An Alternative Material for Tall Building's Glass Façade in Tropical Countries

Mr. Prasanna Bhangdia

B.Arch. (BKPS College of Architecture, Pune University, Pune-16, Maharashtra, India

Abstract- Facade systems, as one of the most complex elements of building, are largely responsible for both the energy-performance and overall aesthetic qualities of a building. With day-to-day innovation in materials & modern technologies, various different materials other than glass are available which can be used for facade of building. Ethylene Tetra Fluoro Ethylene (ETFE) is one of the most exciting materials in today's design industry and has set the construction world alight with the potential it offers. This research is about study of ETFE; An innovative material & its application as facade material for tall buildings in tropical countries.

Index Terms- Glass façade, Tall building, Tropical countries

I. INTRODUCTION

Façades play a very important role in the quality of a building. It forms the barrier between the internal space and the outside climate. Structurally the façade line is the most efficient line for placing the main structural elements. The façade is the medium through which the interaction takes place between the activities inside and outside. The image of a building, and therefore also of the users, is reflected through the design of the façade. In this case it is very important to use proper material for facade of tall buildings because not only they affect cost of building but also become a key stone in selection of structural system for building. Along with these, facade of building should also respond to its surroundings and hence designing facade for a tall building becomes an important aspect. There are several materials which are used for facade of tall buildings. With day to day innovations, variety of different materials are available having better aesthetic quality and energy performance than conventional materials. One of them is Ethylene Tetra Fluoro Ethylene (ETFE), discovered in 1950's, a polymer compound having distinctive properties than others, thus is an interesting material in design industry. It is a transparent polymer which weights approximately 1% of glass for same area and hence is easy to transport & erect[1]. Light weight of material helps to minimize sizes of structural member and thus reduces cost of construction. It is an inflammable material having very high melting point and does not produces droplets on burning[2]. There are many more features of ETFE over traditional glass and hence this research attempts to highlight those advantages.

II. BACKGROUND

Originally invented by DuPont as an insulation material for the aeronautics industry, ETFE was not initially considered as a main-stream building material, its principle use being as an upgrade for the polythene sheet commonly used for green house poly tunnels. The advantages of its extraordinary tear resistance, long life and transparency to ultra-violet light off-set the higher initial costs and 20 years later it is still working well. It wasn't until the early 1980s, when German mechanical engineering student, Stefan Lehnert, investigated it in his quest for new and exciting sail materials, that its use was reconsidered. Although discounted for Stefan's original purpose, he saw its strength, high light transmission and structural properties as an advantage to the construction industry and started to develop the systems we see today[3].

III. AIM OF RESEARCH

Aim of this research is to study properties of ETFE and its advantages when used as facade of tall buildings in tropical countries.

IV. OBJECTIVE & METHODOLOGY

In order to achieve the aim various objectives and their corresponding methodology have been set.

• To study ETFE; an innovative material-

This will include study of secondary data available from book, magazines, internet and previous research paper published which explains this new material.

• To Review ETFE foil and cushions as suitable replacement for Glass-

This will include comparison between glass and other conventional facade material with ETFE, based on available data and from this conclusion will be drawn

V. INTRODUCTION TO ETFE

ETFE is a melt-process able fluoropolymer, belonging to the sub-category of polymer materials called thermoplastics. This category relates to polymer materials that soften and become easily shaped and bent when heated Ethylene tetra fluoro ethylene (ETFE) is a fluorine-based plastic. It was designed to have high corrosion resistance and strength over a wide temperature range. ETFE has a relatively high melting temperature, excellent chemical, electrical and high-energy radiation resistance properties[4]. Following are some of the features which makes ETFE special,

1. Light Weight of material

As ETFE film is lightweight, it requires less structural steel to support it, less materials results in
a much lighter carbon footprint. Greater design capabilities due to the lightweight and flexibility of the ETFE film. Unlike glass, ETFE film is shatterproof, thus itself it is an advantage.

2. Excellent Light Transmission

ETFE film produces a bright and open space that can emulate the outdoors. Due to the high transmittance of daylight, lighting costs can be reduced which in turn will contribute to saving energy. By choosing a specific ETFE film, light transmission can be controlled to best suit the exposed area.

3. Superior Durability & self cleaning property

ETFE is highly resistant to chemical damage, as well as being resilient to wild weather. ETFE film can retain well its strength for over 20 years whilst also retaining its transparency with its self-cleaning capabilities.

4. Insulation Property

When ETFE film is used in the two or three layer model, it can be a great source of insulation for the inside of the structure. Along with this new technology has arrived of using various infill material within ETFE cushion.

5. Eco friendly

ETFE is recyclable; once it has been removed from a structure it can be recycled back into useable ETFE products. ETFE is a lightweight fabric, which requires less fabrication than traditional building materials, reducing C02 emissions in the air.

6. Fire resistance performance

ETFE film has passed International standards in fire resistance. It is entirely anti flammable, i.e. it does not catch fire nor does it spreads fire through it. Beyond this it does not produce droplets caused by fire.

VI. FURTHER DEVELOPMENT

ETFE is also available with fritting i.e. insulated coating material above cushion. This helps to control light gain and thus to control heat intake in building. This will reduce energy consumption within building, which is otherwise used to achieve desirable interior environment[5]. Now a days we have option to control transparency of cushion and noise insulation as per requirement of space. ETFE does not produce much glare as compared to conventional glass, thus gives quite pleasant external as well as internal view[6]. Few experiments are going on to check performance of ETFE by replacing air bound between two layers of cushion with another material. If successfully done, will further help to improve performance of material and ultimately the building[7].

VII. COMPARISON WITH OTHER MATERIALS

Based on secondary data available from various sources we can compare ETFE with other conventional materials which are generally used for facade of buildings in tropical countries,

Property	**Laminated Safety glass 13.5 mm**	**Insulated Double glass 24 mm**	**PVC**	**Polycarbonate 16 mm wall**	**PTFE**	**ETFE**
Life span	10-15 yr	10 years	15+ years	15+ years	30+ Years	30+ years
Self weight	36 kg/m2	30 kg/m2	1 kg/m2	3.3 kg/m2	1 kg/m2	1 kg/m2
Panel size	3.2 x 6 m	3.2 x 6 m	Up to 14 m	1.4 x 12 m	Up to 4 m	10 x 10 m
Weight of support	55-75 kg/m2	55-75 kg/m2	30-40 kg/m2	35-45 kg/m2	30-40 kg/m2	25-30 kg/m2
U value	5.5 W/m2K	2 W/m2K	4.6 W/m2K	2.3 W/m2K	4.6 W/m2K	1.18K/m2K
Light gain	85 %	76 %	10-15%	63 %	15-20%	0-90%
Heat gain	0.69	0.67	0.18	0.53	0.18	0.0 - 0.8
Noise gain	moderate	low	high	moderate	high	high
Fire resistance	Non combustible	Non combustible	Non combustible	Low	Non combustible	Non combustible
Smoke removal	n/a	n/a	n/a	n/a	n/a	available
External cleaning	Regular manual	Regular manual	Regular manual	Regular manual	Self but unsightly	Self cleaning
Repair	Removal of entire panel	Removal of entire panel	Patch repair	n/a	n/a	On spot patch repair
Grass growth	Good	Good	Poor	Poor	Moderate	Excellent
Ease of installation	Moderate	Moderate	Good	Moderate	Good	Excellent
Environmental credentials	Moderate	Moderate	Good	Good	Moderate	Excellent

VIII. ADVANTAGES OF USING ETFE FOR BUILDING FACADE

Due to light weight of material it is easy to handle, transport, erect on position and even fix it. ETFE have a long life span thus no need to replace unless it is seriously damage, and even if need so one can replace entire panel on the spot. Thus no disturbance to surrounding framing members. Cost of construction can be controlled by replacing glass facade with ETFE. Further ETFE have very high melting point and even at burning it does not produces droplets. It can hold fire up to certain temperature after which the air cushion breaks up, evaluating smoke generated by fire outside, and thus helps to save human life to great extend[8]. Self cleaning property of material reduces frequency of building maintenance. Since light transmission through ETFE is good, growth of grass in landscape area inside building is excellent. When we consider all these point, surely ETFE have many advantages over traditional building facade material.

IX. LIMITATIONS

This research is entirely based on secondary data source and no actual experiment was carried out during research period. This is just a theoretical analysis, however its real life model example is yet to come.

X. CONCLUSION

ETFE cushions have been studied in the pursuit of a replacement to glazing, as a solution to the disadvantages associated with use of glass, such as its fragility, weight and behavior towards heat transmission. Glass presents high transmission of near Infra-Red radiation, causing an increase in cooling requirements during warm weather, and regular cooling due to tropical climatic conditions. The excessive use of glazing also increases the embodied energy and thus elevate the building maintenance cost and affect global environment. This can be minimized by replacing glass panel by ETFE. Furthermore, the geometry of the building is often an obstacle to the use of glass which is not case with ETFE, thus designer have freedom to explore various forms. research aims to replace glass by ETFE in order to overcome all these consequences which a tall building face in tropical countries.

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AUTHORS

First Author – Mr. Prasanna Bhangdia, B.Arch. (BKPS College of Architecture, Pune University, Pune-16, Maharashtra, India Email: prasanna.bhangdia@gmail.com)