**Assessment Of Partial Replacement Of Cement With Sugarcane Bagasse Ash As Replacement Material**.

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**ABSTRACT -**

Concrete Is One Of The Most Commonly Used Materials In The Building Industry. It Is A Universal Building Material (Composite) That Can Be Used In A Variety Of Environments (Dry, Water, Underground, In Hot Or Cold Climatic Zones). Another Advantage Of This Material Is The Possibility To Change Its Properties Depending On The Requirements Of The Construction Project And The Price.

1. **INTRODUCTION –**

India Is Moving Towards Sustainable Developments In Various Field. The Manufacturing Industry Plays A Important Role Here. Renewable Building Material Need To Be Identify To Reduce Exploitation Of Natural Resources. Industrial By-Product Can Be Used As Alternatives To Conserve Existing Resources.

From 2018 To 2019, Around 5.5 Million Hectares Of Sugar Cane Were Planted In India And Used To Produce 35 Million Tons Of Sugar, According To ISMA Reports. India Is One Of The Centers Of Sugar Cane Manufacturing.[14] Most Of The Sugar Cane Is Used In Candy. The Sugar Production Process Produces More Than 30 Million Tons Of Waste Each Year. These Bagasse Do Not Contain Reusable Properties And Are Dumped In The Open Field. Around 40-45% Of SCBA Is Used As Combustion Material In The Sugar Industry. SCBA Typically Contains High Levels Of Silica And Calcium Oxide. However, The Ash Recovered From The Industry Does Not Have Many Properties Because It Is Burned In The Open Air At High Temperatures. SCBA Materials Are Often Very Difficult To Handle

## Sources Of SCBA -

Bagasse Ash Is Produced When Sugar Cane Is Burned For Sugar Mills In The Sugar Industry. Bagasse Is Generally Obtained From Two Different Sources In Industry. The Powder Is Obtained After The Combustion Process. A Second Source Of SCBA Is Obtained Directly From Cigarette Smoke. ARA Contains 50% Cellulose, 25% Hemicellulose And 25% Lignin. The Bagasse Content Per Tonne Of Sugarcane Is 26% [27]. The Main Reason For Using SCBA As A Cement Substitute Is Its Pozzolanic Properties. Therefore, Many Researchers Have Proposed Volcanic Ash Studies For The ARA. So They Can Find A Way To Use The Ashes In The Construction Field. 27] This Test Includes Partial Use Of Scbas In Buildings. This Experimental Study Included Two Types Of Tests, Divided Into Two, Fresh Concrete And Hard Concrete Tests. , Flexibility Test, Carbonation Test And RCPT Test Are All In Hard Concrete Test. Cement Replaces 10%, 20% And 30% Of The Total Volume Of Cementitious Material.

1. **MATERIAL –**

## CEMENT -

Generally Speaking, OPC Manufacturing Is Far Superior To PPC Manufacturing. The Chemical Composition Of OPC Contains Significant Proportions Of Various Minerals Such As Calcium, Iron, Alumina And Silica. There Are Many Grades Of OPC, Including OPC53 And OPC43, But Grade 53 Cement Is Widely Used Because Each Exhibits The Desired Consistency And Fineness Results. The Use Of Cement Grade OPC53 Complies With IS Standards [9].

## FINE AGGREGATE -

Fine Aggregate Can Be Classified Into Two Types, River Sand And M Sand, But Due To The Increasing Use Of River Sand, Alternative M Sand Has Been Used For 10 To 15 Years. The Main Reason For Using M Sand Is That M Sand Is Readily Available And Reduces Environmental Degradation. M Sand Has No Elongated Fluffy Particles. Cubic Particles Provide Excellent Durability And Strength To Concrete. The Grain Size Of The Sand M Must Be 150 To 4.75 Microns Mm [9]. Sand M Reduces Concrete Voids And Also Prevents Bleeding And Segregation.

## COARSE AGGREGATE –

Coarse Aggregate Enhances The Adhesive Strength Of Concrete. The Aggregate Must Have The Desired Properties, Such As Size And Shape. It Should Be Angular, Scaly, Or Elongated. These Specially Shaped Aggregates Are Better Suited And Sought After In Concrete Mixtures. The Material Used As The Coarse Aggregate Should Have Dimensions Of Approximately 20 Mm [9].

1. **TEST ON CONCRETE –**

The Test Was Carried Out On Concrete In Two Different Ways. One Is Fresh And The Other Is Hardened. The Workability Of Concrete Is Measured In The Fresh State. The Decay Cone Test Is For Workability And The Hardening Test Includes Studies Of Compression, Bending, Water Absorption, Carbonation, Chloride Ion Penetration And Alkali Content In Concrete.

1. **FRESH CONCRETE TEST –**

Experimental Tests Were Carried Out On Fresh Concrete To Adjust The Workability And Homogeneity Of The Cement Used. One Of The Fresh Concrete Tests Includes The Concrete Slump Cone Test. This Is One Of The Most Economically Feasible Tests For Determining Operability And Consistency. This Will Help You Find The Desired Moisture Content And The Hardening Ability Of The Concrete. If The Clearance Is Up, It Is True Clearance, If It Fails, It Is Shear Clearance.

# **HARDENED CONCRETE TEST -**

## TEST FOR COMPRESSION -

Concrete Compression Test Is One Of The Basic Tests For Hard Concrete [10]. Compression Tests Can Be Carried Out Using Cubic Specimens. This Is An Essential Step That Engineers And Technicians Must Follow To Obtain Accurate Results In Concrete Compressive Strength Testing [17]. The Test Block Is Located In The Center Of The Pressure Tester Tray And The Cleaning Surface Is To The Side. The Compressed Mass Fc Is Resolved As The Most Extreme Load (Downhill Heap) That The Sample Can Sustain In The Contact Load Region. The Data Obtained From The Tests Is Very Useful For Drawing Conclusions About The Resulting Mixture. The Test Must Be Stopped 7 And 28 Days After Storage Of The Cubic Sample [9].

Fc = Failure Load / Area

1. **FLEXURAL STRENGTH TEST –**

The Tensile Strength Of Concrete Can Be Easily Determined From Bending Tests. This Is A Basic Mechanical Test To Determine The Total Deflection Of A Beam. Loads Can Be Applied As Point Loads [5]. Specific Bending Test Results Can Be Expressed In Mpa Or Psi [3]. In The Point-Bend Stacking Test, 100x100x500 Mm Solid Shafts Are Stacked At 400 Kg/Min. The Bending Quality Of The Samples Is Reported As The Crack Modulus R [7]. The Molds Fell Off After 7 And 28 Days, Respectively. We Use A Universal Testing Machine To Obtain Test Results.

RL=Pl/Bd2

Where R Is The Depletion Potential, P Is The Most Extreme Load, L Is The Length Extension, B Is The Width, And D Is The Depth Of The Specimen. This Equation Is Only Valid If The Fracture Of The Deformed Surface Is Less Than One-Third From The Center Of The Length. If The Crack Is Less Than 5% Of The Extended Length, The Modified Equation [7] Is Used.

R=3pa/Bd2

## CARBONATION TEST –

## The Carbonation Test Is One Of The Tests To Confirm The Durability Of Concrete, Which Is Related To The Behavior Of Concrete Against Corrosion [4]. Carbonation Tests Are Mandatory To Prevent Corrosion Of Reinforcements [4,8,19,23,29]. This Includes Measuring The Depth Of Carbonation That Occurs In Concrete. Cubic Mussel Samples Were Taken For Carbonation Testing And Four Different Mixtures Were Taken With 0%, 10%, 20% And 30% SCBA [19]. Phenolphthalein Indicators Are Used To Test The Carbonation Of Concrete. The Method For Estimating The Carbonation Depth Is To Get Information From 10 Focal Points From Different Sides Of Each Sample, And For One Sample, Get A Total Of 30 Focal Points From Different Edges In 3 Cases, For One Sample. Obtain And Collect The Depth Of Carbonation. Adjacent 0.5 Mm. [23].

## WATER ABSORPTION TEST –

## Good Concrete Is Known For A Test Called The Water Absorption Test. It Is Used To Reduce Penetration Values ​​[4]. You Can Find Water Injected. The Thawing And Freezing Mechanism Is As Follows. Identified [21, 22]. In This Test, We Estimate The Limit Of Water That Can Penetrate The Mortar. Water Retention Measurements Have Been Determined And Normalized For Extended Regions Of Samples With Feed Water At Different Times [22]. For Samples, It's 0, 5, 10, 20, 30, 50 And 60 Minutes Respectively. Water Ingress Testing Of Cured Samples Is Estimated To Be Complete In 28 Hours. First, The Sample Is Placed In An Oven At 105°C For 24 Hours [4]. After A While, Remove Them From The Grill, Cool And Weigh (Md). The Samples Were Immersed In Water For 48 Hours And Weighed [21].

## RAPID CHLORIDE PENTRETION TEST –

## The Strength Properties Of Concrete Can Be Obtained By A Test Called The Rapid Chloride Infiltration Test. The Device Can Be Made Of Saline Solution And Sodium Hydroxide [13]. In General, You Can Run An RCPT Test To Find The Resistance. For The Penetration Of Chloride Ions. Depends On The Solids Content Ratio Of Water And Concrete. This Is Particularly Effective For Concrete Containing Reinforced Hardened Materials Which Are Slow To React. For Specimens And Flying Tips, A Longer Hydration Time Is Required. Chloride In Concrete Depends On The Concrete Chloride Management Limits [12]. , This Adjuvant Slows Down The Speed Of Dispersion.

## SEM ANALYSIS –

## The Durability And Performance Of Concrete Can Be Obtained By SEM Analysis Method. You Can Analyze The Fine-Structure Behavior Of Particles. The C-S-H Gel Is A By-Product Of Calcium Oxide [20]. The Placement And Shipping Of Hydration Results For Seven Different Mix Grades Of Hydration Concrete Binders Are Shown Below. The Microstructures Of The Seven Mixtures Were Analyzed And Compared, And The Apparent Mixtures Were Compared. The Microstructure And Mass Properties Of The 7 Blends Were Based On The Formed Hydrated Elements After 28 Days [2]. Based On The Development Of Hydration Elements In The Microstructure Of Cement Mixtures, The Purpose Of Solid Mass Is Decomposed And Clarified. This Development And Diffusion Of The Mineral Composition Is One Of The Reasons For The Success Of The Mixing Quality [1]. Replacing Fine Sand With Fine Sand Did Not Show Any Quality Defects At The Same Time. The Resulting Sand Collides With All Fine Particles, Changing The Dispersion Of Minerals [2].

## ACID ATTACK TEST –

## Components Sensitive To Acid Attack Can Be Identified From The Acid Attack Test. It Can Be Tested Mainly On Hard Concrete Producing Calcium Ion Hydroxide [8]. Capillary Porosity May Be Increased In Acid Etch Tests. These Tests Were Performed On Round, Hollow Specimens Stored In Non-Contaminating, Corrosive, And Inflexible Containers With Sufficient Corrosion Reaction To Completely Submerge The Exposed Surfaces [24]. The Test Interval Was Limited To 120 Minutes And The Surfaces Of The Test Sections Were Cleaned After 20, 40, 60 And 120 Minutes. As The Concentration Of Corrosive Substances Increases, The Solid Form And Compressed Quality Of The Chamber Decreases. Specifically, It Converts Calcium Mixtures Into Calcium Salts, Which Are Corrosive Substances [25]. These Reactions Can Destroy Solid Structures. After 28 Days, The Weight Loss Of The Samples Immersed In The Sulfuric Acid Etched Material Was Reduced To 20% Copper Replacement Slag [26]. Prior To This Measurement, The Weightless Sample Was Expanded. Maximum Mass Loss Was Obtained Using A Combination Of 10% GGBS And 10% Metakaolin With 40% Replacement Copper Slag. Maximum Weight Gain Was Achieved By Using A Mixture Containing 5% GGBS, 5% Metakaolin And 20% Copper Slag As An Alternative. This Is Because The Mix Containing 20% ​​Copper Slag Is Smaller In Size Than The Control Concrete. However, Minimal Losses Were Achieved Using A Mixture Containing 5% GGBS, 5% Metakaolin, And 20% Copper Slag. However, The Overall Adversity Was Greater For The Mixture Containing 40% Copper Slag [26]. The Activity Of GGBS And Metakaolin Gradually Thickens The Concrete. Known To Compete With Corrosive Solid Fractions. The Same Performance Can Be Obtained With Low Chloride Corrosion Immersion.

## DISCUSSION OF EXPERIMENTAL RESULTS –

## COMPRESSION TEST –

Nirup Chamaetal. We Tested Concrete Cubes Of Nominal And Alternate Mixes. The Compressive Strength Of A Typical Or Nominal Mix Is ​​28 Mpa, And When Bagasse Ash Is Replaced By Concrete, The Compressive Strength Increases With The Level Of Bagasse Ash, Reaching 10% Of The Ideal Value . Further Increases In Bagasse Ash In The Concrete Mix Will Reduce The Compressive Strength Of The Alternative Mix. [15]

Prashant O Modani Et Al. The Nominal Mix And Alternate Mix Cube Was Also Tested. The Compressive Strength Of The Sample With 10% Bagasse Replaced Is Greater Than The Compressive Strength Of The Sample With 0% Bagasse. A Further Increase In Bagasse Ratio Reduces Compressive Strength And Significantly Reduces Fresh Solids. Likewise, The Cohesive Strength Of The Mixture With Bagasse Increased At A Higher Rate Than Expected During The Ongoing Occupation Of The Bagasse Pozzolana. [18]

1. **FLEXURAL STRENGTH TEST-**

Nirup Chama Et Al. Flexural Strength Was Tested With Nominal And Alternating Mix. The Flexural Strength Of A Typical Mix Is ​​3.13 Mpa, And Since The Concrete Is Supplied With Bagasse, The Flexural Strength Increases By Up To 10% Depending On The Level Of The Bagasse Chip. Above 10%, The Bend Quality Value Will Continue To Drop. [15]

Mr. Bharath And MS. Anjali Also Tested The Flexural Strength Of Nominal And Alternative Concrete Mixes. Since The Concrete Is Supplied In Bags, The Flexural Strength Of The Nominal Mix Is ​​2.85 Mpa And The Flexural Strength Increases With The Contents Of The Bag. The 20% Flexural Strength Value Continued To Drop. [6]

1. **CARBONATION TEST –**

Carbonation Depths In Different Parts Of The Sample Were Measured At Different Percentages [29]. Phenolphthalein Is Used As An Indicator And The Sample Test Turns Pink, Indicating That There Is No Charring. If It Is Colorless, The Sample Is Burnt. A Pravalika And N Venkat Rao Tested Cubes Of Nominal And Replacement Mixes. According To Their Study, The Depth Of Carbonation Gradually Increased With A Mixture Of 0% To 15% And Then Decreased Sharply With A Mixture Of 20% And 30% [19]. M.A. Sanjuan Tested Cubes With A Nominal Mix And A Substituted Mix. Carbonation Depth Fluctuates With Increasing Ash Content: 8 Mm For 0%, 5.5 Mm For 10% And 8.7 Mm For 20%. [23]

1. **WATER ABSORPTION TEST –**

Water Absorption In Percent, Which Is The Difference Between The Sample Weight And The Dry Weight. Salmabanu Luharet Et Al. The Cubes Were Monitored For 28 Days, Water Absorption Tests Were Performed, Accelerated Curing Was Performed, And The Cubes Were Kept In Water At 85°C For 24 Hours, And The Wet And Dry Loads Were Calculated. Water Absorption Increases From 0% To 15% And Then Faces Reduction Or Depletion. [22]

Ruchab Hetar Et Al. Cube Molds Were Monitored For 28 Days For Water Absorption Testing, Accelerated Curing, And Held In 85°C Water For 24 Hours To Calculate Wet And Dry Loads. Absorption Increases From 0% To 20%, Then Faces A Decline. [21]

1. **RAPID CHLORIDE PENETRATION TEST –**

The RCPT Survey Of The Material Was Conducted By Jemimah Carmichaeletal. Note That Replacing Concrete With Nanomaterials Reduces Elemental Chlorine Input. By Replacing Concrete With Nanoconcrete And Flying Nanoparticles, The Reduction In Chloride Particle Penetration Continues Evenly To Half The Replacement Level. Inflating Nanoconcrete Can Reduce Chloride Vulnerability By Up To 90% Compared To Normal Cement Concrete. In All Cases, When Replacing The Concrete With Nanosilica And Nanosilica, The Maximum Reduction In Chloride Ion Input Was At Substitution Levels Of 20% And 30%, Respectively. [13]

1. **SEM ANALYSIS TEST –**

Praveen Kumar S Et Al. Scanning Electron Microscopy (SEM) Analysis Was Performed On The Cubes Of Interest, Replacing Cement With 10%, 20%, And 30% SCBA, Respectively, Which Resulted In The Formation Of C-S-H Gels In The Samples Starting From Day 28. Foam Is Defined As A Complete Fiber System. When The Material Was Tested With 10% SCBA For 28 Days, A Very Thick System With Few Noticeable Pinholes Was Observed. The Material Sample Containing 15% Bagasse Also Showed A Very Thick System Composed Of C-S-H. [20]

Andreao Et Al. Also Performed Scanning Electron Microscope (SEM) Analysis Of The Cube Of Interest And Found That The Upper And Lower Adhesives Of The Ashes Exhibited Microstructure Densification Inferred From C-S-H Development. I Did It. The C-S-H Coarse Liniment Grid Should Be Combined With The Portland Stones Mentioned Elsewhere. Debris Hardening Concrete Adhesive Reduces Holes In Desired Sample. At The Intersection Of The Pores, The Proximity Of The Powdery Acicular Elements Is Consistent With The Alignment Of The Calcium. Particular Attention Should Be Paid To Sulfoluminized Products. Other Sporadic Particles With A Rough Surface Appeared, Bound To Inorganic Compounds Such As Silica And Potassium [2].

1. **ATTACK OF ACID TEST ON CONCRETE –**

Sravan Conducted A Pilot Acid Corrosion Test On Concrete Cubes To Check Not Only Chemical Corrosion To Concrete, But Also Weight Loss. They Found That The Most Extreme Weight Loss Was Observed In Mixtures With 0% And 30% SCBA Under All Conditions During The Soluble Base Introduction Period. Baseline Weight Loss Was Observed At 15% SCBA Content During The 7, 28 And 56 Day Break-In Periods. During All Induction Periods, A Painful Reduction In Body Weight Was Observed As SCBA Content Increased From 0% To 15%, With SCBA Content Greater Than 15% Weight Loss Up To 30% SCBA Content. Cumulative Weights Upon Introduction Of Antacid 56d Were 94%, 96%, And 93% For 0%, 15%, And 30% SCBA, Respectively. Consider SCBA As A Concrete Substitute For Concrete, Showing Better Results Under The Conditions Of Soluble Alkali Introduction. [26]Shripad Umale Et Al. Acid Etching Tests On The Concrete Revealed That The Concrete Blocks Were Coated With 5% Acid After 30 And 60 Days Exposure, Respectively. Exist

Sixty Days After Introduction, A Maximum Reduction Of About 0.8% In Solid Squares Intercalated With HCL Etchant Was Observed. Also, With A Short Introduction Date Of 30 Days, The Maximum Reduction Of HCL Recorders Was 0.6%. In The Case Of Sulfur Corrosion, The 30-Day Onset Time Rotation Scheme With Increased Load Is Considered Unusual. [25]

1. **CONCLUSION –**

The Main Conclusions Drawn From This Study Are As Follows.

**1.** SCBA Performs Better Than Nominal Mix When Partially Mixed With Concrete

**2.** Water Absorption And Permeability Decrease With Increasing ARA.

1. **REFRENCES –**
2. Adithya saran A.S et al. “SEM Analysis on Sustainable High Performance Concrete” *International Journal of Innovative Research in Science, Engineering and TechnologyVol. 6, Issue 6, June 2017*
3. Andreao et al. “Sustainable use of sugarcane bagasse ash in cement-based materials” *Green Materials 7.2 (2019) 61-70*
4. Ankur Anand and Dr.A.K.Mishra “Comparative study of concrete strength by partially replacing cement with sugarcane bagasse ash and fly ash “International Journal of Science, Engineering and Technology Research (IJSETR) Vol 5,Issue 4,Apr 2016
5. Aylin “Water Absorption and Sorptivity Properties of concrete containing granular blast furnace slag” *IOSR Journal of Mechanical and civil Engineering (IOSR-JMCE) Vol 15,Issue 6 Dec-2018*
6. Bahurudeen, A., et al. "Performance evaluation of sugarcane bagasse ash blended cement in concrete." *Cement and Concrete Composites* 59 (2015): 77-88.
7. Bharath ,M.Anjali “Experimental Investigation on Mechanical & Durability of Concrete Containing fly ash and Quarry Dust” *International Research Journal of Engineering and Technology (IRJET) Volume: 05 Issue: 03 | Mar-2018*
8. Berenguer, Romildo A., et al. "Sugar Cane Bagasse Ash as a partial substitute of Portland cement: effect on mechanical properties and emission of carbon dioxide." *Journal of Environmental Chemical Engineering* (2020)
9. Erbektas, Ali Riza, O. BurkanIsgor, and W. Jason Weiss. "Comparison of Chemical and Biogenic Acid Attack on Concrete." *ACI Materials Journal* 117.1 (2020)
10. Ganesan, K., Rajagopal, K., & Thangavel K., 2007. Evaluation of Bagasse Ash as Supplementary Cementitious Material, Journal of Cement and Concrete Composites 29, p. 515
11. Gursimran Singh, NirbhayThakur&Nitish Kumar Sharma “Experimental Research on the Strength Parameters of Concrete using Sugarcane Bagasse Ash, Marble Waste Powder and Recycled Concrete Aggregate” *International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN: 2278-3075, Volume-8 Issue-8 June, 2019*
12. Hansen, Bradley S., Jay Shannon, and Isaac L. Howard. "Improved Understanding of Concrete Compressive Strength Utilizing Cement Paste Testing." *Advances in Civil Engineering Materials* 8.1 (2019): 267-284
13. Hiren Patel, Piyush Jain, Kaizad Engineer and Mohammed Vasim M Kajalwala “The Experimental Investigation of Durability Test on Concrete Cubes” *International Journal of Advance Engineering and Research Development Volume 4, Issue 5, May -2017*
14. Jemimah Carmichael. M, Prince Arulraj. G “Rapid Chloride Permeability Test on Concrete with Nano Materials” *International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249 – 8958, Volume-8, Issue-3S, February 2019*
15. Kumar, K. Sampath, et al. "A Comprehensive Study on Partial Replacement of Cement with Sugarcane Bagasse Ash, Rice Husk Ash & Stone Dust." *International Journal of Civil Engineering and Technology* 7.3 (2016)
16. Nirup Chama et al. “Utilization of SCBA as Supplementary Cementacious Material in Concrete” *IJSTE - International Journal of Science Technology & Engineering | Volume 4 | Issue 1 | July 2017*
17. Patel, Jaymin kumar A., and D. B. Raijiwala. "Experimental study on use of sugar cane bagasse ash in concrete by partially replacement with cement." *International Journal of Innovative Research in Science, Engineering and Technology* 4.4 Apr (2015)
18. Parvathy Karthika, V. Gayathri “Experimental Studies on Durability Aspects of High Strength Concrete using Fly ash and Alccofine” *International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878, Volume-7 Issue-4S, November 2018*
19. Prashant O Modania, M R Vyawahare “Utilization of Bagasse Ash as a Partial Replacement of Fine Aggregate in Concrete” Procedia Engineering 51 (2013) 25 – 29
20. Pravalika and N Venkat Rao “Effect of carbonation on the properties of concrete” International Journal of Civil Engineering and Technology (IJCIET) Volume 9, Issue 7, July 2018, pp. 1605–1611
21. Praveen Kumar S, G. Sankarasubramanian, and S. Sindhu. "Strength, permeability and microstructure characterization of pulverized bagasse ash in cement mortars." Construction and Building Materials 238 (2020)
22. Rushab H et al. “Effect of water absorption and sorptivity on durability of pozzocrete mortar” International journal of emerging science and engineering vol 1, Issue 5 Mar 2013
23. Salmabanu et al. “A study on water absorption andsorptivity of

geopolymerconcrete”. International journal of civil engineering vol 2 issue 8 Aug 2015

1. Sanjuan et al “Concrete Carbonation test in natural and accelerated conditions” Advances in cement research vol 15, Issue 4, Oct 2003
2. Shiny Brintha, Sakthieswaran “Acid Attack on Concrete Containing Industrial Wastes” International Research Journal of Engineering and Technology (IRJET) 2018
3. ShripadUmale, Prof G.V Joshi “Study of Effect of Chemicals (Acid) Attack on Strength and Durability of Hardened Concrete” International Research Journal of Engineering and Technology (IRJET) Volume: 06 Issue: 04 | Apr 2019
4. Sravan, ChallaHari, and MugipudiManoj. "Study on the Properties of Concrete Made with Sugar Cane Bagasse Ash under Acid and Alkaline Attack." (2019)
5. Srinivasan, R., and K. Sathiya. "Experimental study on bagasse ash in concrete." International Journal for Service Learning in Engineering, Humanitarian Engineering and Social Entrepreneurship 5.2 (2010)
6. Stanish, R.D. Hooton and M.D.A. Thomas “Testing the Chloride Penetration Resistance of Concrete: A Literature Review” ACI Materials Journal, Vol. 89, No. 5, pp.2017
7. Tae-Kyun Kim et al. “Performance Based Evaluation of Carbonation Resistance of Concrete According to Various Curing Conditions from Climate Change Effect” International Journal of Concrete Structures and Materials Vol.11, No.4, pp.687–700, December 2017