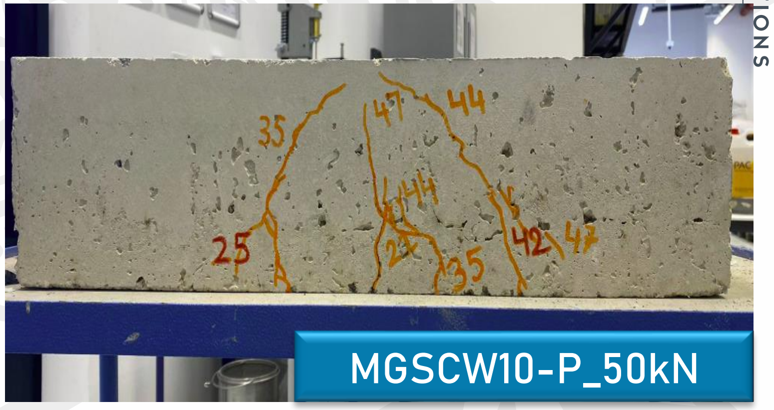

M0_44kN


MGS_41kN


MGSCW10_50kN

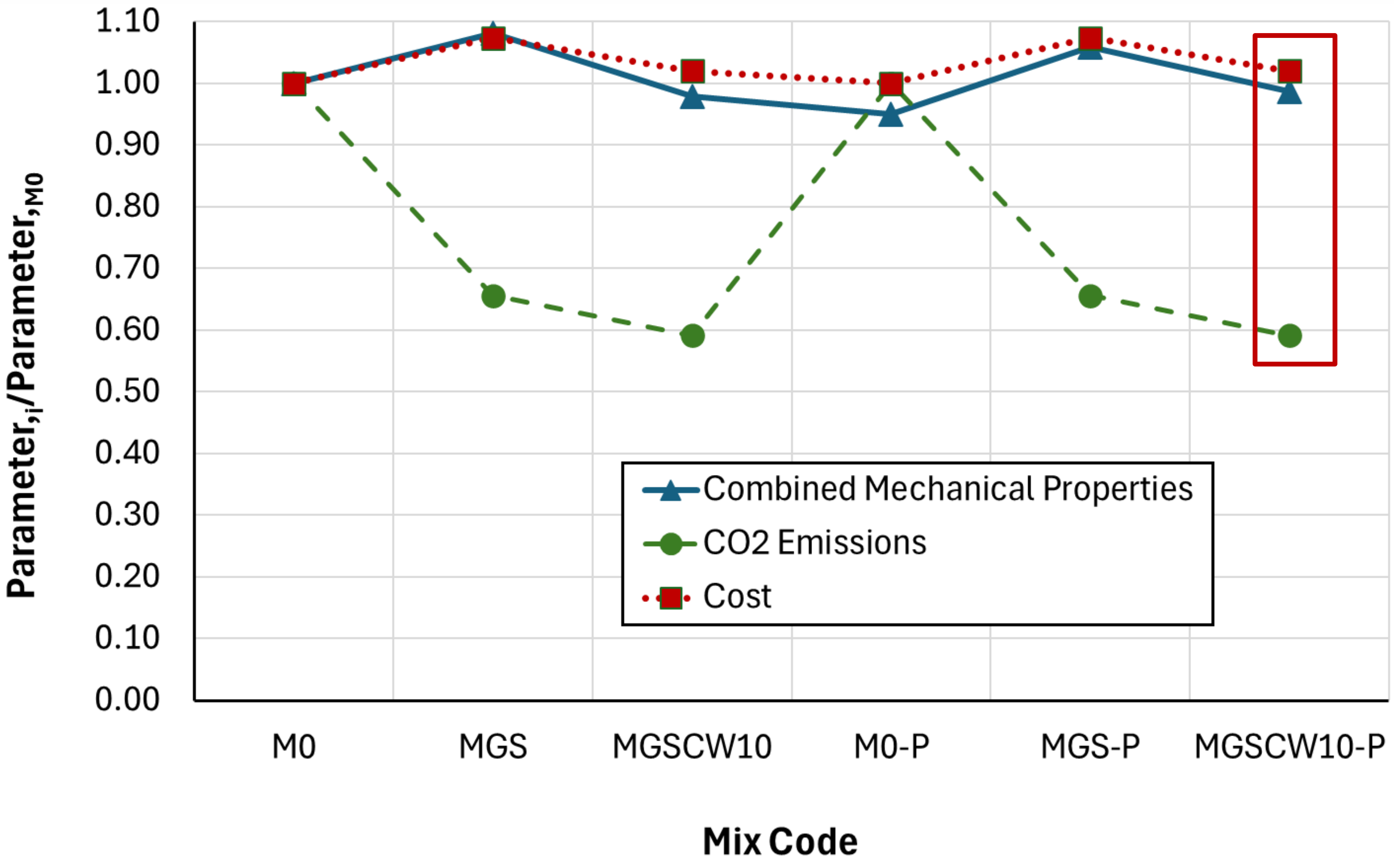

M0-P_50kN


MGS-P_38kN


MGSCW10-P_50kN

Over +14% than M0

Conclusions

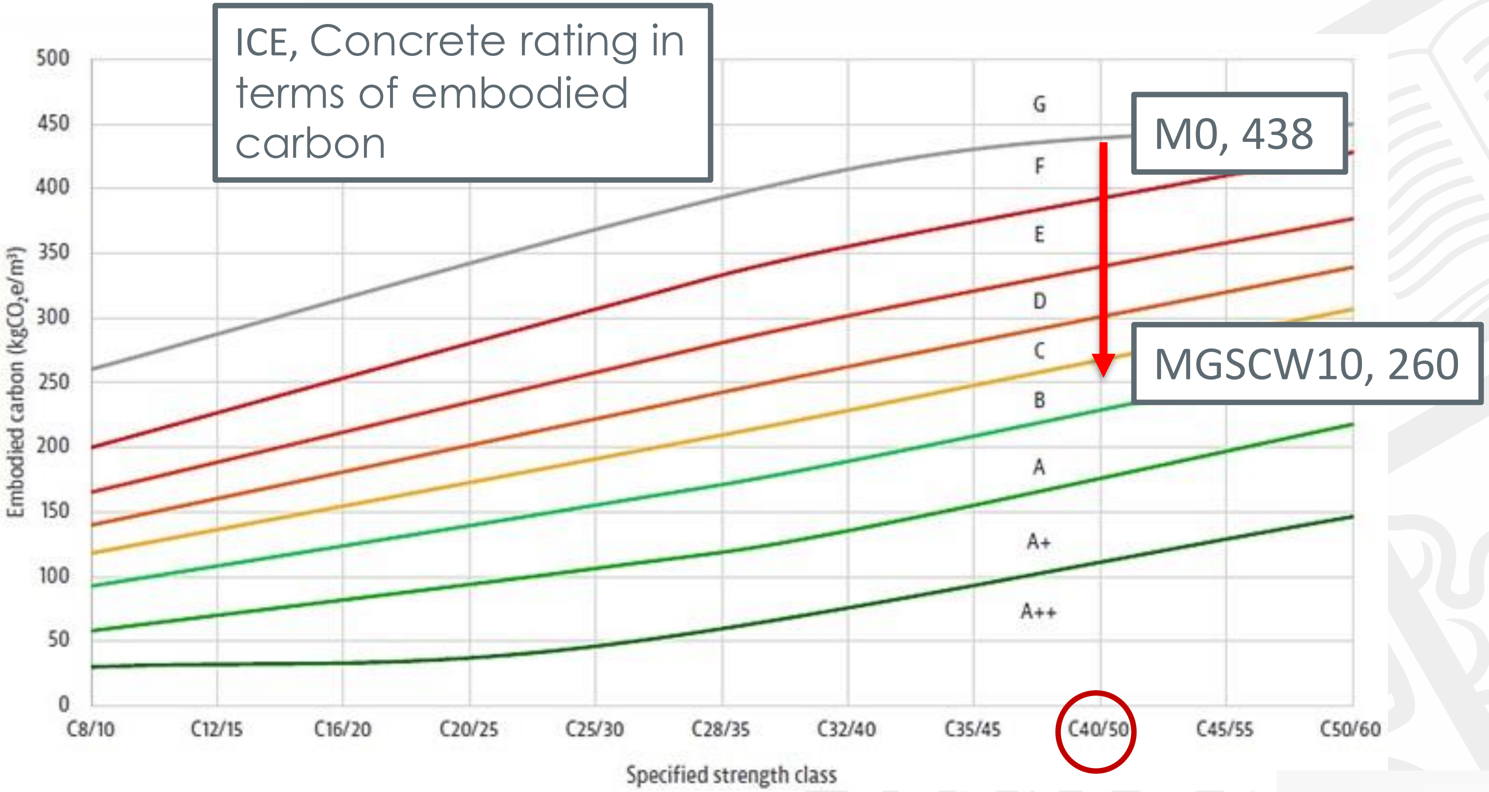


MGSCW10-P

- 70% cement replacement with waste materials.
- 37% less **shrinkage** than M0.
- Over 5 times more **post-crack energy** than M0.
- 33% higher **shear capacity** than M0.
- Over 15% **bending capacity** than M0.

Conclusions

500 bottles (1.5L)/m^3



- Reducing steel reinforcement in concrete. Subsequently, this reduces the cost of RC elements (**Lowering the houses' pricing**) and the CO_2 emissions produced by steel manufacturing.

References

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4. Mouna Y., Batikha M and Suryanto B. (2021). "**Low Carbon Recycled Aggregate Concrete: Roles of Slag and Silica Fume**", ZEMCH International Conference, 26-28 October, Dubai, UAE.

5. Batikha M., Ali S.T.M., Rostami A. and Kurtayev M. (2021). "**Using recycled coarse aggregate and ceramic waste to produce sustainable economic concrete**", International Journal of Sustainable Engineering, 14 (4), 785–799. https://doi.org/10.1080/19397038.2020.1862353

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THANK YOU!