



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJIRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 11, Issue 1, January 2022

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 7.569

9940 572 462

6381 907 438

ijirset@gmail.com

www.ijirset.com

Improving Building Energy Efficiency by E.I.F.S

Salim Raees Shaikh¹, Mohammad Rafiullah Md. H. Mansoori², Razin Ahmad Shaikh³,
Mohd Tanjeem Khan⁴, Dr Satish Deshmukh⁵, Prof. Suraj Tandale⁶

P.G. Student, Department of Civil Engineering, Trinity Academy of Engineering, Pune, India¹

Civil Engineer, Department of Civil Engineering, JIEMS, Akkalkuwa, India²

P.G. Student, Department of Civil Engineering, Trinity Academy of Engineering, Pune, India³

Civil Engineer, Department of Civil Engineering, Jamia Institute of Engineering and Management Studies,
Akkalkuwa, India⁴

Professor, Department of Civil Engineering, Trinity Academy of Engineering, Pune, India⁵

Asst. Professor, Department of Civil Engineering, Trinity Academy of Engineering, Pune, India⁶

ABSTRACT: Recently the use of artificial stucco (formally known as Exterior Insulation and Finishing System). Exterior insulation and finish system is a non load bearing, exterior wall cladding system. That consist of an insulation board attached either adhesively or mechanically or both to the substrate, an integrally reinforced base coat and a texture protective finish coat. It has been used since 1960's in North America, First on masonry building, but since the 1990's .The majority work on wood framed building. There is history of water infiltration problem causing damage to the building resulting in costly, legal cases so recommended system include a drainage plain to laid water down and out from behind cladding.

KEYWORDS: EIFS, Insulation Wall, Expanded Polysterene, shotcrete.

I. INTRODUCTION

Exterior insulation and finish system is a non load bearing, exterior wall cladding system. That consist of an insulation board attached either adhesively or mechanically or both to the substrate, an integrally reinforced base coat and a texture protective finish coat.

It has been used since 1960's in North America, First on masonry building, but since the 1990's .The majority work on wood framed building. There is history of water infiltration problem causing damage to the building resulting in costly, legal cases so recommended system include a drainage plain to laid water down and out from behind cladding.

The material which we use in it EPS (EXPANDED POLYSTERENE).We are replacing the concrete fascad by EPS and also the partition walls are replaced by EPS. That's why the building self-load decreases, so the structure will sustainable. The impact resistance of this fascad rendered. R.C.C concrete is replaced by the EPS.

It is thermal resistance also resist heat, snow, water and summer erection etc. It is light weight material which can be water resistible, moisture resistible also protection from lateral stability and giving good strength. Installation of EPS is by hand, using the tools are simple hand tools. The construction cost as much lesser than normal construction work. It decreases construction time and it has been economic feasibility and protective by chemical composition or hazards.

The need of our work is making green building efficiency.

Expanded Polystyrene (EPS) core 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.

EPS 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 EPS panels consist of a 3-dimensional welded wire space frame utilizing a truss concept for stress transfer and stiffness as shown in Fig. 1.1.

EPS 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.

EPS panel after shotcrete has the following five components (as Fig. 1.1):

- i. The outer layer of shotcrete.
- ii. Welded reinforcing mesh of high wire.
- iii. The core of expanded polystyrene sheet.
- iv. Diagonal wire (stainless or galvanized wire).
- v. 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.

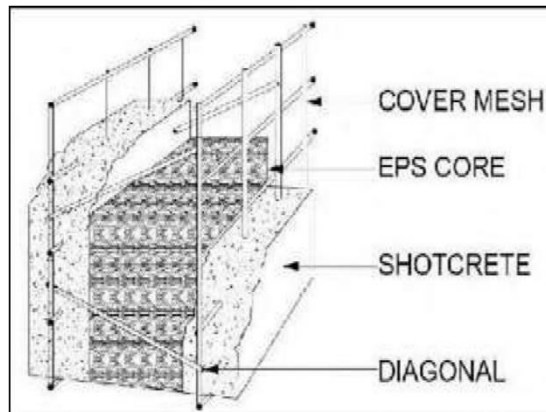


Fig 1.1: Typical cross section of wall panels

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.

EPS panel is a versatile structural element designed for floors, walls, partitions, roof and stairs. Fig. 1.2 & Fig. 1.3 shows the welded reinforcing mesh of the EPS panels at different cross-sections.



Fig 1.2: Reinforcing mesh expanded panel polystyrene core and Diagonal wire.

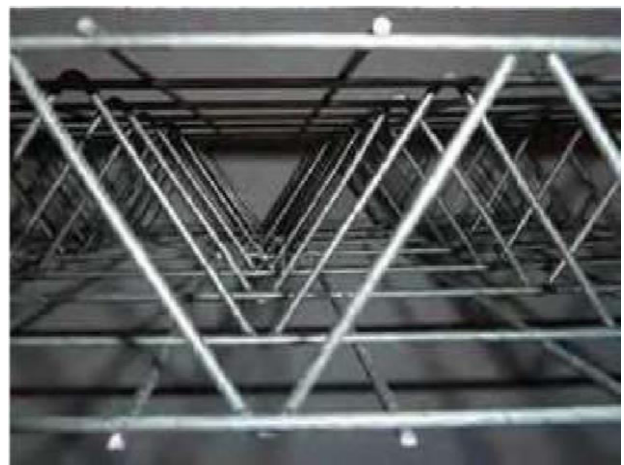


Fig 1.3: Welded reinforcing mesh 3-D without expanded Polystyrene core.



The typical EPS panel is generally manufactured with dimensions of 1200 mm 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 shotcreting of cement & coarse sand in the ratio of 1:4 applied under pressure. The shotcreting coat encases the EPS Core with centrally placed steel welded wire mesh.

II. RELATED WORK

Prior to 1996, Exterior Insulation and Finish Systems (EIFS) had become popular as an exterior building envelope cladding system in the residential and commercial construction market in North America [1]. Since 1996, the commercial construction sector has continued to experience rapid growth; however, residential construction dropped as the EIFS cladding system, as being built at the time, became associated with certain water intrusion problems. Nissen [10] presented a summary of serious moisture problems in barrier EIFS-clad walls in New Hanover County, including the city of Wilmington, NC. Moisture problems ranging from high moisture content in the exterior sheathing to wood rot in some houses were observed. Many of the 3200 EIFS-

2.1 Achilles Karagiozis, PhD. Distinguished Research and Development Staff, Oak Ridge National Laboratory, Oak Ridge, TN 37831-6070:

Clad homes in that area needed some remedial repair. Most of the water intrusion issues were traced to flashing details and the penetration of water into the wall systems at window joints. The installation of code mandated sub-sill window flashing was not practiced by builders nor was diverter flashing used at roof/wall intersections. Investigations showed that approximately 45% of the damage occurred below the corners of windows and 35% below missing roof flashing. Problems of water intrusion were not unique to EIFS but the adverse publicity was focused on the system. The issue of water penetration was limited to interface locations, not within the field of the wall. Typically, small amounts of penetrating water could dry through the wall assembly but problems developed if there chronic wetting and moisture did not dry out quickly enough. Questions were also raised about the effect of interior vapor control strategy. At the time, an interior vapour barrier was mandated by code. Another major finding was that the windows installed in these homes were not appropriate for the climate zone. These two reasons, in combination with the flashing issues, were the prime reasons for the failed performance observed in Wilmington, NC. Although the problems with water intrusion appeared to be universal with all cladding materials, only EIFS was studied quantitatively. Information on other claddings in NC is mostly anecdotal.

2.2 John Edgar, Technical Manager - Building Science, Sto Corp., Atlanta, GA 30331:

During this time period (1996 to 2001), a large number of papers appeared that sometimes added more confusion to the general literature. Many of the articles published were primarily generated by opinions and not basic building science. Early versions of MOIST (M1), MATCH (M2) and WUFI (W) were valuable in studies of moisture transport but were lacking material property data, surface transport coefficients, conservation of mass and energy, and ability to account for wind-driven rain (M1 & M2) and water penetration.

A number of scientific breakthroughs in the understanding of the transport of heat, air and moisture through a building enclosure became available from the International Energy Agency Annex 24 on Heat, Air and Moisture Transfer through New and Retrofitted Envelope Parts. Simpler versions of these models, such as WUFI, have now (since 2001) become available to the general public. The hygrothermal tools and data that would have assisted the analysis of moisture-induced failures were not available prior to 2001. Of course, it is not possible to predict system behaviour of improperly constructed wall systems even at this time simply because of the lack of detailed knowledge about specific faults.

In 2003, the Department of Energy (DOE) requested that Oak Ridge National Laboratory address the performance issues associated with exterior foam insulation. The perception of problems related to the use of exterior foam insulation (EIFS) led to a substantial reduction in construction built using EIFS. This reduced the potential energy savings in new and renovation residential construction. To meet the Zero Energy

2.3 New moisture problems menace coastal homes, Scott Brooks, Greater Wilmington Business, Volume 1.5, June 2000:

Building (ZEB) objectives laid out by the DOE Building America program, one cost effective option was to use EIFS wall systems. A strategic research plan was developed and proposed to EIFS Industry Members Association (EIMA) to partner with ORNL to investigate the performance of EIF wall systems. At the same time, ORNL would integrate some newer concepts arising from their previous research on moisture-engineered EIFS walls. These innovations included, water drained systems using a fluid-applied water resistive barrier, and EIF systems designed



with vented or ventilated drainage cavities. The research project was conducted in two phases. Below is a brief description of each phase of the research project.

2.4 Experimental Investigation of Punching Shear on FRP Strengthened Slab in International Journal of Advances in Scientific Research and Engineering (IJASRE), ISSN:2454-8006, DOI: 10.31695/IJASRE:

Punching in slabs is usually associated to the application of concentrated loads or to the presence of columns. One of the main concerns related to flat slabs is its punching shear capacity at slab column connection. Provided that bending capacity is installed, punching shear failure is hence characterized by the development of a truncated cone shaped surface at the slab-column connection. Frequently, there is the need to strengthen existing flat slabs against punching shear failure. One of the strengthening practices, which have been tested within current experimental programmes, consists on gluing carbon fibre reinforced polymers on concrete surface. Moreover, we want to know the behaviour of RC flat slab under FRP material against punching shear. The effect of FRP bars against punching shear is checked.

2.5 Cheple, M. and Huelman, P. H., (2000), Literature review of exterior insulation finish systems and stucco finishes, Technical Report, Dept. of Commerce, University of Minnesota:

The failures of exterior cladding are compounded when water invades exterior wall cavities, causing failure of insulation and leading to the deterioration of structural wall members. These types of problems have not been limited to EIFS systems, but appear to be causing damage in houses with traditional stucco installations as well as other types of cladding systems. This paper represents a summary of a review of the literature on stucco and EIFS applications as well as field studies at specific locations. It is a compilation and review of the recent research. This review is necessary to best determine the most efficient procedures for determining the causes, and therefore the prevention of, failures of stucco, EIFS, and other cladding systems. It has been conducted with emphasis on water intrusion of both exterior insulation finish wall finish systems and stucco clad systems. The review is divided into eight sections. An introduction (Section I) of the problem is followed by a section of definitions of terms associated with stucco and EIFS. The third section lays out in general some of the problems that have been reported with EIFS and stucco clad systems. Eleven case studies (Section IV) are followed by a review of suggestions for better methods of design and installation (Section V). Section VI. Measurement and Modelling, addresses both measurement challenges and building science principles that must be included in the discussion. Conclusions (Section VII) and selected recommendations for future research (Section VIII) as identified by researchers and investigators conclude the report.

2.6 A Review on Effect Analysis of Punching Shear on FRP Strengthened Slab 2018 IJSRST | Volume 4 | Issue 5
Print ISSN: 2395-6011:

They studied behavior and capacity of steel fiber reinforced concrete (SFRC) flat slabs of different dimensions. In addition, Amen Agbossou studied the experimental and theoretical behavior of slabs strengthened by FRP. The experimental results show that FRP significantly increases punching failure stress, resulting in a reduction of slab rotation around the loading column. The theoretical investigation presents a finite element model for the bending of strengthened slabs

2.7 Thermal Performance Impacts of Venting EIFS Assemblies Khaled H. Khaled Master of Building Science- Winter 2019 Program of Building Science Ryerson University:

The starting point of this review provides an overview of EIFS thermal and moisture performances, durability, and issues facing the EIFS industry in Canada. The review continues with introducing three different types of EIFS including: face-sealed, vented, and ventilated. The building physics of cavity ventilation, including ventilation driving forces and ventilation flow mechanics is also reviewed and the impact of air flow on heat transfer and its application on vented and ventilated EIFS assemblies is discussed. Finally, a previous initiative (Smegal, 2017) for full scale EIFS field testing is analysed and its parameters and results are used to calibrate a simulation model for predicting the thermal performance impacts of using vented EIFS assemblies at different building heights, as discussed later in the Methodology and Approach section.



III. METHODOLOGY

PROCESS OF APPLYING EIFS :

Without impacting life indoors, EIFS can be installed on new buildings or old structures that need facelift or structural improvements. Plastering contractors can be install it at the construction can be delivered on site as factorymade panels to attach building via crane.

EIFS is typically attached to the outside face of the exterior walls with an adhesive (cementitious or acrylic based) or mechanical fasteners. Adhesive are commonly used to attach EIFS to gypsum board, or concrete board, or concrete subretes. EIFS is attached with fasteners (specially designed for this application) when install over the sheet-good weather such as are commonly used over wood sheathings. The supporting wall surface should be continuous (not “open framing”) and flat.



Fig 3.1 :Application of EIFS

Typical Construction Sequence of EPS Core Panel Systems Foundations

1. Foundation

Foundations for the EPS Core Panel system whether strip or raft is conventional. If strip foundations are used, they should be level and stepped as this makes panel positioning easier. For EPS Core panels, parallel sided timber or metal template of the width of panel shall berequired to mark the position of the wall panels on the foundation and the spacing of the starter bar holes.

2. Wall start up

- i. Line wall positions shall be marked and profiled.
- ii. A timber or metal template of the exact width of panel (from wire to wire) shall be used to mark the position of the panels with chalk or pencil lines.(Fig.3.2)



Fig 3.2 Position of panel mark



Fig 3.3 Zig-Zag pattern of eachside panel

- iii. On the panel lines, positions shall be marked to drill the starter bar holes. These should be in a zig-zag pattern at 600mm centres on each side of the panels. Starter bars should be at all panel joints and on the opposite side in mid panel plus at all wall corners and joints. (Fig.3.3)
- iv. Starter bars should be either 6mm or 8mm dia. 500mm long with 100mm drilled into the foundations and 400mm above.
- v. Drill bits shall be used to give a tight fit with the starter bars.
- vi. Once starter bars are in position, place the EPS Core panels between the starter bars starting from a corner. Starter bars shall be wire-tied to the panel mesh and the panels to each other on the overlapping mesh. (Fig.3.4 & 3.5)



Fig.3.4 EPS Core panels between the starter bars



Fig 3.5 Overlapping mesh starting from a corner

3. Wall construction

- i. All corners and wall joints shall be reinforced with right angled wire mesh to the full height of the walls. (Fig.3.6 & Fig.3.7)
- ii. To cut panels to fit for door & window openings, wire should be cut with a wire cutter or angle grinder. Measure and mark the cut lines before starting to cut.
- iii. After the wire mesh has been cut, EPS shall be cut with a hacksaw blade or stiff blade hand saw.
- iv. Added steel mesh reinforcement (U type meshes) shall be required around door and window openings to ensure that no plaster cracks form in these areas. Mesh reinforcement strips shall be tied diagonally with wire around openings before plastering.
- v. Once wall panels are in place and tied together, bracing shall be required to hold them vertical before plastering. This shall be done only on one side of the panels. (Fig.3.8)
- vi. Once the panels are plastered on one side, the wall bracing shall be removed after 24 hours. Plastering on other side can be done without bracing.



Fig 3.6 Interior wall joints



Fig 3.7 Exterior wall joints



Fig 3.8 Wall panel hold vertical before plastering

4. Door and Window fittings

4.1 First method

- i. Fix a metal angle iron or hollow tube sub frame into the openings before plastering. Fix and plaster these in place and then secure the frames to the sub frame.
- ii. In order to secure heavy door/window frames, it is advisable to burn or cut away the EPS where the fixing bolts are to be secured to the wall and to fill this space with mortar or concrete to hold the bolts. (Fig.3.9 & Fig.3.10)



Fig 3.9 EPS Door/Window hold

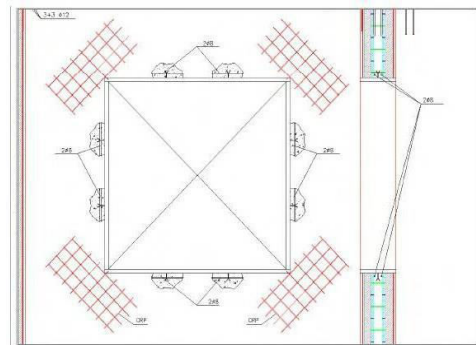


Fig 3.10 Cross-section to mortar hold

4.2 Second method

- i. Before plastering metal 'cliscoe' type window and door frames (which should be sized to the width of the panels) may be fitted into the pre-cut panels.
- ii. Metal lugs from the back of metal frames shall be wire tied to the panel mesh to keep the frames in position. (Fig.3.11)

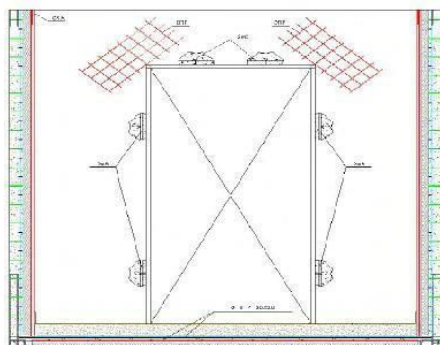


Fig 3.11 Frame position



5. Plastering

The installation steps are:

- i. Fix rods into the RCC beams and columns(if not cast in previously).
- ii. Lay panels between rods and affix with binding wire.
- iii. Cut out windows/door openings (if not done already)
- iv. Install piping and fitting into the core.
- v. Attach adjacent panels with mesh pieces provided.
- vi. The wall is finished with sand/cement mixture using the traditional method or by a shotcreting machine to create a monolithic structure.

General Requirements

- i. The design shall satisfy the standards of IS 456, IS 1905, IS 11447, IS 875 (Part 1-5), IS 1893 (Part 1), IS 4326, IS 13920.
- ii. Cutting drawings shall be prepared with clarity to facilitate the cutting at the manufacturing plant of the various wall or floor panels to appropriate sizes. In case of wall panels opening for doors, windows etc. shall be suitably marked in the respective panels.
- iii. When the panels are to be cut at the factory in accordance with the cutting joints, these shall be suitably marked on the surfaces beforehand to facilitate correct identification for proper placement during erection at the construction site.
- iv. In construction using EPS panels as loadbearing structural walling, the walls in the ground floor shall be typically founded on the reinforced concrete (RC) plinth beam.
- v. Appropriate starter bars shall be embedded at the locations in a staggered way to a minimum specified distance. This ensures the connections of the super structure with the foundation spread over the entire wall length over the network of RC plinth beams. (vi) Plinth beams shall be supported on appropriate foundations, typically comprising spread footings or raft foundations suitably designed.
- vi. In the case of multi-storey buildings in high seismic zone, the design and detailing shall ensure proper transfer of base shear at the interface of the foundation and the super structure.
- vii. EPS panels used as walls or floors shall be shotcrete with a concrete of grade not less than M20 using aggregate of size less than 5mm.
- viii. The insulation core of expanded polystyrene (EPS) must comply with ASTM C578 and IS 4671: 1984. With 40 mm of shotcrete applied to both sides, each panel achieves a fire rating of 90 minutes [EVG].
- ix. Reinforcement mesh with steel wires shall be used in accordance with ASTM A185 [EVG].
- x. The diagonal truss wires, as well as the wire used in the manufacture of welded wire fabric, must be in conformity with ASTM A82 [EVG].
- xi. In case of cantilever projections such as balconies, suitable RC beams (Concealed within EPS forms) may be designed and detailed as required.
- xii. Special care shall be taken during construction to ensure proper connections at the junction such as plinth to wall panels, wall panel to wall panel, wall panels to slab panel etc. Design basis
- xiii. The design of EPS Panels is based on the below mentioned standards, codes and engineering practices.
- xiv. List of Codes(National & International) Expanded Polystyrene, often referred to as EPS, is a kind of rigid, closed cell foam plastic. EPS properties have a low thermal conductivity, high compressive strength, is light weight, inert. It can be used as a building material or a design element, and can be molded into many shapes for a number of household uses as well.

Expanded Polystyrene (EPS) is processed from its resin form. The resin contains a pentane gas which is safely released during the expansion process. With the addition of steam, the EPS resin expands up to 40% of its original size. The expanded pellets are then transferred into a block molded pellets are then transferred into a block molder.

IV. CONCLUSION

Comparison of EPS Core panel construction vs. RCC Construction.

Item of Work: Cost comparison of enclosed plan, four storeyed building having four dwelling units on each floor (Covered Area \approx 30.0 sq.m of each unit) with conventional type brick masonry RCC framed structure vs EPS panel walling and roofing system.

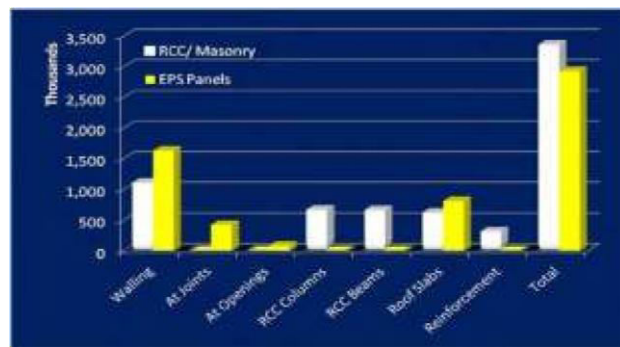


Fig. 4.1 Cost comparison of Conventional type brick masonry & RCC framed Structure Vs EPS Core Panel

Benefits of penalisation include greater speed and schedule reliability that can potentially convert to cost savings, less dust and dirt on site that are a result of rasping backs of panels to fit on walls for a site-fabricated system, and greater safety because of less time on scaffolds and fewer trips around the building. Prefabricated panels may be less costly for certain projects under certain conditions such as in poor weather and/or where site labour costs are high or working conditions difficult. Prefabricated panels can be delivered to the site net panel area. If proficient applicators can install the water resistive barrier and panels for offsite penalisation becomes a viable alternative to site-applied systems. The system is convenient to regular construction of bricks about fireproofing. Another case study using an off-site panelised EIFS is in progress.

- i. EPS core Panel system is a modern, efficient, safe and economic construction system for the construction of buildings. It has got the potential in achieving the Government of India's ambitious project "Housing for all by 2022".
- ii. After carrying out extensive research, industry interaction meetings, feedback received, EPS Core panel system is 3 times faster than conventional RCC construction.
- iii. 12 – 14 % cheaper than conventional RCC construction.
- iv. Low carbon footprint, as the material used in the construction is sustainable in nature.
- v. The Interactive User friendly Software developed by CBRI will help engineers, designers etc. in designing safe efficient Load bearing and nonload bearing EPS core panels.
- vi. Proper construction schedule should be followed for ensuring the time between erections to shotcreting is completed within 48 hours. This will avoid deterioration of EPS panels, which leads to reduced insulation properties.
- vii. A specially designed cost effective light weight machine should be developed for shotcreting the EPSLB/NLB panels.
- viii. Proper waste disposal system should be in place, ensuring minimum wastage and spillage of concrete in the surrounding areas.
- ix. A self-supporting scaffolding system need to be designed for EPS panel construction .In the current practice there is cracking at the joints of EPS – LB/NLB panel. The crack can be avoided by providing chicken mesh as per the structural requirement.
- x. Durability study, life cycle analysis study etc. should be carried out on EPS Core panel system for a better understanding and acceptability of the technology in the construction sector.

REFERENCES

1. Achilles Karagiozis, PhD. Distinguished Research and Development Staff, Oak Ridge National Laboratory.
2. John Edgar, Technical Manager - Building Science, Sto Corp., Atlanta, GA 30331.
3. New moisture problems menace coastal homes, Scott Brooks, Greater Wilmington Business, Volume 1.5, June 2000.
4. Experimental Investigation of Punching Shear on FRP Strengthened Slab in International Journal of Advances in Scientific Research and Engineering (IJASRE), ISSN:2454-8006, DOI: 10.31695/IJASRE
5. 4 Cheple, M. and Huelman, P. H., (2000), Literature review of exterior insulation finish systems and stucco finishes, Technical Report, Dept. of Commerce, University of Minnesota



6. A Review on Effect Analysis of Punching Shear on FRP Strengthened Slab 2018 IJSRST | Volume 4 | Issue 5 | Print ISSN: 2395-6011
7. Thermal Performance Impacts of Venting EIFS Assemblies Khaled H. Khaled Master of Building Science- Winter 2019 Program of Building Science Ryerson University



**Impact Factor:
7.569**



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 9940 572 462  6381 907 438  ijirset@gmail.com



www.ijirset.com

Scan to save the contact details