Experimental Study On Thermocrete Panel

T.Subramani[1], J.Karthick Rajan[2], P.Jithu[3], S.Mohammed Shebin[4], S.Mohammed Shebin[5]

[1]Professor & Dean, Department of Civil Engineering, VMKV Engineering College, Vinayaka Missions Research Foundation (Deemed to be University), Salem, India

[2] Assistant Professor, Department of Civil Engineering, VMKV Engineering College, Vinayaka Missions Research Foundation
(Deemed to be University), Salem, India

[3,4,5]UG Student, Department of Civil Engineering, VMKV Engineering College, Vinayaka Missions Research Foundation (Deemed to be University), Salem, India

ABSTRACT

This study is about Experimental investigation of Thermocrete Panel. The Thermocrete Panels is a reinforced concrete sandwich panel used for numerous building applications. The Thermocrete panel consists of a super-insulated core of rigid Thermocol (polystyrene) sheet between two engineered sheets of steel welded wire fabric mesh. A galvanized steel truss wire is pierced completely through the Polystyrene core at offset angles for superior strength and welded to each of the outer layer sheets steel welded wire fabric mesh. To complete the concrete structure, a special mix of shotcrete is applied to each side of the panel after installation in walls & roof of the building and trowel finished to produce a highly insulated energy efficient RCC building with a useful life of more than 50 years. The Thermocrete panels can be used for various building applications such as single storey, double storey& multi storey buildings. Thermocrete panels are also used in place of brick / c.c block masonry walls & metal framed walls. They are also used for floor systems, roofing structure, columns, beams, as well as in stairs and boundary walls.

Keywords: Experimental, Panel, Thermocrete, Concrete.

1. INTRODUCTION

1.1 General

Thermocrete Panel system is a modern, efficient, safe and economic construction system for the construction of buildings. These panels can be used both as load bearing as well as non-load bearing elements. Thermocrete core panel is a 3D panel consisting of 3-dimensional welded wire space frame provided with the polystyrene insulation core. Panel is placed in position and shotcrete on both the sides.

The Thermocrete panels consist of a 3-dimensional welded wire space frame utilizing a truss concept for stress transfer and stiffness. Thermocrete panel includes welded reinforcing meshes of high-strength wire, diagonal wire and self-extinguishing expanded polystyrene uncoated concrete, manufactured in the factory and shotcrete is applied to the panel assembled at the construction site, which gives the bearing capacity of the structure. Thermocrete panel after shotcrete has the following five components.

- The outer layer of shotcrete.
- Welded reinforcing mesh of highwire
- The core of expanded polystyrenesheet.
- Diagonal wire (stainless or galvanized wire).
- The inner layer of shotcrete.

The welded mesh fabric connected piercing polystyrene with truss of steel wire, welded to the welded fabric at an angle. It gives a rigidity spatial structure, and simultaneously prevents polystyrene core shifting. Figure 1 shows the typical cross section of wall panels.

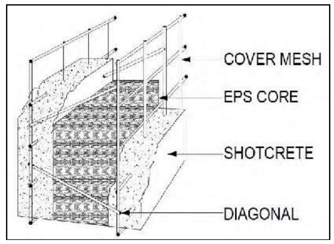

Figure 1 Typical cross section of wall panels

Individually welded internal strut wires or diagonals extend through the panel core between each surface. These galvanized strut wires are welded continuously in the required spacing so they form, with the welded wire fabric, into a triangulated truss system which greatly increases the panel strength Thermocrete panel is a versatile structural element designed for floors, walls, partitions, roof and stairs. Figure 2 shows the Reinforcing mesh expanded polystyrenecore and diagonal wire.

Figure 2 Reinforcing mesh expanded polystyrenecore and diagonal wire

Figure 3 shows the welded reinforcing mech 3-D panel without expanded polystyrene.

Figure 3 Welded reinforcing mesh 3-D panel without expanded polystyrene

The typical Thermocrete panel is generally manufactured with dimensions of 1200 m width, 3000 mm length and over all thickness range of 80-230 mm.The panels are finished at the site using minimum 30 mm thick Shortcreting of cement & coarse sand in the ratio of 1:4 applied under pressure. The Shortcreting coat encases the Thermocrete Core with centrally placed steel welded wire mesh.
Some of the advantages of the Thermocrete Core panel systems are as follows:

- Reduce the cost of construction
- Reduce Construction period
- Reduce transport cost. Light weight panels: do not requires cranes and other heavy construction

equipment. *(A Standard panel of size (1.2×3) m without shotcrete weighs 20kg).*

- The installation does not need heavy construction equipment.
- Ensure high levels of thermal insulation, sound insulation, as well as sanitary and fire safety.
- Thermocrete 3-D panels allow no additional cost to erect buildings in areas with moving soil, especially heaving, subsidence, frozen ground, and remote areas.
- Strength and durability - used extruded polystyrene virtually inert and does not absorb moisture, is durable and resistant to decay.

(a) *Some of the Limitations of the Thermocrete Core Panel System:*

- Thermocrete Panel construction system may only be used in the construction of foundation walls supporting 4 storeys or less, unless designed by a professional engineer.
- Concrete must be applied by either the "shotcrete dry" or "shotcrete wet" process in accordance with ACI 506 R-85, "Guide to Shotcrete," by the American Concrete Institute.
- Compressive strength of concrete shall not be less than 20MPa.
- The steel reinforcement shall have a minimum allowable stress *(fy)* of 415 MPa.
- The Thermocrete Core panel system is environment friendly and aesthetically appealing. It can be constructed quickly resulting in savings in construction time and money. The technology has been in use successfully in many African as well as European countries with involvement of different agencies.

1.2 Advantages of Thermocrete Panel

1.2.1 Thermal & Sound Insulation

Heat and cold transmission are reduced by 50% to-70% through the use of Thermocrete Panel and its superior sound insulation keeps each living space a quiet zone.

1.2.2 Savings in Construction Cost

Savings in construction cost by using our lightweight EPS core sandwiched with a galvanized mesh panel, construction system economize the use of materials and labor and offers economical option for construction of buildings that satisfies any physical and structural requirements. Thermocrete Panel

1.2.3 Time & Labor Savings

Thermocrete Panel goes up so quickly, precisely and easily that fewer masons and other skilled workers are needed to get the job done.

1.2.4 Environmentally Intelligent

Thermocrete Panel is made of EPS foam and galvanized steel frame, so the system does not deplete forestry products. Furthermore, the high density expanded Polystyrene (EPS) thermal insulation core used in the panels contains no ozone damaging CFCs either in the manufacturing process or the end product. All the materials are also recyclable.

1.2.5 As a member of the Green Building Council

Thermocrete Panel construction system can easily be used toward a Led certification of a passive building

1.2.6 Financial Sensibility

Earlier completion means earlier occupancy. Fewer laborers and less equipment mean a lower cost. Together, it means lower total capital investment and a quicker return on Investment (ROI).

1.2.7 Maintenance Saving:

Thermocrete Panel construction system structures require minimal long-term maintenance, especially in areas prone to termite infestation, extreme weather and temperature conditions. Summer heat, winter snow, heavy rains and high wind, nothing gets through Thermocrete Panel.

1.2.8 Lower Utility Bills

Structures built with Thermocrete Panel have experienced up to 50% -80% savings in electricity and gas consumption, made possible by the requirement of smaller and more efficient HVAC / heating and air conditioning systems due to lower heating & cooling loads. Smaller HVAC unit = cost reduction.

1.2.9 Termite Proof

The Thermocrete Panel construction system is totally resistant to termites, insects, and rodents as well as to mold, mildew & fungi.

1.2.10 Hurricane and Earthquake Protection

There are many documented instances where structures built with Thermocrete Panel have survived the severest storms and other natural disasters. The Thermocrete Panel structures can withstand wind velocities of more than 200 miles/hour and endure earthquakes of 0.4 g Ground Acceleration or more than 7 on the Richter scale.

1.2.11 Greater Acceptability

Since the Thermocrete Panel construction system uses the traditional RCC construction materials that are concrete and steel along with an in-built thermal insulation core of high-density Polystyrene, the finished buildings appear exactly similar to any other RCC / conventional building.

1.2.12 Additional Floors

Due to the light weight and easy handling of the Thermocrete Panel panels the construction system is ideally suited for the construction of additional floors on top of existing multistory buildings, without over loading the structure & foundations. It is therefore possible to construct additional floors on existing buildings without compromising the safety of the existing structure.

1.2.13 Construction in Remote Areas

A standard 4’ x 10’ Thermocrete Panel wall panel weighs only 46 Lbs (before concreting at site) making it possible to carry the panels to remote and high-altitude areas where the traditional construction materials like bricks & C.C blocks are not locally.

2. METHODOLOGY

Figure 4 shows the methodology of the study.

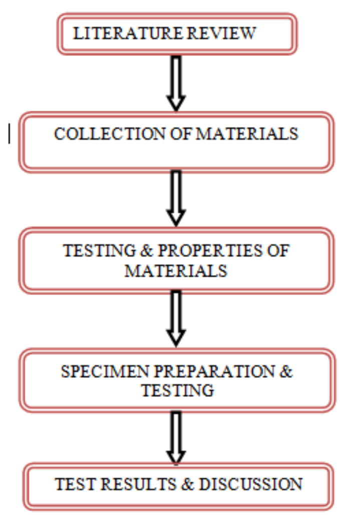

Figure 4 Methodology

3. MATERIALS SELECTION

3.1 Cement

Portland Pozzolana Cement also commonly known as PPC cement. These types of cement are manufactured by using pozzolanic materials as one of the main ingredients. The percentage of pozzolanic material used in the preparation should be between 10 to 30. If the percentage is exceeded, the strength of cement is reduced.Pozzolana is a natural or artificial material containing silica in a reactive form. It may be further discussed as siliceous or siliceous and aluminous material which in itself possesses little, or no cementations properties but will in finely divided form and in the presence of moisture, chemically react with calcium hydroxide at ordinary temperature to form compounds possessing cementations properties. It is essential that pozzolana be in a finely divided state as it is only then that silica can combine with calcium hydroxide (liberated by the hydrating Portland cement) in the presence of water to form stable calcium silicates which have cementations properties.
The pozzolanic materials commonly used are:

- Volcanic ash
- Calcined clay
- Fly ash
- Lica fumes

3.2 Coarse Aggregate

Crushed angular aggregate of size 20mm.The material retained on 4.75mm sieve is termed as coarse Aggregate. Crushed stone and natural gravel are the common materials used as coarse aggregate for concrete. Coarse aggregate are obtained by crushing various types of granite, schist, crystalline and limestone and good quality sand stones. When high strength concrete is required very fine-grained granite perhaps the best aggregate. Concrete made with sand stone aggregate give trouble due to cracking because of high degree of shrinkage. Aggregates should be chemically inert strong hard, durable and limited Porosity. For coarse aggregate crushed 20mm, normal size graded aggregate was used. The specific gravity and water absorption were found to be 2.85and 1.0%. The grading of aggregate would be conformed to requirement as per IS: 383-1970.

3.3 Fine Aggregate

Natural M-sand is used. The M-sand is one of the major industrial wastes produced in the quarries, several tons of crusher sand is produced. The disposal of these wastes creates a serious environmental problem, so we can use the crushing sand in construction industry. The crusher sand is collected from quarries. The size of M-Sand is same as the fine aggregate. It is collected from quarries. The M-sand could be used as partial replacement for sand for some construction application such as concretes, manufacture of pre-cast concrete elements, cement blocks etc. This is mainly used in road works, concrete, cement blocks and as a filler material.

3.4 Water

Potable water is used. Ordinary drinking water available in the construction laboratory was used for casting all specimens of this investigation. Water helps in dispensing the cement even, so that every particle of the aggregate is coated with it and brought into ultimate contact with the ingredients. It reacts chemically with cement and brings about setting and hardening of cement. It lubricates the mix and compact property. Potable water, free from impurities such as oil, alkalis, acids, salts, sugar and organic materials were used. The quality of water was found to satisfy the requirement if IS 456-2000.

3.5 EPS

Polystyrene (PS) is a synthetic aromatic hydrocarbon polymer made from the monomer styrene. Polystyrene can be solid or foamed. General-purpose polystyrene is clear, hard, and rather brittle. It is an inexpensive resin per unit weight. It is a rather poor barrier to oxygen and water vapour and has a relatively low melting point. Polystyrene is one of the most widely used plastics, the scale of its production being several million tons per year. Polystyrene can be naturally transparent, but can be coloured with colourants. Uses include protective packaging (such as packing peanuts and CD and DVD cases), containers, lids, bottles, trays, tumblers, disposable cutlery and in the making of models.
As a thermoplastic polymer, polystyrene is in a solid (glassy) state at room temperature but flows if heated above about 100 °C, its glass transition temperature. Figure 5 shows the Expanded polystyrene sheet.

Figure 5 Expanded polystyrene sheet

Figure 6 shows the wire mesh.

Figure 6 Wire mesh

3.6 Wire Mesh

Welded wire mesh, or welded wire fabric, or "weld mesh" is an electric fusion welded prefabricated joined grid consisting of a series of parallel longitudinal wires with accurate spacing welded to cross wires at the required spacing. Machines are used to produce the mesh with precise dimensional control. The product can result in considerable savings in time, labour and money.

4. MATERIAL TESTING

4.1 Cement

In this present study Portland pozzolanic cement (PPC) is used as per IS 1489:1991

- Specific Gravity Test
- Fineness Test On Cement

- Consistency Test Of Cement
- Initial And Final Setting Time

4.2 Fine Aggregate

A fine aggregate obtained from the river is used for experimental purpose. The less amount of clay and silt (<3% by weight). The hire from silt, clay, salt, and organic material and it was clean and dry. It us size of retained in 1.18 sieve.

- Fineness Modulus Of Fine Aggregate
- Specific Gravity Test On Fine Aggregate (Pycnometer Test)
- Water Absorption Of Fine Aggregate
- Physical Properties Of Fine Aggregate

4.3 Coarse Aggregate

The corseaggregte is strongest and orous componenet in concrete. Presence of coarse aggregate reduces the drying shrinkage and other dimensional changes occuring on account of movement of moisture. The coarse aggregate used passes in 19mm and retaines in 11.4mm sieve. It is well graded(should different particle size and maximum dyr packing density and minimum voids) and cubical in shape.

- Sieve Analysis For Coarse Aggregate
- Specific Gravity Test For Coarse Aggregate
- Physical Properties Of Coarse Aggregate

5. CASTING AND CURING

5.1 General

Selectiong suitable ingredienbts of concrete M20 such as cement, aggregate, water , Expanded polystrene sheets and wire mesh determing their relative proprotions with the object of producing concrete of required minimum strength, workability and durability as economically as possible. Figure 7 shows the shortceting of panel.

Figure 7 Shortcreting of panel

6. TESTING PROCEDURE

6.1 Slump Test

The test is performed in the following steps:

- Place the slump mould on a smooth flat and non-absorbent surface.
- Mix the dry ingredients of the concrete thoroughly until a uniform colour is obtained and then add the required quantity of water in it.

- Place the mixed concrete in the mould to about one-fourth of its height.
- Compact the concrete 25 times with the help of a tamping rod uniformly all over the area.
- Place the mixed concrete in the mould to about half of its height and compact it again.
- Similarly, place the concrete up to its three-fourth height and then up to its top. Compact each layer 25 times with the help of tamping rod uniformly. For the second and subsequent layers, the tamping rod should penetrate into the underlying layer.
- Strike off the top surface of the mould with a trowel or tamping rod so that the mould is filled to its top.
- Remove the mould immediately, ensuring its movement in vertical direction.
- When the settlement of concrete stops, measure the subsidence of the concrete in millimeters which is the required slump of the concrete.

6.2 Compression Test on Concrete

The determination of the compressive strength of concrete is very important because the compressive strength is the criterion of its quality. Other strength is generally prescribed in terms of compressive strength. The strength is expressed in N/mm^2. This method is applicable to the making of preliminary compression tests to ascertain the suitability of the available materials or to determine suitable mix proportions. At least three specimens should be made available for testing. Where every cylinder is used for compressive strength results the cube strength can be calculated as under. Minimum cylinder compressive strength = 0.8 x compressive strength. The concrete specimens are generally tested at ages 7 days,14days,28days. At the time of testing, each specimen must keep in compressive testing machine. The maximum load at the breakage of concrete block will be noted. From the noted values, the compressive strength may calculate by using below formula.
Compressive Strength = Load / Area

6.3 Flexural Strength Test

Specimens were dried in open air after 7 days of curing and subjected to flexural strength test under flexural testing assembly. Apply the load at a rate that constantly increases the maximum stress until rupture occurs. The fracture indicates in the tension surface within the middle third of span length. The flexural strength was obtained using the formula (R)

$$R = Pl/bd^2$$

Where,
R = Modulus of rupture (N/mm^2)
P = Maximum applied load (N/mm^2)
l = Length of specimen (mm)
b = Width of specimen (mm)
d = depth of specimen (mm)

7. CONCLUSION

Thermocrete Panel goes up so quickly, precisely and easily that fewer masons and other skilled workers are needed to get the job done. Thermocrete Panel is made of EPS foam and galvanized steel frame, so the system does not deplete forestry products. Furthermore, the high density expanded Polystyrene (EPS) thermal insulation core used in the panels contains no ozone damaging CFCs either in the manufacturing process or the end product. All the materials are also recyclable. Thermocrete Panel construction system can easily be used toward a Leed certification of a passive building. Earlier completion means earlier occupancy. Fewer laborers and less equipment mean a lower cost. Together, it means lower total capital investment and a quicker return on Investment (ROI). Thermocrete Panel construction system structures require minimal long-term maintenance, especially in areas prone to termite infestation, extreme weather and temperature conditions. Summer heat, winter snow, heavy rains and high wind, nothing gets through Thermocrete Panel. In this study the material properties of Thermocrete panel are discussed and the following conclusions are drawn Structures built with Thermocrete Panel have experienced up to 50% -80% savings in electricity and gas consumption, made possible by the requirement of smaller and more efficient HVAC / heating and air conditioning systems due to lower heating & cooling loads. Smaller HVAC unit = cost reduction. The Thermocrete Panel construction system is totally resistant to termites, insects, and rodents as well as to mold, mildew & fungi.

References

[1] T.Subramani., S.Krishnan. S.K.Ganesan., G.Nagarajan "Investigation of Mechanical Properties in Polyester and Phenyl-ester Composites Reinforced With Chicken Feather Fiber" International Journal of Engineering Research and Applications Vol. 4, Issue 12(Version 4), pp.93-104, 2014.

[2] T.Subramani, J.Jayalakshmi , " Analytical Investigation Of Bonded Glass Fibre Reinforced Polymer Sheets With Reinforced Concrete Beam Using Ansys" , International Journal of Application or Innovation in Engineering & Management (IJAIEM) , Volume 4, Issue 5, pp. 105-112 , 2015

[3] T.Subramani, D.Latha , " Experimental Study On Recycled Industrial Waste Used In Concrete" , International Journal of Application or Innovation in Engineering & Management (IJAIEM) , Volume 4, Issue 5, pp. 113-122 , 2015

[4] T.Subramani, V.Angappan , " Experimental Investigation Of Papercrete Concrete" , International Journal of Application or Innovation in Engineering & Management (IJAIEM) , Volume 4, Issue 5, pp. 134-143 , 2015

[5] T.Subramani, V.K.Pugal , " Experimental Study On Plastic Waste As A Coarse Aggregate For Structural Concrete" , International Journal of Application or Innovation in Engineering & Management (IJAIEM) , Volume 4, Issue 5, pp.144-152 2015

[6] T.Subramani, B.Suresh , " Experimental Investigation Of Using Ceramic Waste As A Coarse Aggregate Making A Light Weight Concrete " , International Journal of Application or Innovation in Engineering & Management (IJAIEM) , Volume 4, Issue 5, pp. 153-162 , 2015

[7] T.Subramani, M.Prabhakaran , " Experimental Study On Bagasse Ash In Concrete" , International Journal of Application or Innovation in Engineering & Management (IJAIEM) , Volume 4, Issue 5, pp. 163-172 , 2015

[8] T.Subramani, A.Mumtaj , " Experimental Investigation Of Partial Replacement Of Sand With Glass Fibre" , International Journal of Application or Innovation in Engineering & Management (IJAIEM) , Volume 4, Issue 5, pp. 254-263 , 2015

*[9] T.Subramani, S.B.Sankar Ram **Experimental Study on Concrete Using Cement With Glass Powder, IOSR Journal of Engineering,**Volume 5 , Issue 5, Version 3, pp43-53, 2015*

[10] T.Subramani, S.Kumaran , " Experimental Investigation Of Using Concrete Waste And Brick Waste As A Coarse Aggregate " , International Journal of Application or Innovation in Engineering & Management (IJAIEM) , Volume 4, Issue 5, pp. 294-303 , 2015

***[11]** T.Subramani, G.Ravi, **"Experimental Investigation Of Coarse Aggregate With Steel Slag In Concrete", IOSR Journal of Engineering,** Volume 5,Issue 5, Version 3, pp64-73, 2015*

[12] T.Subramani, K.S.Ramesh , " Experimental Study On Partial Replacement Of Cement With Fly Ash And Complete Replacement Of Sand With M sand" , International Journal of Application or Innovation in Engineering & Management (IJAIEM) , Volume 4, Issue 5 , pp. 313-322 , 2015

[13] T.Subramani, G.Shanmugam , " Experimental Investigation Of Using Papercrete And Recycled Aggregate As A Coarse Aggregate " , International Journal of Application or Innovation in Engineering & Management (IJAIEM) , Volume 4, Issue 5, pp. 323-332 , May 2015

[14] T.Subramani, P.Sakthivel , " Experimental Investigation On Flyash Based Geopolymer Bricks" , International Journal of Application or Innovation in Engineering & Management (IJAIEM) , Volume 5, Issue 5, pp. 216-227 , 2016 .

[15] T.Subramani, R.Siva, "Experimental Study On Flexural And Impact Behavior Of Ferrocement Slabs" International Journal of Application or Innovation in Engineering & Management (IJAIEM), Volume 5, Issue 5, pp. 228-238 , 2016

[16] T.Subramani, A.Anbuchezian , " Experimental Study Of Palm Oil Fuel Ash As Cement Replacement Of Concrete " , International Journal of Application or Innovation in Engineering & Management (IJAIEM), Volume 6, Issue 3, March 2017 , pp. 001-005 , ISSN 2319 - 4847.

[17] T.Subramani, A.Anbuchezian , " Experimental Study Of Mineral Admixture Of Self Compacting Concrete " , International Journal of Application or Innovation in Engineering & Management (IJAIEM), Volume 6, Issue 3, March 2017 , pp. 006-010 , ISSN 2319 - 4847.

[18] T.Subramani, A.Anbuchezian , " Experimental Test On Bitumen With Addition Of 35% Of Plastic Fibre " , International Journal of Application or Innovation in Engineering & Management (IJAIEM), Volume 6, Issue 3, March 2017 , pp. 017-022 , ISSN 2319 - 4847.

[19] T.Subramani, A.Anbuchezian , " Stabilization Of M30 Concrete Pavement By Partially Replacing Cement By 20% Of Flyash And Sodium Silicate " , International Journal of Application or Innovation in Engineering & Management (IJAIEM), Volume 6, Issue 3, March 2017 , pp. 023-031 , ISSN 2319 - 4847.

[20] T.Subramani, A.Anbuchezian , " Experimental Investigation On Flexural Behavior Of Folded Ferro Cement Panels " , International Journal of Application or Innovation in Engineering & Management (IJAIEM), Volume 6, Issue 3, March 2017 , pp. 045-049 , ISSN 2319 - 4847.

[21] T.Subramani, A.Anbuchezian , " Experimental Study On Replacement Of Concrete Material By Water Treatment Plant Waste Sewage " , International Journal of Application or Innovation in Engineering & Management (IJAIEM), Volume 6, Issue 3, March 2017 , pp. 050-057 , ISSN 2319 - 4847.

[22] T.Subramani, A. Fizoor Rahman , " An Experimental Study On The Properties Of Pet Fibre Reinforced Concrete " , International Journal of Application or Innovation in Engineering & Management (IJAIEM), Volume 6, Issue 3, March 2017 , pp. 058-066 , ISSN 2319 - 4847.

[23] T.Subramani, M.Meganathan, S.Priyanka , " Experimental Study On Strength Properties Of Diaphanous Concrete With Vermiculite " , International Journal of Application or Innovation in Engineering & Management (IJAIEM), Volume 6, Issue 5, May 2017 , pp. 229-238 , ISSN 2319 - 4847.

[24] T.Subramani, T.Anandavel, S.Priyanka , " Experimental Investigation Of Waste Plastic Fiber In Reinforced Cement Concrete Using Recycled Coarse Aggregate " , International Journal of Application or Innovation in Engineering & Management (IJAIEM), Volume 6, Issue 5, May 2017 , pp. 239-250 , ISSN 2319 - 4847.

[25] T.Subramani, S.Priyanka , " Experimental Test On Carbon Nano Powder On The Properties Of Concrete " , International Journal of Application or Innovation in Engineering & Management (IJAIEM), Volume 6, Issue 5, May 2017 , pp. 294-303 , ISSN 2319 - 4847.

[26] T.Subramani, P.Babu, S.Priyanka , " Strength Study On Fibre Reinforced Concrete Using Palmyra Palm Fibre Using Fem Software " , International Journal of Emerging Trends & Technology in Computer Science (IJETTCS), Volume 6, Issue 3, May - June 2017 , pp. 198-207 , ISSN 2278-6856.

[27] T.Subramani, G.Unni Krishnan, R.Arumugam, A.Godwyn Michael Cornelies, H.Gopu , " Experimental Study Of Quarry Sand And Rice Husk Replacing In Concrete " , International Journal of Application or Innovation in Engineering & Management (IJAIEM), Volume 6, Issue 5, May 2017 , pp. 312-319 , ISSN 2319 - 4847.

[28] T.Subramani, R.Sengottaiyan, K.Roop Kumar, V.Arun Kumar , S.S.Shanjay Sundara Sood , " An Exprementai Investigation On Mineral Admixture For High Perfomence Of Concrete " , International Journal of Application or Innovation in Engineering & Management (IJAIEM), Volume 6, Issue 5, May 2017 , pp. 320-326 , ISSN 2319 - 4847.

[29] T.Subramani, M.Senthilkumar, V.Ashok Kumar, Pawan Kumar Singh, R.Silambarasan , " Experimental Study On M-Sand With Addition Of Sugar As Admixture In Concrete " , International Journal of Emerging Trends & Technology in Computer Science (IJETTCS), Volume 7, Issue 2, March - April 2018 , pp. 100-107 , ISSN 2278-6856.

[30] T.Subramani, A.Fizoor Rahman, K.M.Mohamed Irfan, G.Ramajayam, Shubram Mohan , " Experimental Study Of Applying Translucent Concrete In Green House Building Concrete Using M-Sand " , International Journal of Emerging Trends & Technology in Computer Science (IJETTCS), Volume 7, Issue 2, March - April 2018 , pp. 116-125 , ISSN 2278-6856.

[31] T.Subramani, M.Senthilkumar, G.Gopinathan, A.S.Kabil, R.Naveen Kumar , " Experimental Study On Pervious Concrete Using Different Size Of Coarse Aggregate " , International Journal of Emerging Trends & Technology in Computer Science (IJETTCS), Volume 7, Issue 2, March - April 2018 , pp. 126-133 , ISSN 2278-6856.

[32] T.Subramani, S.Sekar, Kuriakose saji, Syam gopalakrishnan, A.Arul prakash , " Experimental Study On Pollution Control Concrete " , International Journal of Emerging Trends & Technology in Computer Science (IJETTCS), Volume 7, Issue 2, March - April 2018 , pp. 149-157 , ISSN 2278-6856.

[33] T.Subramani, N.Liyamin Ahad, Eldhose Jolly, Manuel Cheriyan, S.Priyanka , " Experimental Study On Mechanical Behavior Of Roof Panel Using Steel Fibre With Alkaline Solution " , International Journal of Emerging Trends & Technology in Computer Science (IJETTCS), Volume 7, Issue 2, March - April 2018 , pp. 169-176 , ISSN 2278-6856.

[34] T.Subramani, S.Gunalan, Hari Prasath, K.Vasantha Sethupathi , S.Priyanka , " Experimental Investigation Of Concrete Using Peengan Waste " , International Journal of Emerging Trends & Technology in Computer Science (IJETTCS), Volume 7, Issue 2, March - April 2018 , pp. 208-215 , ISSN 2278-6856.

[35] T.Subramani, V. Karthick, A. Mohammed Asif, Mohammed Salman, S.Priyanka , " Experimental Study on Hybrid Fiber Concrete With Banana And Sugarcane Fiber " , International Journal of Application or Innovation in Engineering & Management (IJAIEM), Volume 8, Issue 3, March 2019 , pp. 200-209 , ISSN 2319 - 4847

[36] T.Subramani, Akshay Vijayan, P.Mohammed Fayas, Jestin Thomas, S.Priyanka , " Experimental Study on Flyash and Lime With Gypsum in Concrete " , International Journal of Application or Innovation in Engineering & Management (IJAIEM), Volume 8, Issue 3, March 2019 , pp. 257-268 , ISSN 2319 - 4847.

[37] T.Subramani, J.Karthick Rajan, F.Mohamed Ibrahim, K.Mano Vikaram, P.M.Rajesh , " Experimental Study on Hybrid Fiber Concrete (Polypropylene Fiber with Basalt Fiber) " , International Journal of Application or Innovation in Engineering & Management (IJAIEM), Volume 8, Issue 3, March 2019 , pp. 269-278 , ISSN 2319 - 4847.
[38] T.Subramani, Febin Skaria Jacob, Limil Antoney, Rahul Pillai Suresh, S.Priyanka , " Experimental Study On Concrete With Plastic Waste And Master Gelinium " , International Journal of Application or Innovation in Engineering & Management (IJAIEM), Volume 8, Issue 3, March 2019 , pp. 288-296 , ISSN 2319 – 4847
[39] T.Subramani, S.Priyanka , " Experimental Study on Research of Bricks with Copper Tailing Waste " , International Journal of Application or Innovation in Engineering & Management (IJAIEM), Volume 8, Issue 3, March 2019 , pp. 329-334 , ISSN 2319 – 4847
[40] T.Subramani, S.Priyanka, K.Thirunavukkarasu , " Experimental Investigation of Concrete using Basalt Fibre And GFRP Sheet " , International Journal of Application or Innovation in Engineering & Management (IJAIEM), Volume 8, Issue 3, March 2019 , pp. 335-340 , ISSN 2319 - 4847.
[41] T.Subramani, J.Karthick Rajan , " Experimental Study on Hybrid Fibre Concrete " , International Journal of Application or Innovation in Engineering & Management (IJAIEM), Volume 8, Issue 3, March 2019 , pp. 349-356 , ISSN 2319 - 4847.
[42] T.Subramani, J.Karthick Rajan , " Experimental Investigation Paver Block Natural Fiber " , International Journal of Application or Innovation in Engineering & Management (IJAIEM), Volume 8, Issue 3, March 2019 , pp. 357-364 , ISSN 2319 - 4847.