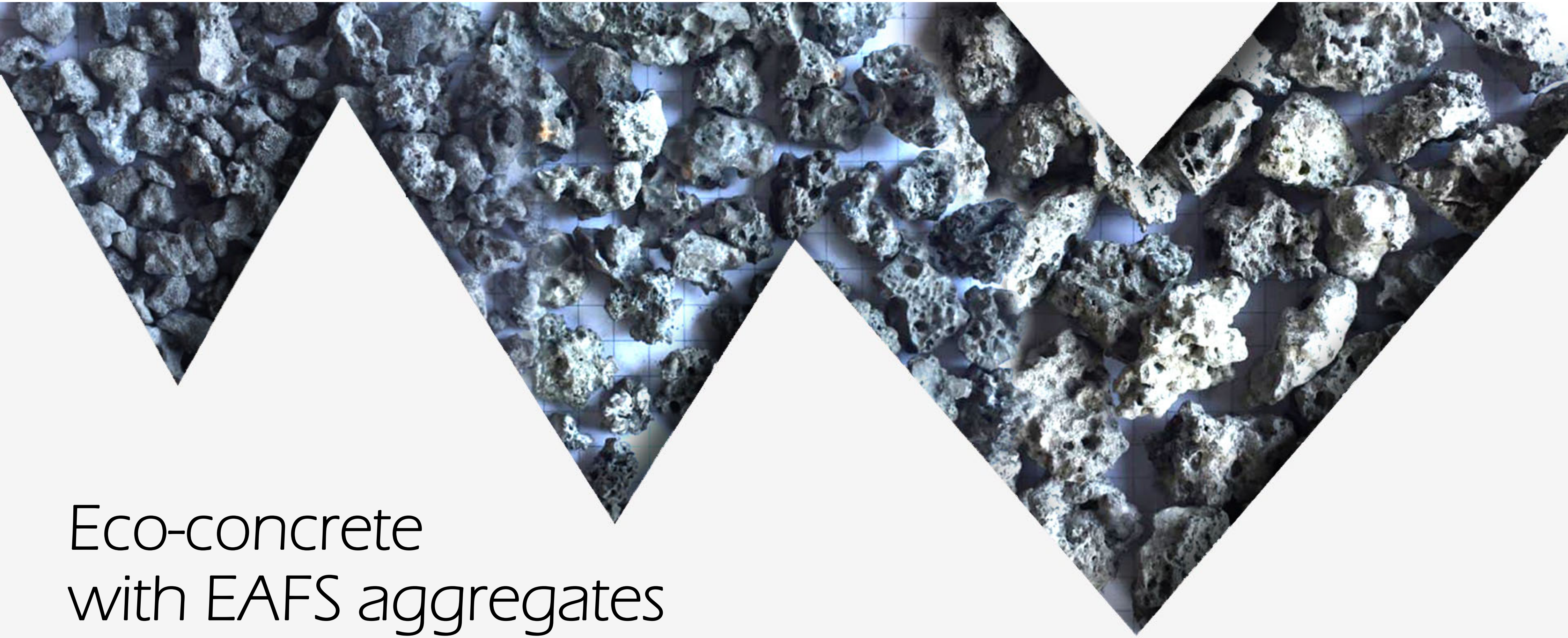

Eco-concrete with EAFS aggregates reinforced with fibers addition

Thesis Supervisor: Prof. Dr. Carlos Thomas

Student: Ali Aghajanian

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- # What is eco-concrete?

Eco-concrete is an environmentally friendly concrete that is made using by-products and industrial wastes such as Steel furnace slag (SFS).

- # What are steel furnace slags (SFS)?

Steel furnace slag is a waste by-product of steel production, SFS is produced with two technology:

  - (BOF): basic oxygen furnace, where iron is converted to steel.
  - (EAF): an electric arc furnace, where steel is produced by melting scrap steel.

- # What are fibers?

Fibers are filaments that are made of different materials, sizes, properties and shapes.

Steel fibers

Plastic fibers

Synthetic fibers

PP fibers

Why eco-concrete?

Eco-concrete by using by-products and industrial wastes, especially the steel industry, helps a lot in controlling and reducing the use of natural resources, including natural aggregates. Also, in this type of concrete, it is tried to use alternative materials to minimize the consumption of cement, the production of which has a great role in the production of greenhouse gases, especially CO_2.

In 2010, India consumed 216 billion tonnes of cement, which is expected to reach 425 billion tons in 2020 and 860 billion tons in 2030. The growth of cement use in concrete is increasing so that in industrialized countries, its consumption is usually between 200 and 600 kg of cement per capita. There are many predictions for the possible growth of cement consumption in the world [1].

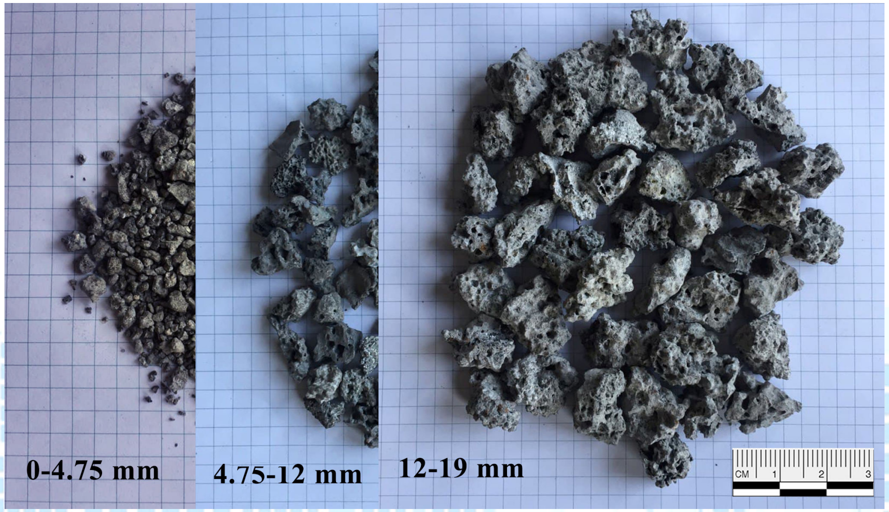
EAF technology is used in about 30% of European carbon and low alloy steel production. In Spain alone, approximately 70% of all steel is produced in arc furnaces (10t/year of EAF steel), which represents about 15% of all European EAF steel (67 t/year) [2–4]. electric arc furnace steel slags (EAFS) is a aggregate that is produced from this industry as a by-product and can have a great impact on the mechanical properties of concrete [5-7].

Also Fibres have different modulus of elasticity and fracture strain, which are considered as the most suitable materials to improve the behaviour of concrete due to their good ductility and high tensile strength. In this regard, extensive research is being done to add fibers to concrete to improve the mechanical properties of concrete [8-10].

Eco-concrete with EAFS aggregates reinforced with fibers addition

This study focus to determine the role and behavior of EAFS aggregates with other concrete components such as micro-silica additives and different types of fibers. In this regard, the role of each component of EAFS aggregates (coarse and fine aggregates) was investigated separately. Then, the performance of this aggregate with micro-silica was investigated and in the last step, the effect of four types of steel, plastic, synthetic and PP fibers with different percentages was investigated.

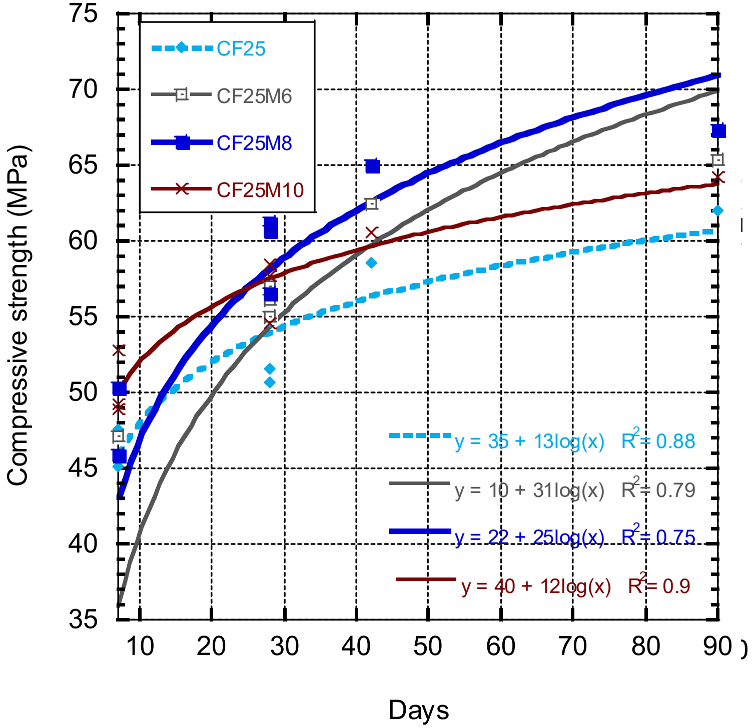
- *Aggregates*



- Fibers

Results

- Compressive strength



Coarse aggregates replacement

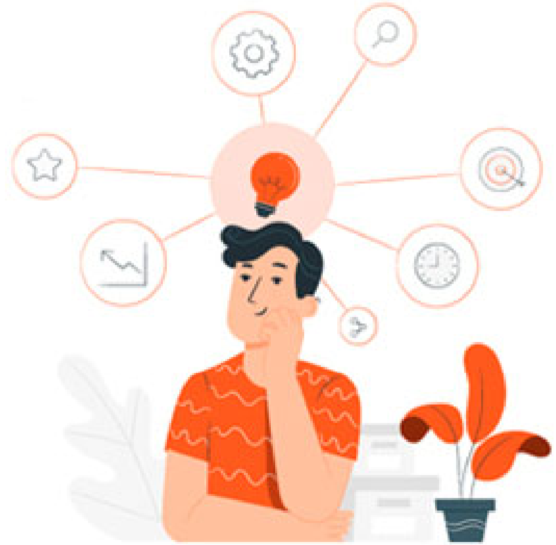
By replacing different percentages of EAFS coarse aggregates, it can be seen that with the increase of this replacement, the compressive strength of concrete significantly increases after 90 days, this resistance is approximately 20 MPa more than the control concrete (D).

Fine aggregates replacement

By replacing different percentages of EAFS fine aggregates, it can be seen that with increasing this replacement, the compressive strength of concrete [illegible] increasing so that after 90 days, this [illegible] gaining strength approximately 18 MPa higher than control concrete (D) [illegible] behavior similar to CF25 concrete compressive strength

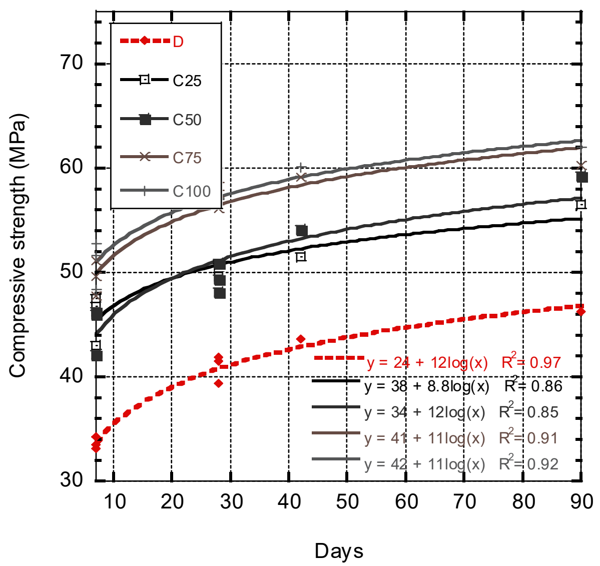
Micro-silica addition

Addition of micro-silica up to 8% [illegible] increases [illegible] resistance [illegible] decreases to the point that by adding 10% micro-silica, this trend is reversed and the compressive strength decreases.

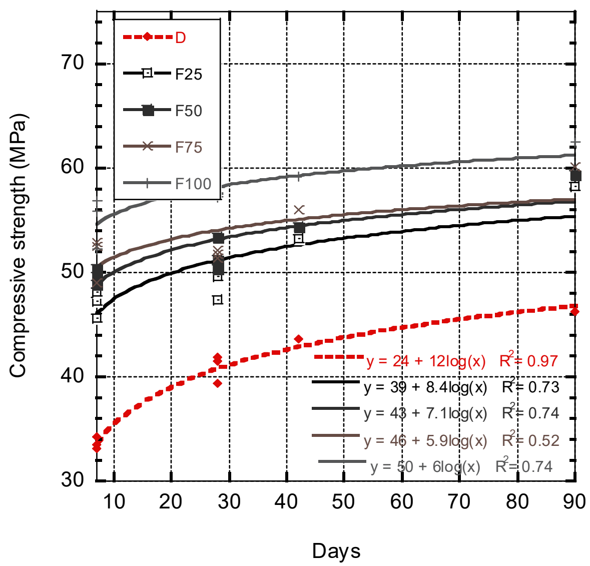


Results

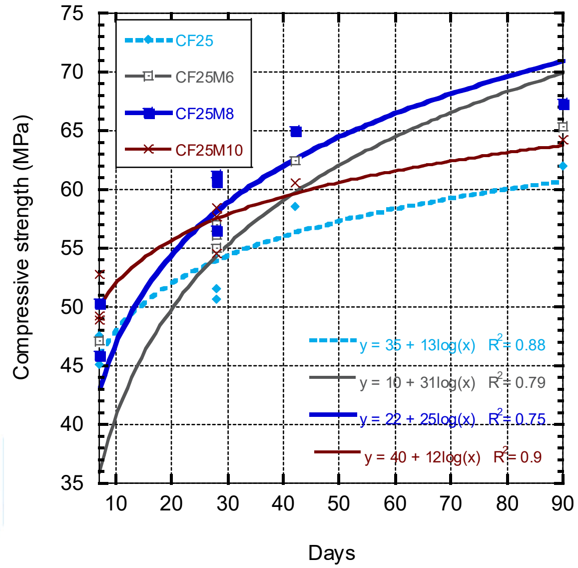
- Compressive strength



Coarse aggregates replacement



Fine aggregates replacement

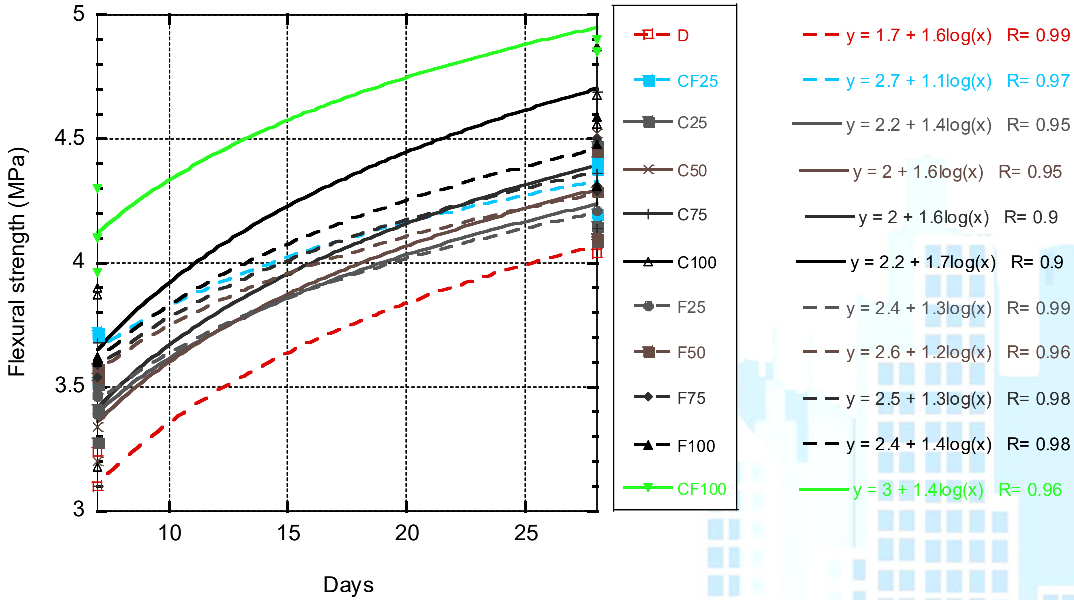


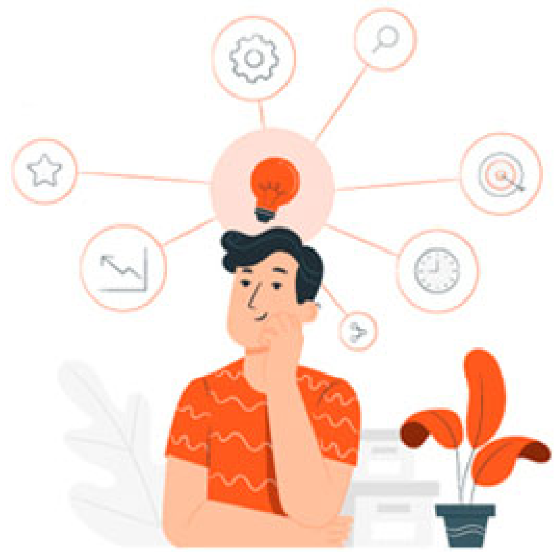
Micro-silica addition

Results

- Flexural strength

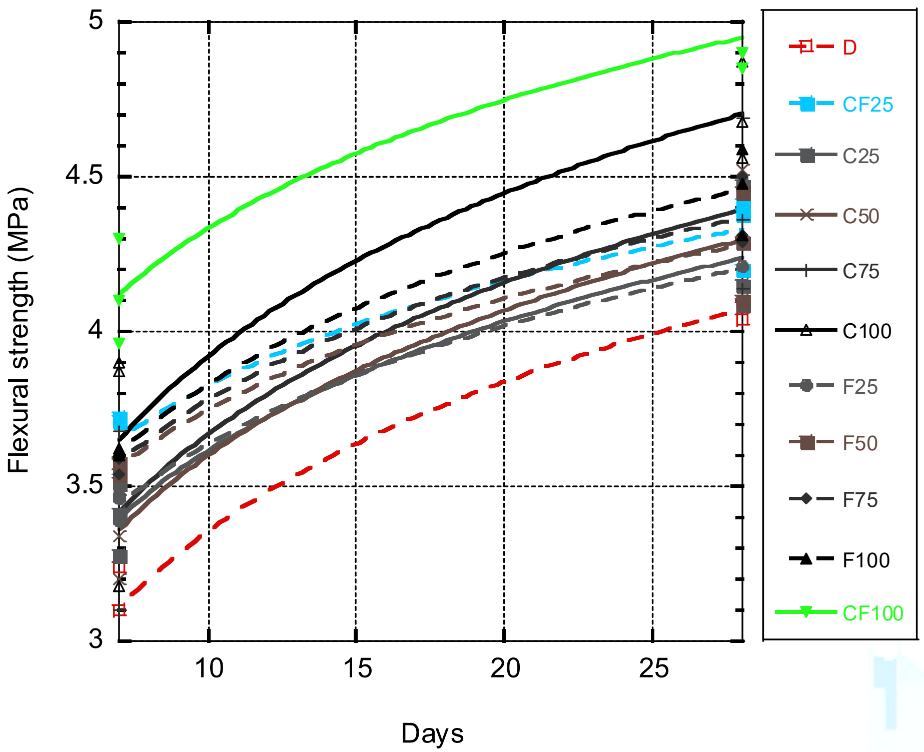
By replacing 100% and 75% aggregate with coarse aggregates of EAFS, a significant change in the bending resistance of the samples is seen, but in other samples, the changes in the flexural strength of the samples are not seen compared to control concrete. Although in the seven-day strength, the results of flexural strength of all samples are close to each other, but it can be clearly seen that with the addition of 75% of EAFS coarse aggregates, after ten days, the process of obtaining flexural strength increases with a high slope. Considering that the mixing design is the same in all samples and the process of obtaining flexural strength in samples with EAFS fine aggregates is continuous and slow, it can be concluded that this type of performance is not related to the type of cement used or other items and all to EAFS coarse It binds in concrete.



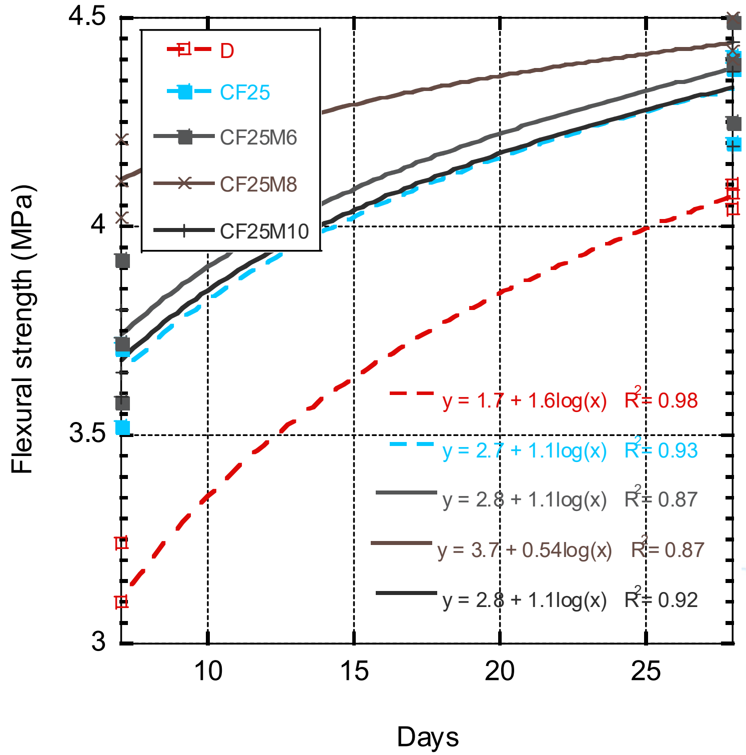


Results

- *Flexural strength*



Coarse and Fine aggregates replacement



Micro-silica addition

Still researching…

- Effects of fibers on compressive strength, tensile and flexural concrete

This research is ongoing and we are currently investigating the effects of fibers on concrete containing EAFS aggregates.

- In the first part, steel fibers with 3, 6 and 9% by volume of concrete have been studied and the results are available.
- In the second part, the plastic fibers were examined with the same percentages as in the previous section and the results are complete.
- In the third part, we start using similar percentages of synthetic fibers in concrete.
- In the final part is to evaluate the performance of PP fibers with similar percentages of other fibers, which has not been implemented yet.

These four categories of fibers are selected for the following reasons:

- Intrinsic rigidity and high flexural tensile strength.
- Making self-consuming fibers from municipal waste.
- Cheapness and availability.
- Minor effect on concrete density.

Future research

Our research team, led by Prof. Dr. Carlos Thomas, is looking to improve the performance of EAFS aggregates to find a way to replace them completely with natural aggregates. In this regard and in the continuation of this research, my study is on:

- The possibility of add-on other by-products such as rice husk ash (RHA) to add to the mixing plan to improve the performance of this aggregates.
- Replacement of the RHA with different percentages of cement.
- Investigation of performance and reaction of Portland cement (OPC) with EAFS aggregates in the Interfacial Transition Zone (ITZ).

Other educational activities

1. Writing chapter "Durability of concrete with rice husk ash addition" of The Structural Integrity of Recycled Aggregate Concrete Produced with Fillers and Pozzolans book under the supervision of Prof. Dr. Carlos Thomas.

2. Writing chapter "Boron-based fillers in concrete" of The Structural Integrity of Recycled Aggregate Concrete Produced with Fillers and Pozzolans book under the supervision of Prof. Dr. Carlos Thomas.

3. Publish the article titled Effect of micro-silica addition into EAFS eco-efficient concrete.
Journal applied science "Structural Behaviour of Concrete Waste Materials" (accepted under review).

4. Publish the article titled Siderurgical Aggregate Cement-Treated Bases and Concrete Using Foundry Sand.
Journal applied science "Advances in Recycling of Construction Materials" (2020).

5. Passing an international course for five months in isfahan university of technology (IUT) in Iran (May-Sep 2020).

6. Passing an international course for five months in Virginia Polytechnic Institute and State University (VT) in the United States (May-Sep 2021).

Reference

[1] T. Jahren, P., & Sui, Concrete and Sustainability, 2017.

[2] Ortega-López V, Fuente-Alonso JA, Santamaría A, San-José JT, Aragón Á. Durability studies on fiber-reinforced EAF slag concrete for pavements. Construction and Building Materials 2018;163:471–81. https://doi.org/10.1016/j.conbuildmat.2017.12.121.

[3] Yearbook SS. World Steel Association: Brussels 2014.

[4] Yüksel İ. A review of steel slag usage in construction industry for sustainable development. Environment, Development and Sustainability 2017;19:369–84. https://doi.org/10.1007/s10668-016-9759-x.

[5] Maghool F, Arulrajah A, Du Y-J, Horpibulsuk • Suksun, Chinkulkijniwat A. Environmental impacts of utilizing waste steel slag aggregates as recycled road construction materials n.d. https://doi.org/10.1007/s10098-016-1289-6.

[6] Wang G, Wang Y, Gao Z. Use of steel slag as a granular material: Volume expansion prediction and usability criteria. Journal of Hazardous Materials 2010;184:555–60. https://doi.org/10.1016/j.jhazmat.2010.08.071.

[7] Shelburne WM, Degroot DJ. The use of waste & recycled materials in highway construction. Civil Engineering Practice 1998;13:5–16.

[8] Blanco A, Pujadas P, De La Fuente A, Cavalaro SHP, Aguado A. Assessment of the fibre orientation factor in SFRC slabs. Composites Part B: Engineering 2015;68:343–54. https://doi.org/10.1016/j.compositesb.2014.09.001.

[9] Orbe A, Losada R, Rojí E, Cuadrado J, Maturana A. The prediction of bending strengths in SFRSCC using Computational Fluid Dynamics (CFD). Construction and Building Materials 2014;66:587–96. https://doi.org/10.1016/j.conbuildmat.2014.06.003.

[10] Khayat KH, Roussel Y. Testing and performance of fiber-reinforced, selfconsolidating concrete. Materials and Structures/Materiaux et Constructions 2000;33:391–7. https://doi.org/10.1007/bf02479648.

Thank you
for your accompanying and attention.