



STATE -of- ART of RECYCLING of CONCRETE

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Abstract: Concrete is fundamental for any foundation headway. One of the certifiable issues breaks in concrete, which will lessen the substantial life. To help improvement exercises, it is essential to find choices into oneself recuperating of breaks. In actuality side, the pace of support is expanding bit by bit, while the issue of usefulness and security is likewise broadening an immediate consequence of the existence of people in danger. India is one of the primary makers of cement on the planet and tremendous measures of fixing work were made. In the replacement of customary fixing procedure, oneself recuperating through microorganisms can be utilized. Additionally, calcium lactate (calcium sources) in concrete likewise might be utilized.

Key Words: Concrete, Cement, Bacteria.

1. INTRODUCTION:

Destruction pace of constructions are extending energetically step by step while the cost of unloading locales increments due to non openness of adjacent destinations. Safe and sagacious organization of C&D squander is quite difficult for present day society. Speedy urbanization advancement is changing waste organization from a low need, restricted issue to an unavoidable social and environmental issue with threats to general wellbeing and climate. Wastefully oversaw garbage removal might potentially impact wellbeing and climate. Organization of squanders needs to combine the standards of waste minimization of and reusing and pursue the handling and removal office in a viable way. Comparatively Construction and Demolition (C and D) Squanders is expected to be arranged at all stages in a viable way. C and D waste in metropolitan networks are overwhelmingly created from Demolition of existing, old fragile constructions. These incorporates (1) Existing structures remodel like (private, modern, business) (2) Residential or business or lodging development of new structures (3) Excavation or recreation of black-top or substantial streets; (4) Development of fly over spans (4) Water/phone/web/sewer pipe lines redesign/establishment and so forth (C&D) squanders are commonly included substantial rubble, block squares and tiles, sand furthermore build up, lumber, plastics, cardboard and paper, metals. Substantial rubble more regularly than not lays out the greatest part of C&D. It has been shown that squashed strong rubble, after detachment from other C&D squander and sieved, can be used as substitute for standard coarse total in concrete or as a sub-base or a base layer in black-tops as reused totals. Exactly when any framework is cut down, broad measures of waste is made in a reasonably more limited time period, dependent upon the annihilation methodology used. Standard cement commonly contains around 12% concrete and 80% total by mass. This infers that, for substantial making, we are consuming sand, rock, and squashed rock at the pace of 10 to 11 billion tones every year. Mining and transport exercises involved for age of huge measure of total consume energy which antagonistically influence the forested regions and stream site environment .So there is a need of appropriate waste the executives for this situation. Also checking out future foundation situation in India, need for the legitimate administration of development squander is required. It's obviously true that substantial is a, efficiently manufactured material in the improvement world, similar to steel what's more soil are. Regardless, much effort has been made to reuse and direct important normal resources and assets and continued reusing can be proper for concrete, just like for the situation for steel and aluminium. A strong method is to use reused total underway of reused total concrete (RAC). Anyway Recycled totals are associated with old concrete mortar created by crushing obliterated substantial waste. RAC



is made by blending RA alongside other normal fixings, including concrete, water, fine total and different materials. The utilization of these materials as substitution of normal totals is an engaging other option, considering the advantages that it brings to the two issues referenced previously. Notwithstanding the way that there is expanding reuse of coarse total for making new concrete in the West and far Eastern piece of world like Japan and Korea, there is nearly nothing knowledge of the likely utilization of such total in India. Truth is that after China, India is the essential purchaser of concrete in the world, which by proposal recommends that India is likewise one of the essential buyers of substantial making materials like fine and coarse total. Since total sources are compelled, it is fundamental to deal with the capability of reused coarse and fine total in the development of cement in India. The Swachh Bharat Mission under service of metropolitan advancement envisions treatment of 100 percent squander created in metropolitan networks by second October, 2019 as a key objective, which consolidates C&D squander.

In India, unapproved and ill-advised removal is normally the standard prompting bunch issues. Additionally, the asset capability of C&D squander is lost without reusing. The significance of C&D squander the executives aren't lost among the partners, particularly in enormous urban areas, where effect has effectively been felt. Be that as it may, powerful administration of C&D squander is hampered by a few difficulties in India. Nonetheless, appropriate administration and handling of C&D waste can prompt productive reusing, as the experience of different nations have shown. The inappropriately overseen C&D squander stacks sway the metropolitan and common habitat in various ways which could comprehensively be ordered into the accompanying classifications:

Social:

- Colossal stores of C&D squander on trails, carriageways, rear entryways, and so on is a typical scene in Indian urban areas turning the encompassing area unesthetic.
- C&D flotsam and jetsam is massive and for the most part can't be taken out by typical road clearing or family squander assortment staff as they ordinarily don't convey the hardware not one or the other enough limit in the assortment vehicle nor enough labour supply. Neighbourhood individuals frequently will quite often dump metropolitan strong waste on the C&D squander pile making it a blend of waste further causing what is going on.
- C&D squander is additionally subtly unloaded in open depletes and water channels. The flotsam and jetsam obstruct the channels and makes water logging during downpours. Reports of water logging of channels going to a wellspring of pestilences are normal in India.
- C&D squander unloaded on roads and pathways block traffic and people on foot, regularly adding to gridlock and even mishaps.
- C&D waste can incorporate risky substances like sharps, broken glass, rocks, broken wooden logs, rusted metal, broken ceramics, and so on which make a risky climate when unloaded on unfenced open spots.

Ecological:

- C&D flotsam and jetsam throughout course of time frames fine residue making air contamination and decreasing perceivability.
- The leachate and fine synthetic particles from C&D squander dumps debase the dirt prompting land and groundwater contamination. Particularly perilous parts incorporate paints, oil and asbestos sheets.
- Dumping of C&D squander in wetlands, water channels and riverbeds disturbs the hydrology and obliterates the sea-going environment.

Monetary:

- C&D squander generally gets stirred up with other metropolitan strong waste during the interaction of move or at the assortment site. Once blended in with MSW, C&D squander is extremely challenging to isolate. These outcomes are in expanded handling cost and decreased effectiveness.



□ C&D garbage removal forces huge expenses on nearby government offices counting expenses of cleaning channels gagged with C&D squander.

□ The enormous volume of C&D squander tops off landfills and dump-yards coming about in opening of more landfills or elective dump locales.

Asset Shortage:

□ India is seeing a development blast because of fast urbanization which is driving to high paces of abuse of essential assets for development materials.

□ For example, from a practically 100 percent of concrete and blocks, 40-60% of steel, 85% of Industry that can be reused or paint, and 70% of glass delivered in India goes into the reused to be subbed in development area.

□ Sand, soil, stone and limestone are basic assets utilized in the area that are previously confronting supply disturbances and value spikes because of mining boycotts and limitations.

□ Therefore, utilization of optional materials should be elevated to enhance the utilization of essential materials and reused C&D squander is one of the most outstanding accessible choices.

Concrete is routinely conveyed using alluvial stream rock and sands. The materials are extensively open and are modestly prudent to process and accordingly, they are for the most part used. Additionally, they convey incredible cement due to their actual properties, for model, shape, degree, etc. The ordinary strategy of course of action of these store happened in excess of an enormous number of years. These stores are over abused. There is deficiency of sand. There is overflow sand mining which brings about utilization of ground water and stance environmental issues. Mining is denied by specific state legislatures for the going with reasons: (I) Digging the sand from stream bed in overflow sum is hazardous to the earth. (ii) The delving of profound pits in the stream bed impacts the ground water level. (iii) Due to overflow sand lifting, disintegration of nearby grounds occurs. It is a fundamental sight that the well reinforcement of the scaffolds is revealed widely in light of the fact that of unnecessary lifting of sand around the base endangers the life and security of spans.

2. LITERATURE REVIEW :

Fan hang et al. [1] Utilizing reused substantial totals (RCA) from old concrete substantial asphalt blocks as balancing out base in street development can accomplish the reasons for energy preservation, asset protection, and material reusing. Be that as it may, because of the effect of old concrete mortar, reused totals have different execution. The free mortar can be gone back over from the reused totals by utilizing indoor scraped area analyser, and the exhibition upgrades of RCA can be acquired through looking at the essential attributes of totals and the strength of reused totals settled by concretes.

Ji-Kun Zhao et al. [2] In the event that the structure isn't sensible use of waste, which will bring expanded creation of concrete industry, will deliver bigger natural issues. This perspective is the current common and ecological issues expected to determine significant. This paper analyses and sums up the way how the reuse of substantial material, can be utilized completely in three angles.

Wei Wu et al. [3] With the advancement of reused totalled cement explores, and the debilitating of development materials, it's protected to anticipate that more extensive use of reused accumulated to designing development is an inescapable pattern. Here a down to earth issue is introduced whether the substantial can be reused again when the design built by reused totals should be wrecked or kept up with as its administration life is reaching a conclusion.

Xia He et al. [4] Against carbonization execution is a substantial durability mark of reused elite execution concrete in environment. A symmetrical trial turned into deliberate on this paper thinking about water-concrete share, reused coarse and first-class general, slag, fly debris, carbonization time, in addition to the tension beneath neath load. Exploratory effects confirmed that (1) water-concrete share and what sort of concrete hook up with the extent of hydration of cement and thickness, eventually have an effect on the counter carbonation execution of cement; (2) carbonation profundity has



a fantastic dating among the carbonization and the rectangular basis of the time; and (3) carbonization profundity will increment beneath neath malleable pressure.

Li Ying et al. [5] Accepting reused general as item, investigates the alternate routineness of impact factors, for example, water lessening specialist, concrete utilization, sand share, water concrete share and general concrete share beneath neath the distinct compressive power whilst the widths of the reused general water-penetrable massive attain from 9.5mm to 16mm.

Zhong et al. [6] Fiber supported concrete as a kind of problematic cloth of composite constructed up, which has gotten extensive attention within side the cloth discipline and designing. In this analysis, the extent of basalt fibre have been 0,0.1%, 0.15%, 0.20%, on this example of, styles of numerous techniques to restoring fibre impacted hub compressive power of basalt fiber reused massive squares that have been relieved via normal temperature and excessive temperature.

A. Alsharid et al. [7] Reused total (RA) is generally utilized in development industry. These utilizations incorporate street sub-base lines bedding and inlaying. This examination shows the possibility of delivering economical squares made of reused materials. In this paper, the consolidated impacts of reused total (RA) and reused water (RW) on strength and toughness of substantial squares are introduced and talked about.

C. Higuera et al. [8] Fiber-supported cement has turned into a generally involved option in development as the filaments add to the decrease of breaking and work on a portion of the mechanical properties of concrete based materials. Then again, Polyethylene Terephthalate (PET) has become one of the primary wellsprings of defilement, since it is an ineffectively biodegradable material, and the cycles for its treatment are likewise profoundly contaminating.

X. Wang et al. [9] Drying shrinkage twisting is one of the main reasons which cause breaking of substantial materials. Blend plan of C30 regular total concrete (NAC) is utilized reference, the analysis of drying shrinkage thinking about the impact of reused total substitution proportion and blending measure of fly debris, water minimiser, and sweeping specialist was made.

S. Ismail et al. [10] The second of rate properties of the reused substantial total (RCA), as contrasted and the normal total, are brought about by the presence of the permeable remaining mortar with various miniature breaks, which is joined to the first totals. The substandard characteristics of RCA have restricted its utilization in underlying substantial creation. Hence, this study explored the achievability of joining two unique strategies for surface treatment to improve the properties of coarse RCA.

C. P. Selvan et al. [11] Concrete being one of the critical fixings in most polite designing constructions is without a doubt and either straightforwardly or by implication answerable for contaminating the climate, particularly while creating concrete. Keeping this as a viewpoint, a few analysts all around the world are tracking down available resources to diminish the utilization of concrete or supplanting it with substitute materials without compromising the presentation and nature of cement.

D. Wang et al. [12] The improvement of another reusing innovation for squander substantial pieces turns into a major issue in Japan because of the expansion of the pieces and the lessening of the normal coarse totals. In the current work, another innovation of substantial totals reusing utilizing beat releases was performed. A Marx generator was utilized as a beat power source and a highlight side of the equator network arrangement terminal was drenched in water.

M. Ohno et al. [13] Asphalt development work of a street surface which utilized reused development remaining portion soil from development works and so forth was achieved. Utilized materials small development leftover portion soil, sand, rock, concrete and cementing specialist. A blend extent state of the uniaxial compressive strength (7 days) 10 N/mm/sup 2/was chosen from the after effect of extra test, and execution development work was done. An acceptable outcome was acquired.

C. W. Yeh et al. [14] This evaluate is a starter check for kids` down divider, wherein reused piece iron cubicles and different piece iron, squashed, paint, and one-of-a-kind strategies are combined in with concrete cement to supplant the total. This follows the relieving of concrete primarily based totally iron sand concrete appealing adsorption residences. Since, compressive energy is massive for concrete; this take a look at comes to a decision the compressive energy of sizeable that includes iron sand, which may be absorbed through magnets, through using reused piece iron cubicles and different portions of iron.



C. Kline et al. [15] An innovation has been fostered that makes use of CO₂ in sizeable restoring to paintings at the sizeable residences. This cycle has been popularized and is being utilized in greater than 50 organized combo and sizeable object locales throughout America and Canada. At the contemporary-day time organized combo and sizeable object companies are using business; meals grade CO₂ for an excessive price.

A. S. Mahmoud et al. [16] This exam consists of the research of diverse sizeable blends contained waste glass powder as concrete substitution, then, at that point, it changed into contrasted with manage blends. Squander glass powder changed into applied as substitution prices of concrete weight (10, 15, 20 and 25%). The studies middle application produced from fifty four 3-d shapes have 100×100×100mm to check the compressive energy of sizeable examples at 28, fifty six and ninety days, and 9 chambers have aspects (300×100mm) to check stress stain of cement at 28 days.

M. H. S. Zangana et al. [17] Atomic sifters are concerned over a huge scope of makes use of in groups mainly in oil and fueloline managing plants. There is a tremendous sum, tenths of heaps to be organized each 12 months through oil and fueloline companies, in a few instances in a non-secure way. These substances while they may be organized below non-guidelines, it'll destructively have an effect on the climate.

N. M. Mhedhi et al. [18] A evaluate has been tried to enhance some residences of frothed concrete through including strands took place due to reducing waste plastic refreshment bottles. Tests had been brought about discover the effect of including waste plastic filaments (WPF) on the brand new and solidified residences of frothed concrete. To accomplish that, one-of-a-kind frothed sizeable combos had been deliberate at constant water-to-fastener share of 0.35 and 350 kg/m³ of concrete substance.

N. Makaratat et al. [19] In this evaluate, the low CO₂ cement changed into made through related to some contemporary-day squanders in each cowl and totals. Calcium carbide build up (CCR) combined independently with palm oil gasoline debris (PA) and rice husk-bark debris (RA), and changed into applied as a cowl as opposed to Portland concrete within side the sizeable combination. Besides, first-class and coarse reused totals had been absolutely supplanted everyday totals to venture sizeable examples (CCR-PA and CCR-RA cements).S. A. Warad et al. [20] Portland concrete substantial industry has grown-up incredibly lately. It will radically build involves concrete for foundation advancement all through around the world. In any case, Portland concrete substantial shows hurtful impacts like toughness and CO₂ emanation. Many substantial designs have shown genuine declining, way before their proposed administration life, basically those constructions developed in a destructive climate such beach and water-logged regions.

Y. Li et al. [21] The reusing of metal slag will genuinely grow to be a full-size degree for the weather warranty and for this reason may be of super importance. The assembling of Portland concrete is an exceedingly energy-critical interplay, reusing use of severe current consequences are handy in considerable quantities that may be applied to supplant Portland concrete in concrete, referred to as precious cementitious substances or mineral introduced substances.

S. M. Hama et al. [22] Reusing and reusing of squanders are feasible strategies to decrease squander produced and cope with the related herbal issues. Notwithstanding, the packages surely have a variety of risk for improvement. This paper offers glass squander fabric reusing in improvement application. Glass squanders applied as powder and to a degree supplanted concrete in concrete and its effect on some mechanical homes become explored.

C. Kline et al. [23] An innovation has been fostered that makes use of CO₂ in sizeable relieving to paintings at the sizeable homes. This advertised interplay is used by in extra of fifty organized combination and sizeable object locations throughout the USA and Canada. Prepared combination and sizeable object businesses are currently making use of business, food-grade CO₂ for an excessive price.

A. Abbas et al. [24] Of the kind of eleven million heaps of every year robust cement and destruction squander (C&D) in Canada, sizeable facts for round 52% with the aid of using weight. Be that because it may, the extra a part of this sizeable is applied as throughway base or shipped off landfills for removal; only a tiny piece of the sizeable waste is reused in constructing improvement. Thinking approximately the manner that usable normal overall (NA) materials are lessening, there may be a reputation for reused sizeable totals (RCA) to be applied with inside the intended "green concrete" (GC).

Y. Xu et al. [25] In view of the warranty of starting site visitors obstacles of sizeable asphalt, reused overall speedy restore concrete become successfully prepared with the aid of using taking over rapid repairing specialist (JK-24) and reused coarse overall, and the compressive electricity, flexural electricity and factor of interplay bond electricity have



been explored. As is proven with the aid of using the outcomes, the compressive electricity, flexural electricity and connection factor bond electricity of 24h can meet the requirements of starting site visitors with plan flexural electricity of 5.0MPa.

3. CONCLUSION:

It presents basic idea of recycling the concrete with various technologies involved. It also gives the state of art of concrete recycling with the literature of various papers involving various types of recycling, various techniques and various advantages with the recycling.

REFERENCES:

1. Fan Zhang, Rong-gen Pan and Shaojun Yu, "Study on engineering performance improvement of recycled concrete aggregates from old cement concrete pavement blocks," 2011 International Conference on Electric Technology and Civil Engineering (ICETCE), 2011, pp. 2621-2624, doi: 10.1109/ICETCE.2011.5774270
2. J. -k. Zhao, "The Application of Recycled Concrete Environmental Impact Analysis," 2010 International Conference on Digital Manufacturing & Automation, 2010, pp. 629-631, doi: 10.1109/ICDMA.2010.425.
3. Jifeng Liang, Wei Wu and Yanfeng Tian, "Study on the recycling of recycled aggregated concrete," 2011 International Conference on Remote Sensing, Environment and Transportation Engineering, 2011, pp. 8590-8592, doi: 10.1109/RSETE.2011.5964174.
4. Xia He, Si-Yuan Wang and Wei-Sheng Yang, "Experimental study on anti-carbonization performance of recycled high-performance concrete," 2011 Second International Conference on Mechanic Automation and Control Engineering, 2011, pp. 7359-7362, doi: 10.1109/MACE.2011.5988750.
5. Li Ying, Yang Jian Rong and Li Jing Yi, "Study on recycled aggregate water-permeable concrete," 2011 International Conference on Electric Technology and Civil Engineering (ICETCE), 2011, pp. 6236-6239, doi: 10.1109/ICETCE.2011.5776447.
6. Ruijin Guo, Zhong Bi and Fu Wang, "Influence of different mixing methods on the axial compressive strength of basalt fiber recycled concrete," 2016 3rd International Conference on Informative and Cybernetics for Computational Social Systems (ICCSS), 2016, pp. 368-371, doi: 10.1109/ICCSS.2016.7586483.
7. E. Elgaali, A. Alsharif and A. Julfar, "Green blocks made of recycled waste," 2018 Advances in Science and Engineering Technology International Conferences (ASET), 2018, pp. 1-5, doi: 10.1109/ICASET.2018.8376773.
8. S. Ismail and M. Ramli, "Effect surface treatment of recycled concrete aggregate on properties of fresh and hardened concrete," 2013 IEEE Business Engineering and Industrial Applications Colloquium (BEIAC), 2013, pp. 651-656, doi: 10.1109/BEIAC.2013.6560211.
9. C. Higuera-Flórez, J. Cárdenas-Pulido and A. Vargas-Aguilar, "Evaluation of chloride penetration in cement mortars reinforced with different proportions of recycled PET fibers," 2021 Congreso Internacional de Innovación y Tendencias en Ingeniería (CONIITI), 2021, pp. 1-5, doi: 10.1109/CONIITI53815.2021.9619699.
10. Y. -c. Guo, X. Wang, K. -w. Sun and L. -f. Cheng, "Experiment study on drying shrinkage deformation of recycled aggregate concrete," 2011 International Conference on Electric Technology and Civil Engineering (ICETCE), 2011, pp. 1219-1222, doi: 10.1109/ICETCE.2011.5776036.
11. S. Ismail and M. Ramli, "Effect surface treatment of recycled concrete aggregate on properties of fresh and hardened concrete," 2013 IEEE Business Engineering and Industrial Applications Colloquium (BEIAC), 2013, pp. 651-656, doi: 10.1109/BEIAC.2013.6560211.
12. R. Vandanapu, V. Mohanan and C. P. Selvan, "Understanding the influence of replacing cement with GGBS on compressive and flexural strengths of concrete at medium workability conditions," 2019 Advances in Science and Engineering Technology International Conferences (ASET), 2019, pp. 1-4, doi: 10.1109/ICASET.2019.8714522.
13. D. Wang et al., "Optimization of discharge condition for recycling aggregate by pulsed discharge inside of concrete," 2009 IEEE Pulsed Power Conference, 2009, pp. 1075-1078, doi: 10.1109/PPC.2009.5386153.
14. M. Ohno and K. Fukai, "Pavement construction work of a road surface by soil cement concrete that used construction remainder soil," Proceedings First International Symposium on Environmentally Conscious Design and Inverse Manufacturing, 1999, pp. 638-641, doi: 10.1109/ECODIM.1999.747690.



15. C. -W. Yeh, M. -C. Huang, C. -W. Hsu, U. -K. Hsu, M. -T. Wu and C. -L. Hsiao, "Study on the mechanical property of cement-based composites with the addition of iron sand," 2018 IEEE International Conference on Applied System Invention (ICASI), 2018, pp. 699-700, doi: 10.1109/ICASI.2018.8394353.
16. J. Kline and C. Kline, "CO₂ capture from cement manufacture and reuse in concrete," 2018 IEEE-IAS/PCA Cement Industry Conference (IAS/PCA), 2018, pp. 1-10, doi: 10.1109/CITCON.2018.8373097.
17. A. S. Mahmoud, M. M. Yassen and S. M. Hama, "Effect of Glass Powder as Partial Replacement of Cement on Concrete Strength and Stress-Strain Relationship," 2019 12th International Conference on Developments in eSystems Engineering (DeSE), 2019, pp. 109-114, doi: 10.1109/DeSE.2019.00030.
18. M. H. S. Zangana, F. H. Ibraheem, S. I. Khaleel and M. H. Al-Dahhan, "Recycling of spent molecular sieves from oil and gas industry: North gas company as a case study," 2017 International Conference on Environmental Impacts of the Oil and Gas Industries: Kurdistan Region of Iraq as a Case Study (EIOGI), 2017, pp. 54-58, doi: 10.1109/EIOGI.2017.8267625.
19. N. M. Mhedhi, A. A. Hilal and A. Al-Hadithi, "Re-Use of Waste Plastic as Fibers in Production of Modified Foamed Concrete," 2018 11th International Conference on Developments in eSystems Engineering (DeSE), 2018, pp. 295-299, doi: 10.1109/DeSE.2018.00059.
20. N. Makaratat, C. Rattanashotinunt and C. Jaturapitakkul, "Low CO₂ Concrete Made from Calcium Carbide Residue, Palm Oil Fuel Ash, Rice Husk-Bark Ash, and Recycled Aggregates," 2018 Third International Conference on Engineering Science and Innovative Technology (ESIT), 2018, pp. 1-12, doi: 10.1109/ESIT.2018.8665036.
21. R. Lokhande, S. A. Warad and M. B. Ishwaragol, "Experimental Investigation on Geo-Polymer Concrete Cured at Ambient Temperature," 2020 IEEE Bangalore Humanitarian Technology Conference (B-HTC), 2020, pp. 1-4, doi: 10.1109/B-HTC50970.2020.9297867.
22. Y. Li, "Recycling of Steel Slag for Energy Saving and its Application in High Performance Concrete," 2009 Asia-Pacific Power and Energy Engineering Conference, 2009, pp. 1-4, doi: 10.1109/APPEEC.2009.4918641.
23. M. M. Yassen, S. M. Hama and A. S. Mahmoud, "Reusing of Glass Wastes as Powder as Partial of Cement in Production of Concrete," 2018 11th International Conference on Developments in eSystems Engineering (DeSE), 2018, pp. 330-334, doi: 10.1109/DeSE.2018.00065.
24. J. Kline and C. Kline, "CO₂ Capture From Cement Manufacture and Reuse in Concrete: The Carbon XPrize," in IEEE Industry Applications Magazine, vol. 26, no. 1, pp. 42-48, Jan.-Feb. 2020, doi: 10.1109/MIAS.2019.2943659.
25. A. Abbas, G. Fathifazl, O. B. Isgor, A. G. Razaqpur, B. Fournier and S. Foo, "Environmental Benefits of Green Concrete," 2006 IEEE EIC Climate Change Conference, 2006, pp. 1-8, doi: 10.1109/EICCCC.2006.277204.