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A Review on Ecofriendly Concrete Using Non-Biodegradable Materials

Srujan Varma Kaithoju[1*], Dr. B. Dean Kumar[2]
[1*]Research Scholar, Jawaharlal Nehru Technological University, Hyderabad, Telangana, India. ORCID: https://orcid.org/0000-0002-1854-2823
[2]Professor, Department of Civil Engineering, Jawaharlal Nehru Technological University, Hyderabad, Telangana, India. , ORCID: https://orcid.org/0009-0000-6859-0703
***Corresponding Author:** Srujan Varma Kaithoju,
[*]Research Scholar, Jawaharlal Nehru Technological University, Hyderabad, Telangana, India. ORCID: https://orcid.org/0000-0002-1854-2823

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ABSTRACT

The increasing accumulation of non-biodegradable waste has emerged as a global environmental concern, necessitating innovative reuse strategies. This review explores the integration of non-biodegradable materials, such as recycled tyre crumb, plastic aggregates, and hybrid fibres, into concrete production to develop sustainable alternatives to conventional concrete. Special emphasis is placed on the role of magnetic water technology, which enhances concrete's hydration efficiency and mechanical properties. The review critically assesses recent studies involving Scanning Electron Microscopy (SEM), microstructural analysis, and the combined use of treated waste materials and advanced water treatment techniques. Results demonstrate improved compressive, tensile, and flexural strengths, reduced water and admixture consumption, and enhanced durability of eco-concretes. This paper identifies promising approaches and research gaps, aiming to guide future developments in sustainable construction materials.

Key Words: Sustainable Concrete, Eco-friendly Concrete, Non-Biodegradable Plastics, Magnetic Water Concrete, Recycled Concrete aggregate, Recycled Tyre Crumb.

1. INTRODUCTION

Since 1950, global plastic production has increased at a compound annual growth rate of 8.4%; in 2018, annual plastic production was 360 million tonnes, and it is anticipated to hit 500 million tonnes by (Bai et al.,2019).
Lebreton et al.,2018 reported on the shocking axioms on plastic waste that has accumulated in the "Great Pacific Garbage Patch", a model calibrated with data from multi-vessel and aircraft surveys predicted that at least 79 thousand tonnes of plastic waste is floating on the ocean that covers 1.6 million km square is a figure three times that of France.

Magnetised water has emerged as widespread in a variety of fields including construction. Due to the fact that water is diamagnetic, when it is subjected to a magnetic field intensity for a particular duration of time, the water molecules re-orient in a much smaller size. Normal water molecules possess a bond angle of 104 degrees, which when magnetised narrows to a smaller angle, making it more soluble and efficient, and this magnetization ultimately helps to declutter huge clusters of molecules into smaller sets of molecules. (Aiswarya Menon et al., 2019)

It is predicted that thousands of millions of tyres come to the end of their functional life each year, in addition to the 5000 million expected to be dumped on a regular basis by 2030. Till date, only a small portion of it has been recycled, and millions of tyres have been stacked, landfilled, and buried. Tyre trash disposal has become an immense environmental issue and a serious potential danger, thus one viable solution incorporating scrap rubber is by embedding it in concrete (Sofi et al., 2018)

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Due to the fact that the tensile strength of concrete is considerably less than its compressive strength, crack propagation might occur more quickly. Concrete's tensile strength is only roughly ten percent of compressive strength, and it fractures when applied with tensile stresses. fibres like polypropylene reduces early drying shrinkage by enhancing concrete' pulling strength and bridging the cracks. Because polypropylene fibre has a low Young's modulus, it cannot prevent crack formation and propagation at high stress levels, but it can bridge massive cracks (Toutanji et al., 1999, Qian et al., 2000).

2. SEM ANALYSIS OF ECOFRIENDLY CONCRETE CONTAINING ARTIFICIAL AGGREGATES

(Alireza Kashani et al., 2018) stated that the use of recycled tyre crumb (RTC) in concrete can lead to significant strength loss due to weak adhesion between cement and rubber. Five RTC surface treatment methods were used to mitigate this loss, with all methods yielding strength improvements between 27% and 56%. Silica fume coating, a new treatment method, improved strength due to better adhesion between RTC and mortar. SEM-EDS analysis showed the formation of low Ca/Si gel in mortar-rubber interface. Sulphuric acid treatment resulted in etching of the surface and possible formation of polar zinc sulphate crystals. Silica fume coating offers a cost-effective solution. However, adopting treatment may be more difficult due to potential safety and environmental risks

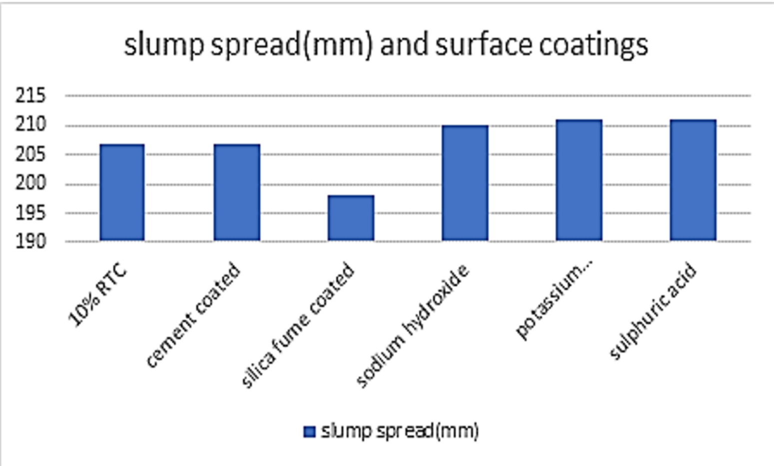

Fig1. Workability of cement Motors with treated RTC based on the mini slump test (Alireza Kashani et al., 2018)

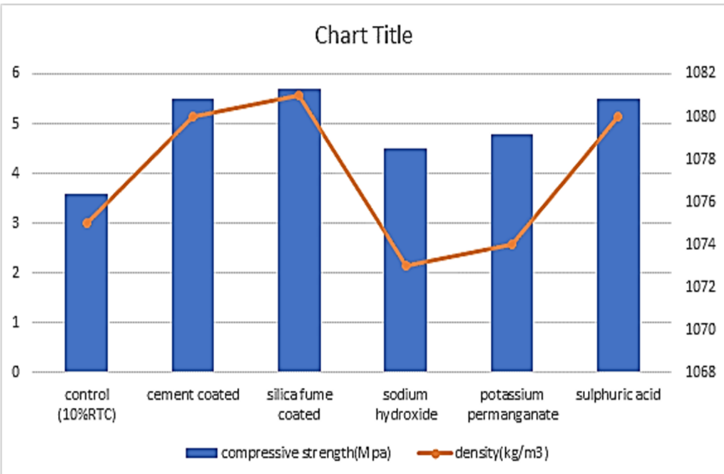

Fig 2. Compressive strength and density of concrete foam samples. (Alireza Kashani et al., 2018)

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(Petros Petrounias et al.,2018) investigated the impact of aggregate type on concrete strength and durability. It focuses on the petrographic characteristics and physio-mechanical properties of six aggregate rocks from central Macedonia. The study found that ultramafic rocks are not suitable to make concrete due to high alteration and serpentine, while mafic and granodiorite were suitable. The strength, abrasion resistance and attrition of aggregates were critical factors in determining concrete's quality. Petrographic analysis can help engineers to determine the best strategy for development of concrete with alternate aggregates.

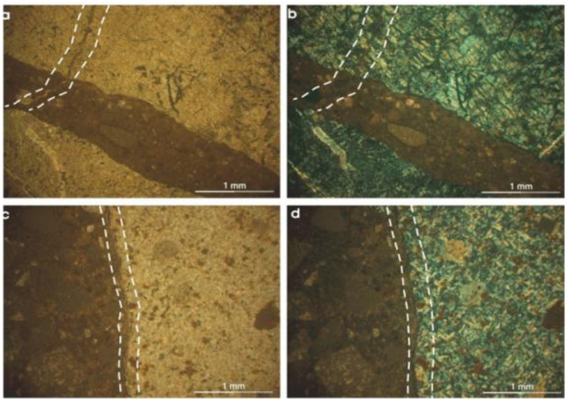

Fig 3. Photomicrographs (a, b) loss of material between diorite aggregate grains and cement paste, (c, d) trans granular microcracks of Serpentinite Aggregate grains and cement paste (Petros Petrounias et al.,2018)

(Alqassim et al.,) proposed the lack of research on the effects of heat on cementitious materials in the United Arab Emirates. The study used laboratory-based tests to evaluate the effects of temperature and heat on matured concrete. The results showed that the maximum weight loss occurred in the range 650-700°C, mainly due to the decarbonation of calcium carbonate. The study also found that the beginning temperature for dehydroxylation of the reformed portlandite was <400°C for all samples pre-heated to 900°C.

Compressive Strength (MPa)	Mix		
	A	B	C
7 days	42.9	33.4	26.7
28 days	50.5	42.7	43.4
90 days	65.1	53.9	53.5
Treatment Temperature (°C)	**Relative Strength (%)**		
150	88.5	95.6	102.9
300	120	117.7	119.3
600	93.4	98	119.3
900	18	20.6	19.3

Table 1. Strength gain Vs Curing time& Relative strength (%) (Alqassim et al.,)

(M.B. Leite et al.,2015) investigated the microstructure of recycled concrete using synchrotron microtomography and Scanning Electron Microscopy (SEM) analysis. It assesses the influence of using Recycled Concrete Aggregate (RCA) upto 50% of total concrete making aggregates and water absorption compensation on the concrete microstructure. study found that RCA in the Saturated, surface dry & initial moisture condition is suitable for producing recycled aggregate concrete, with properties comparable to conventional concrete. However, the study suggests reducing RCA rates, changing mixing sequences, using alternative coating mechanisms, or increasing concrete mixture time to control macropore generation.

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(Yu Song et al.,2020) performed the standard petrography test method for measuring air voids in concrete requires a meticulous examination of sample phase composition under a stereomicroscope. However, using deep learning algorithms with CNN have achieved extraordinary performance on image testing. Their study investigated the suitability of using CNN for concrete segmentation without colour treatment. The CNN method proved as strong medium to process a wide range of concretes, including those not involved in model training. CNN can be a powerful tool for concrete petrographic analysis, opening up new possibilities for concrete research. (Sean Beauchemin et al.,2012) conducted the inter lab study on recycled concrete aggregate (RCA) revealed significant expansion differences after 14 and 28 days. Their research suggested using accelerated mortar bar test to check the difference in expansion fo aggregates sourced from different medium.

(Chiara Telloli et al., 2021) performed experimentation on different concrete mixes containing crushed aggregates, rounded aggregates, porphyry aggregates, the mechanical strengths showed a better results when crushed aggregates were used, even better results are achieved upon using porphyry aggregates due to the rought surface texture. (Fernandes et al.,2015) Worked on concrete deterioration which can be caused by alkali-aggregate reactions, also involve reactive forms of silica in aggregates. This study of mafic volcanic rocks from two quarries revealed the presence of light-brown volcanic glass and alteration minerals, such as clay minerals. The damaging reaction in airport pavement involved abundant volcanic glass in aggregate particles, with varying colour, texture, and composition. The study also found a transient phase between chlorite, smectite, and zeolite group minerals, which differed from the alkali-silica gel typically formed by alkali silica reaction.

3. MAGNETIC WATER CONCRETE

(Malathy Ramalingam et al., 2022) developed a new technology using magnetic-field-treated water (MFTW) to improve the properties of concrete. In their research the water particles are charged reducing the hardness and enhancing the strength of concrete. The MW60 mix, which was tested under different exposure periods, showed improvements in properties of hardened concrete. The strength of MFTW increased up to 25% approximately when compared to conventional concrete, and the four weeks strength of the conventional was achieved at three weeks after casting by curing with the magnetic water. Utilizing magnetic water for concrete mixing improved the physiochemical properties of fresh and hardened concrete with minimal water usage and curing period.

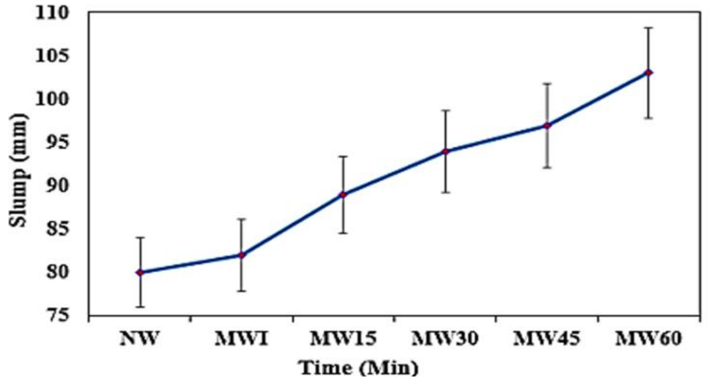

Fig 4. Slump value of concrete with NW and MW at different exposure times (Malathy Ramalingam et al., 2022)

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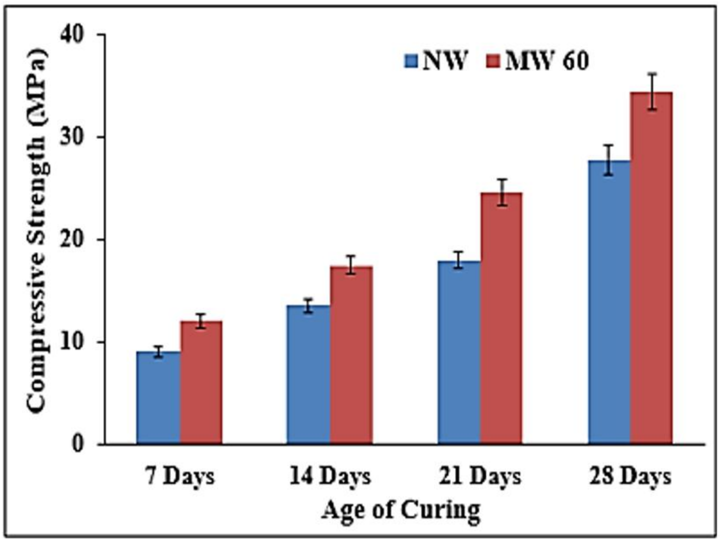

Fig 5. compressive strength of NWC and MWC (Malathy Ramalingam et al., 2022)

(R. Dharmaraj et al.,2021) Worked on the usage of magnetized water in concrete production, focusing on its mechanical and durability properties. Four combinations of potable water and magnetic water were tested, revealing that using magnetic water enhanced the concrete's properties and durability. The results showed that concrete with magnetized water showed 14.86% greater compressive strength, increased tensile and flexural strength, and reduced chemical admixture consumption. The study also found that magnetized water curing improved the concrete's properties over time.

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Table 2. Slump values and workability of concrete (R. Dharmaraj et al.,2021)

Mix	Slump Value (mm)	Workability
Conventional Concrete	53	Medium Workable
Magnetised Water Concrete	76	Highly Workable

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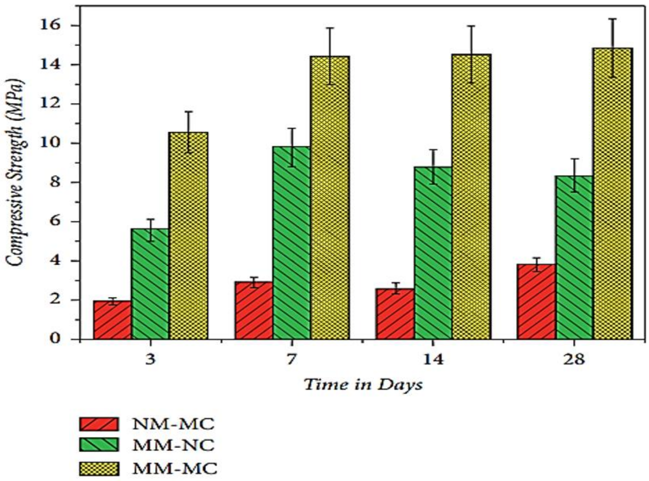

Fig 6. Comparison of the compressive strength of different mixtures. (R. Dharmaraj et al.,2021)

(A. S. Adithya Saran et al., 2017) investigated on the performance and microstructural behaviour of sustainable high performance concrete by replacing conventional concrete making materials with alternate materials like recycled concrete aggregates, fly ash and silica fume, their investigation revealed a better results when alternate aggregates are used high performance concrete, although some of the mixes are not suitable as high performance concrete, they can be used for normal concreting works.

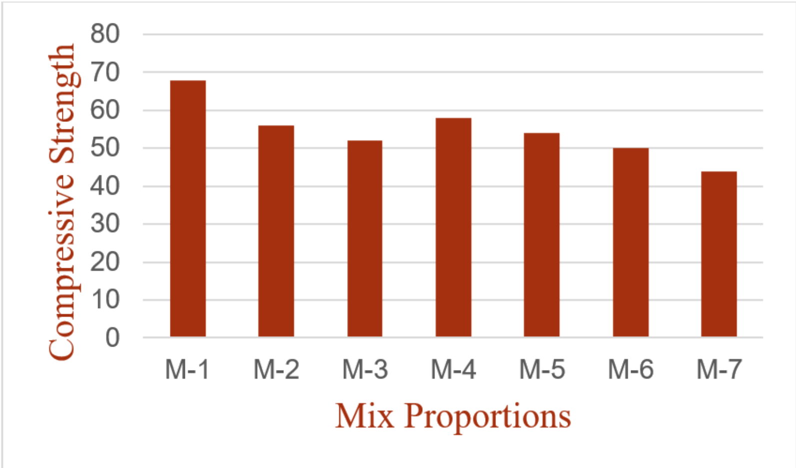

Fig 7. Compressive Strength of concrete after 28 days curing (A. S. Adithya Saran et al., 2017)

(Saeid Ghorbani et al.,2018) investigated the impact of magnetized water on the mechanical and durability of concrete block pavers. Five mixes were prepared with water flowing through a permanent magnetic field. Results showed a significant effect on compressive strength, split tensile strength and flexural strength. Magnetized water also enhanced the resistance to sulfuric acid attack and decreased water absorption. The study found that using magnetized water resulted in a denser structure and lower cost.

(Ashish Dagadu Amate et al.,2020) investigated the impact of magnetized water on concrete's workability and compressive strength. The water, prepared using an electromagnetic field and a permanent circular magnet, was passed through a magnetic field for 180 minutes. The results revealed that using magnetic water improved concrete's mechanical properties, increasing compressive strength and workability while decreasing absorption and seepage. This could lead to increased water-cement ratio and reduced concrete cost. (Mohammed Abdel-Magid et al.,2017) Examined the effect of magnetized water on concrete workability and compressive strength. Four concrete mixes were prepared using a magnetic treatment system. The study found that magnetized water enhances concrete workability by up to

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400%, reduces cube weight by 3%, increases compressive strength by 10%, and reduces cement content by up to two thirds without affecting mechanical strength. The research suggests us that magnetized water can improve concrete quality and cost.

(Raul Fernandez et al.,2013) Studied the interaction between concrete and compacted FEBEX bentonite on a 7-year column. A SEM-EDX study confirmed alkaline diffusion, with calcite and calcium silicates (aluminates) hydrates identified. X-Ray Diffraction (XRD) and Fourier Transform Infrared spectroscopy (FTIR) were used to confirm spatial reaction front results and update the nature of mineral phases formed. Brucite, calcite, and aragonite were identified at the saline water-concrete interface. XRD profiles match the presence of a low Ca-anorthite C–A–S–H phase, but the presence of 11Å-tobermorite cannot be neglected. Additional spectroscopic techniques and further SEM(scanning electron microscopy) or TEM(transmission electron microscopy) observations are needed to fully characterize the alkaline alteration of bentonite. (Mehmet Emiroglu et al.,2007) Examined the ITZ of concrete prepared with rubber reinforcement procured from waste vehicle tires. The research investigates the bonding characteristic and fracture analysis between rubber tires and cement matrix. Results show that rubberized concrete has lower mechanical strengths compared to traditional concrete. However, the addition of waste tire rubber does not negatively affect the C-S-H formation in concrete.

(Sushant Waghmare et al., 2020) investigated the impact of components on mechanical properties. Microstructure analysis of concrete specimens is done using methods like XRD, SEM and Energy Dispersive Spectroscopy, Failure mechanisms and unidentified ingredients in cement motor. SEM has helped scientists and non-scientists to understand the world beyond the limits of understanding. The higher resolving power of SEM and EDX Microprobe expands the capabilities to study concrete microstructure and deterioration mechanisms. Normally water consists of closely packed and strong hydrogen atom bonds. Two hydrogen atoms are present in water molecule, and they are formed as large clusters, When the magnetic field is induced into the water this magnetic field will break the large clusters into small ones and the bonds between the hydrogen atoms will be weakened as a result of the activity of the water molecules will be increased and hence it impacts the concrete positively.

4. HYBRID FIBRE REINFORCED CONCRETE

(Pramod Kolase et al., 2022) explored the use of magnetized water in concrete, revealing that it improves workability and strength compared to non-magnetized water. The water has higher pH, lower hardness, and is more workable than normal concrete. There is an enhancement in density of concrete with age and reduction of density with percentage of fibre. Magnetic water concrete is durable, with a decrease in compressive strength 1.71% less than normal concrete after acid and sulphate attacks. Test shows that the concrete using magnetized water enhances workability than that of concventional concrete. Loss in compressive strength of MWC is 2.12% less than that of NWC after sulphate attack. Loss in strength due to sulphate attack is 17.5% more as compared to acid attack

(Mix Tariq Alkhrissat et al.,) Investigated the use of magnetic-field-treated water (MFTW) in improving concrete properties. It was found that improvisation of water used in concrete can be done by enhancing the magnetic field exposure. The MW0.9 mix increased workability, compressive strength, and splitting tensile strength by 9.2%, 32.9%, and 34.2%, respectively, compared to normal water concrete. The study also found that increasing magnetization improved water physiochemical characteristics, improved concrete workability, reduced TDS and electrical conductivity (EC) values, and improved cement hydration and workability-related parameters

Mix Id	Water Type	Magnetic Field (Tesla)	Percentages of fibres (%)
NW	Magnetised	0	0
MW0.3	Magnetised	0.3	0.3
MW0.6	Magnetised	0.6	0.6
MW0.9	Magnetised	0.9	0.9

Table 3. Mix details for magnetic fields @ Water (155kg/m^3), CA (1200kg/m^3), FA (800kg/m^3),Cement (420kg/m^3) (Mix Tariq Alkhrissat et al.,)

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(Aiswarya Menon et al., 2019) Explored the production of Geopolymer Concrete (GPC) using Magnetized water and Recycled Tyre Steel Fiber (RTSF) as a constituent material. The study aims to produce GPC with alkali activators and introduces water magnetization over normal water. The study analyses the impact of magnetized water and RTSF on GPC's workability, durability, compressive and split tensile strength at different molarities of alkali activator (AA) solution. The optimum magnetization is achieved when water is magnetized for 6 hours. The research investigated the effects of magnetized water and recycled tire steel fibre on Geopolymer concrete properties. Results showed that magnetized GPC and hybrid GPC showed greater compressive and split tensile strength with increased molarity, but reduced workability with increased morality. Magnetized GPC had higher workability due to higher solubility and water availability

Mix	Designation
GPC	Normal GPC with 8M
GPC1	4 hours magnetised GPC 8M
GPC2	6 hours magnetised GPC 8M
GPC3	8 hours magnetised GPC 8M
GPC2-0.25	6 hours magnetised GPC 8M 8M0.25 RTSF
GPC2-0.5	6 hours magnetised GPC 8M 8M0.5 RTSF
GPC2-0.75	6 hours magnetised GPC 8M 8M0.5 RTSF
GPC	Normal GPC with 12M
GPC1	4 hours magnetised GPC 12M
GPC2	6 hours magnetised GPC 12M
GPC3	8 hours magnetised GPC 12M
GPC2-0.25	6 hours magnetised GPC 8M 12M0.25 RTSF
GPC2-0.5	6 hours magnetised GPC 8M 12M0.5 RTSF
GPC2-0.75	6 hours magnetised GPC 8M 8M0.75 RTSF

Table 4. Mix Designs adopted (Aiswarya Menon et al., 2019)

(Mohammad Hajforoush et al.,2020) Proposed that by applying a homogeneous magnetic field (HMF) to steel fibre reinforced concrete (SFRC) specimens increased mechanical strength by 18-16% and flexural toughness by 7% compared to specimens without magnetic treatment. However, HMF exposure decreased water absorption and permeable porosity by 11-18%. (P.Srinidhi et al.,) Addressed that the concrete is a crucial material in infrastructure development, but it's strength and durability are often compromised by high levels of NaCl in water. Coconut fibre have been used to reduce heat of hydration in concrete. Magnetic water, a new technology, has been used to increase compressive strength. PERMAG (N406), a rare earth magnet, is used to generate magnetic water solutions. The combination of magnetic water and coconut fibre has been found to improve concrete's strength. This project aims to enhance concrete strength by adding magnetic water and coconut fibre, a cost-effective and eco-friendly method. Incorporating coconut fibre increases the compressive strength by 20.18% to 27.26% compared to conventional concrete. The project also improves the concrete's split tensile and flexural strength by 6.5% to 26.8% and 2.27% to 28.33% at 28 days. The project also reduces cement content by 5-10% and increases workability with a water/cement ratio of 0.30. Magnetic water is circulated about one hour by using PERMAG.

(Fakhri Javahershenas et al.,2020) Investigated the effect of exposure time of uniform magnetic field (UMF) on the microstructural and mechanical properties of steel fibre-reinforced concrete (SFRC) with different fibre volume fractions. To assess the brittleness index, SEM analysis along with compressive strength and flexural strength tests were performed. The results demonstrated an increased mechanical strength at uniform magnetic field exposure time at 0.7% steel fibres, the researcher also investigated the mechanical and microstructural behaviour of SFRC with fibre volume fractions of 0.4, 0.7 and 1% and corresponding increase in Uniform magnetic field time, the mechanical strength

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increased upto 16.42, 20.81 and 16.88% with 0.4, 0.7 and 1% volume fractions of fibres respectively. There is also a notable increase in the flexural strength at higher exposure times of Uniform magnetic field.
(Hassan Karam et al.,) Worked on Magnetic water which has been used in various industries, including agriculture, healthcare, construction, dairy production, and oil. Concrete mixes were prepared using tap water (TW) and magnetized water (MW) in a laboratory setting. The results showed that MW increased concrete strength by 10-15%, tensile strength and flexural strength by 7-28%, and increased workability, leading to enhanced concrete quality without water addition. This positive effect highlights the potential of magnetic water in concrete preparation.
(Saddam M. Ahmed et al.,) Proposed the impact of magnetic water on concrete compressive strength and workability. Results showed that concrete with magnetic water increases 10-20% strength of concrete compared to conventional concrete. Good results are achieved when the magnetic strength is 1.2 Tesla and the water current velocity is 0.71 m/s. The study recommends using water with a velocity of 0.71 m/s and time treatment of 4.5 sec./litre.

Author	**MAX Compressive Strength @28days**	**MAX Slump cone test**	**MAX Flexural strength**	**MAX Split tensile strength**
Pramod Kolase et al.,	38.12 MPa (M25 grade) Using magnetic water and 0.45%of Polypropylene.	109mm(high) Using magnetic water and 0.15% of Polypropylene.	7.7 MPa Using magnetic water&0.45% of Polypropylene.	3.5 MPa Using magnetic water and 0.45% of Polypropylene.
Tariq Alkhlrissa et al.,	29.9 MPa Using 0.9 tesla magnetic field for curing & 0.9% polythene fibres	130 mm(high) Using 0.9 tesla magnetic field for curing & 0.9% polythene fibres	-	2.08 MPa Using 0.9 tesla magnetic field for curing & 0.9% polythene fibres
M. Sridhar et al.,	45.01 MPa (M30 grade) Using six hours magnetised GPC, NaOH of molarity 12M & 0.75% of recycled tyre steel fibres	130mm Using six hours magnetised GPC and NaOH of molarity 12M, 0.75% of recycled tyre steel fibre	-	4.21 M Pa Using six hours magnetised GPC and NaOH of molarity 12M, 0.5% of recycled tyre steel fibre
P. Srinidhi et al.,	38.03 MPa (M25 grade) Using magnetised water for curing and 1.5% of coconut coir	50mm Using magnetised water for curing and 1% of coconut coir	8.5MPa Using magnetised water for curing and 1.5% of coconut coir	-
Fakri Mavahershenas et al.,	46.95MPa (M40 grade) By using 1% steel fibre content and exposing to a uniform magnetic field for 3 minutes.	-	7.88MPa By using 1% steel fibre content and exposing to a uniform magnetic field for 3 minutes.	-
Hassan Karam et al.,	15.62% increment Using magnetic water and 30 percentage of fly ash.	110mm Using magnetic water &30 percentage of fly ash.	6.16MPa Using magnetic water and 30 percentage of fly ash.	34.66MPa Using magnetic water and 30 percentage of fly ash.
Saddam M. Ahmed et al.,	55.5MPA (1:1.75:3) Using magnetised water and 0.425 w/c ratio	115mm Using magnetised water and 0.56 w/c ratio	-	-

Table 5. Results of various mechanical properties of Concrete

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5. ECO FRIENDLY CONCRETE

(Shivam Singhal et al.,) suggested the use of magnetic water in making concrete used for civil engineering structural applications aiming at sustainable infrastructural development by reducing the usage of binding material hence reducing the carbon foot print and environmental impact. Concrete cast with magnetic water performed better when compared to conventional concrete, not only reducing the binding material but also improving other parameters of concrete like compressive, split and flexural strengths hence making the concrete an ecofriendly material. There is a notable increase of compressive strength up to 55% than conventional concrete when magnetic water is used in concrete, in addition to this there is a remarkable increase of tensile and flexural strengths.

(Huan-xiao Hu et al.,) improvised the usage of magnetic water in concrete by introducing magnetic water in cement grout to enhance the performance, for which a lab built device for magnetization was used to magnetize regular tap water and cement grout samples with water cement ratios of 0.5 and 1.0 The results showed that MW positively affected the stability of cement grout, with stability improvement ratios ranging from 5-67.31 & 0.58-24.16%, respectively. The study also found that direct magnetization had no obvious effect on the stability of cement grout.

(Ahmed M. Elkerany et al.,) Analysed the effects of utilizing metakaolin (MK) as supplementary cement material (SCM) and magnetized water (MW) as concrete mixing water in sustainable concrete mixes. Improved results can be found by using 10% MK as a cement additive, enhancing mechanical characteristics when Treated water (TW) or MW was used. Using MW instead of TW in MK concrete increased all mechanical properties measured at 28 days by about 32-35%. The results showed indications of more C-S-H gel production and less CH when using MW in MK concrete. Moreover, fewer micro-cracks and pores were detected when using MW with 10% MK as a cement additive. The research work also showed that using magnetized water in metakaolin concrete can enhance its mechanical and microstructural characteristics, making it suitable for further developments and use in concrete mixes.

(Karuppasamy Narayanan et al.,) Investigated on enhancing the properties of concrete using magnetic field treated water (MFTW) with using a stationary magnet of intensity 0.9 Tesla. their technique enlighted on using MW as a water-reducing agent to improve the workability of fresh concrete with a 0.38 w/c ratio for achieving M40 grade concrete. The results showed a 12% improvement in compressive strength and an 8.9% improvement in split tensile strength compared to normal water (NW) with 1% SP. At 30% cement volume reduction, Magnetic Water Concrete (MWC) performed better than Normal Water Concrete (NWC). Experimental results exposed that magnetized water acts as a water reducing agent, making it suitable for preparing concrete mix without the addition of super plasticizer (SP). The slump value of concrete mix prepared with magnetized water obtained from instant exposure to a magnetic field and without the addition of super plasticizer is 96 mm, compared to 98 mm for normal water concrete mix with 1% SP. Utilizing MW within 20 minutes after magnetization can be recommended to achieve desired workability without SP. Reducing Agent in High Strength Concrete.

(Siva Konda Reddy et al.,) Explored the use of magnetic water concrete in civil engineering, aiming to produce sustainable structures with low environmental impact and reasonable cost. The study shows that magnetic water concrete has better workability, mechanical properties than normal concrete. It also shows that using magnetic water can reduce the amount of cement used in concrete mixes. This study also found that magnetic water concrete has a 55% high compressive strength than Normal Water Concrete (NWC),18% improved tensile strength and 25% higher flexural strength. The density of magnetic water concrete is high, and water absorption is less as compared to normal water concrete. Density of magnetic water concrete is high, and water absorption is less as compared to NWC.

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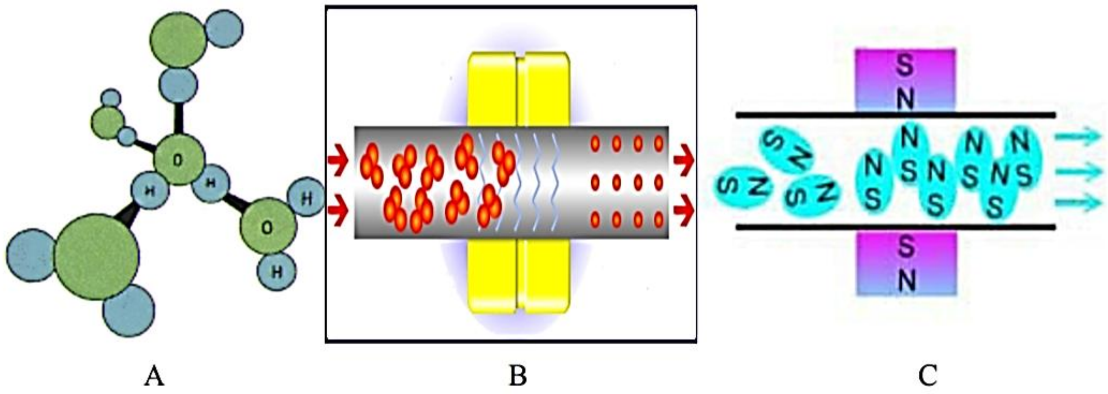
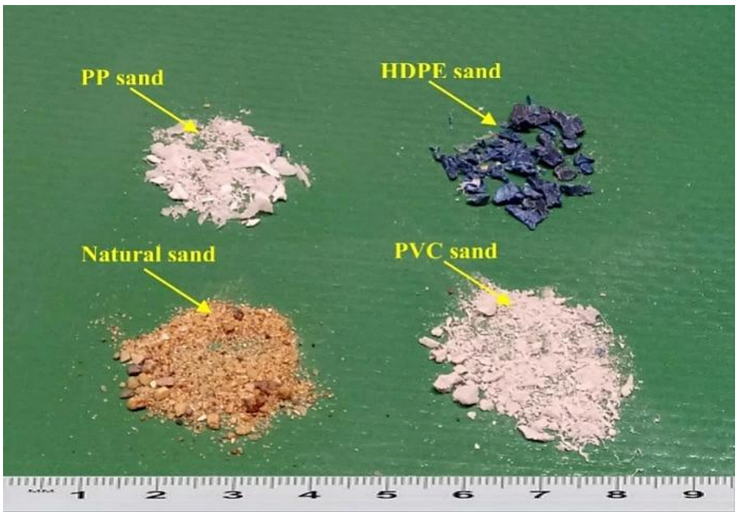


Fig 10. Mechanism of magnetic water: A. Water cluster; B. Breakage of cluster; C. Orientation (Siva Konda Reddy et al.,)

(Huan-Xiao Hu et al.,) Investigated on magnetized tap water using a self-made apparatus. To illustrate the magnetization mechanism, experiments are conducted on the conductivity and evaporation of magnetized water (MW) at various temperatures. The findings indicate that, in comparison to conventional tap water (RW), the conductivity and evaporation of the magnetized water both rise to varying degrees. At 50 and 80 °C, respectively, the greatest increases in conductivity and evaporation are 10.6%, 25.6%, and 16.7%. Magnetized water was used to make cement grout samples with water-cement ratios (w/c) of 0.5 and 1.0.

(Cathleen Hoffmann et al.,) Worked on Recycled Concrete (RC), bricks, and masonry debris used as concrete aggregates is a significant technique to support a sustainable material flow. However, there are still a number of unknowns that prevent RC from being used widely. Regarding the usage of RC, the variations in the make-up of commercial-grade recycled aggregates (RAs) and their impact on the characteristics of freshly-poured and cured concrete are of special importance. Over the course of many weeks, differences in the content of RA were examined in this experiment. These aggregates were then used to create concrete mixes so that the changes in the qualities of the concrete could be assessed. Two of them were used to demonstrate the main benefit of RC-mixtures for structural application over normal concrete by having a high percentage of RA.



[33] **Fig 11. Plastic and natural sands (Abdelkader Mahi et al.,)**

(Abdelkader Mahi et al.,) Suggested that plastic waste valorisation growth to be a significant environmental concern. Their reuse as aggregates in the production of new building materials could help to reduce these wastes, save the environment, and promote sustainable development. This project is a component of a comprehensive, long-term development strategy. In this experimental study author evaluated and compared the results of replacing both fine and coarse aggregates with three different plastic wastes. High density polythene, polypropylene, and polyvinyl chloride, where the materials used to make the trash. Three different percentages 25,50 and 75 of natural aggregates were replaced with the same quantity of plastic aggregates. In addition to morphological, thermochemical and acoustic features their impact on the environment was evaluated.

6. CONCLUSION

The following are the conclusions drawn after reviewing the research papers

1. The alternate aggregates like crumb rubber, plastics and recycled concrete aggregates can be used in concrete as an alternative to the conventional concrete making materials
2. The alternate aggregates like crumb rubber, plastics, recycled concrete aggregates perform better in any type of concrete when proper surface treatment with chemicals and pozzolanas.
3. The use of alternate aggregates is limited in any type of concrete; excess use of these materials can lead to performance and durability issues.
4. The performance of concrete with alternate aggregates can be improved by using structurally modified water like magnetic water.
5. The petrographic study of concrete cores containing alternate aggregates like recycled concrete aggregate revealed the occurrence of abundant white products forming rims around the aggregate particles and covering crack surfaces with a thin layer.
6. The silica fume coating of tyre crumbs is one of the most feasible methods for improving the compressive strength of concrete composite foam with recycled tyre crumb.
7. Magnetized Geo polymer concrete (GPC) had higher workability due to higher solubility and water availability. Magnetized GPC mix exhibits optimum workability, compressive strength, and split tensile strength compared to controlled GPC. The optimum amount of magnetization occurs after 6 hours.
8. The addition of coconut fibre increases the concrete's compressive strength by 20.18% to 27.26% compared to conventional concrete and also improves the concrete's split tensile and flexural strength by 6.5% to 26.8% and 2.27% to 28.33% at 28 days
9. In addition to coconut fibres which is an ecofriendly solution to fibres in concrete, poly propylene and glass fibres can show increased performance in ecofriendly concrete.
10. The increasing concern for the environment is the valorisation of plastic garbage. Reusing them as aggregates to create new construction materials might help cut down on waste, protect the environment, and advance sustainable development.
11. Fibre reinforced ecofriendly concrete can be developed by incorporating alternate aggregates like recycled concrete aggregates, plastics, crumb rubber with proper surface treatments and to improve the mechanical strengths and properties, different fibres like poly propylene, coconut, glass can be added individually or combining them together.

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REFERENCES

[1] Kashani, A., Ngo, T. D., Hemachandra, P., & Hajimohammadi, A. (2018). Effects of surface treatments of recycled Tyre crumb on cement-rubber bonding in concrete composite foam. Construction and Building Materials, 171, 467-473.https://doi.org/10.1016/j.conbuildmat.2018.03.163

[2] Petrounias, P., Giannakopoulou, P., Rogkala, A., Stamatis, P., Lampropoulou, P., Tsikouras, B., & Hatzipanagiotou, K. (2018). The effect of petrographic characteristics and physico-mechanical properties of aggregates on the quality of concrete. Minerals, 8(12), 577.https://doi.org/10.3390/min8120577
[3] Alqassim, M., Jones, M., Berlouis, L., & Nic Daeid, N. (2016). A thermoanalytical, X-ray diffraction and petrographic approach to the forensic assessment of fire affected concrete in the United Arab Emirates. Forensic Science International, 264, 82-88.https://doi.org/10.1016/j.forsciint.2016.03.015
[4] Leite, M.B. and Monteiro, P.J.M., 2016. Microstructural analysis of recycled concrete using X-ray microtomography. Cement and Concrete Research, 81,pp.38-48. https://doi.org/10.1016/j.cemconres.2015.11.010
[5] Song, Y., Huang, Z., Shen, C., Shi, H., & Lange, D. A. (2020). Deep learning-based automated image segmentation for concrete petrographic analysis. Cement and Concrete Research, 135, 106118.https://doi.org/10.1016/j.cemconres.2020.106118
[6] Beauchemin, S. and Fournier, B., 2012, May. Petrographic analysis of aggregate particles used in the accelerated mortar bar test for evaluating the potential alkali-reactivity of recycled concrete aggregates (RCA). In 14th International Conference on Alkali-Aggregate Reactivity, Austin, Texas (USA).
[7] Telloli, C., Aprile, A., & Marrocchino, E. (2021). Petrographic and physical-mechanical investigation of natural aggregates for concrete mixtures. Materials, 14(19), 5763.https://doi.org/10.3390/ma14195763
[8] Fernandes, I. (2011). Petrographic and chemical characterization of concrete deterioration products. SGEM International Multidisciplinary Scientific GeoConference EXPO Proceedings.https://doi.org/10.5593/sgem2015/b12/s2.068
[9] Ramalingam, M., Narayanan, K., Masilamani, A., Kathirvel, P., Murali, G., & Vatin, N. I. (2022). Influence of magnetic water on concrete properties with different magnetic Field exposure times. Materials, 15(12), 4291. https://doi.org/10.3390/ma15124291
[10] Dharmaraj, R., Arunvivek, G. K., Karthick, A., Mohanavel, V., Perumal, B., & Rajkumar, S. (2021). Investigation of mechanical and durability properties of concrete mixed with water exposed to a magnetic Field. Advances in Civil Engineering, 2021,1-14. https://doi.org/10.1155/2021/2821419
[11] Saran, A.A. and Magudeswaran, P., 2017. SEM analysis on sustainable high performance concrete. Int J Innov Res Sci Eng Technol, 6(6), pp.10237-10246. https://doi.org/10.15680/IJIRSET.2017.0606016
[12] Ghorbani, S., Gholizadeh, M., & De Brito, J. (2018). Effect of magnetized water on the mechanical and durability properties of concrete block pavers. Materials, 11(9), 1647. https://doi.org/10.3390/ma11091647
[13] Dagadu, A., Sanjay Bhosale, S., Nandkumar Banage, U., Ranjit Chavan, P., Rohit Pandit Biranje, & Waskar, V. G. (n.d.). Effect of Magnetic Water on Performance Evaluation of Concrete. International Research Journal of Engineering and Technology (IRJET), 07(04). https://www.irjet.net/archives/V7/i4/IRJET-V7I4173.pdf
[14] Abdel-Magid, T. I., Hamdan, R. M., Abdelgader, A. A., Omer, M. E., & Ahmed, N. M. (2017). Effect of magnetized water on workability and compressive strength of concrete. Procedia Engineering, 193, 494-500. https://doi.org/10.1016/j.proeng.2017.06.242
[15] Fernandez, R., Ruiz, A.I., Vigil de la Villa, R., Cuevas, J. and Turrero, M.J., 2013. A SEM-EDX Study of the Processes at the Concrete/Compacted Bentonite Interface (No. NEA-RWM-CLAYCLUB--2013-1).
[16] Emiroglu, M., Yildiz, S., & Kelestemur, M. H. (2008). An investigation on its microstructure of the concrete containing waste vehicle tire. Computers and Concrete, 5(5), 503-508. https://doi.org/10.12989/cac.2008.5.5.503
[17] Waghmare, S., Microstructural Analysis of M30 Grade Concrete Using Scanning Electron Microscopy (SEM) Method. https://doi.org/10.9790/9622-1005016571
[18] Kolase, P.(2022).Influence of Magnetized Water on Fibre Reinforced Concrete. Researchgate . https://www.researchgate.net/publication/358458995
[19] Alkhrissat, T. (2023). Investigation of the effect of magnetic water and polyethylene fiber insertion in concrete mix. Journal of Composites Science, 7(7), 303. https://doi.org/10.3390/jcs7070303

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2024,9(4)
e-ISSN: 2468-4376
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[20] Hajforoush, M., Kheyroddin, A., & Rezaifar, O. (2020). Investigation of engineering properties of steel fiber reinforced concrete exposed to homogeneous magnetic field. Construction and Building Materials, 252,119064. https://doi.org/10.1016/j.conbuildmat.2020.119064
[21] Srinidhi, P., Gokulapriya, K., & Prathiban, P. (2019). Experimental Study on Strength Enhancement of Concrete by using Magnetic Water and Coconut Fiber. International Research Journal of Engineering and Technology, 06(04). http://dx.doi.org/10.13140/RG.2.2.14164.76160
[22] Javahershenas, F., Gilani, M. S., & Hajforoush, M. (2021). Effect of magnetic field exposure time on mechanical and microstructure properties of steel fiber-reinforced concrete (SFRC). Journal of Building Engineering, 35, 101975. https://doi.org/10.1016/j.jobe.2020.101975
[23] Karam, H. and Al-Shamali, O., 2013, August. Effect of using magnetized water on concrete properties. In Third International Conference on Sustainable Constructional Materials and Technologies held at Kyoto Research Park, Kyoto, Japan on 18th–22nd August (pp. 1-12).
[24] M. Ahmed, S. (2009). "Effect of magnetic water on engineering properties of concrete". AL-Rafdain Engineering Journal (AREJ), 17(1), 71-82.https://doi.org/10.33899/rengj.2009.38451
[25] Shivam, S. and Sanjeev, G., 2017. Increasing the strength of concrete using magnetized water. *International Journal of Scientific & Engineering Research*, *8*(10), pp.370-375.
[26] Hu, H.X., Deng, C. and Chen, W., 2022. The effect of magnetization conditions on the stability of cement grout. Case Studies in Construction Materials, 16, p.e01016
[27] Elkerany, A. M., Keshta, M. M., Elshikh, M. M., Elshami, A. A., & Youssf, O. (2023). Characteristics of sustainable concrete containing Metakaolin and magnetized water. Buildings, 13(6), 1430. https://doi.org/10.3390/buildings13061430
[28] Ramalingam, M., Narayanan, K., Sivamani, J., Kathirvel, P., Murali, G., & Vatin, N. I. (2022). Experimental investigation on the potential use of magnetic water as a water reducing agent in high strength concrete. Materials,15(15),5219. https://doi.org/10.3390/ma15155219
[29] Siva Konda Reddy, B. (2013). Influence of magnetic water on strength properties of concrete. Indian Journal of Science and Technology,7(1),14-18. https://doi.org/10.17485/ijst/2014/v7i1.7
[30] Hu, H., & Deng, C. (2021). Effect of magnetized water on the stability and consolidation compressive strength of cement grout. Materials,14(2),275. https://doi.org/10.3390/ma14020275
[31] G Hoffmann, C., Schubert, S., Leemann, A., & Motavalli, M. (2012). Recycled concrete and mixed rubble as aggregates: Influence of variations in composition on the concrete properties and their use as structural material. Construction and Building Materials,35,701-709. https://doi.org/10.1016 /j.conbuildmat.2011.10.007
[32] H Hoffmann, C., Schubert, S., Leemann, A., & Motavalli, M. (2012). Recycled concrete and mixed rubble as aggregates: Influence of variations in composition on the concrete properties and their use as structural material. Construction and Building Materials,35,701-709. https://doi.org/10.1016 /j.conbuildmat.2011.10.007
[33] Bai, B., Jin, H., Fan, C., Cao, C., Wei, W., & Cao, W. (2019). Experimental investigation on liquefaction of plastic waste to oil in supercritical water. Waste Management, 89, 247-253.https://doi.org/10.1016/j.wasman.2019.04.017
[34] Lebreton, L., Slat, B., Ferrari, F., Sainte-Rose, B., Aitken, J., Marthouse, R., Hajbane, S., Cunsolo, S., Schwarz, A., Levivier, A., Noble, K., Debeljak, P., Maral, H., Schoeneich-Argent, R., Brambini, R., & Reisser, J. (2018). Evidence that the great Pacific garbage patch is rapidly accumulating plastic. Scientific Reports, 8(1). https://doi.org/10.1038/s41598-018-22939-w
[35] Sofi, A. (2018). Effect of waste Tyre rubber on mechanical and durability properties of concrete – A review. Ain Shams Engineering Journal, 9(4), 2691-2700. https://doi.org/10.1016/j.asej.2017.08.007
[36] Toutanji, H. A. (1999). Properties of polypropylene fib reinforced silica fume expansive-cement concrete. Construction and Building Materials,13(4),171-177. https://doi.org/10.1016/s0950-0618(99)00027-6
[37] Qian, C., & Stroeven, P. (2000). Development of hybrid polypropylene-steel fibre-reinforced concrete. Cement and Concrete Research,30(1),63-69.https://doi.org/10.1016/s0008-8846(99)00202-1