

# The EPS and XPS technical proprieties comparison and their usage in Albanian Contexted

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## -----ABSTRACT-----

Extruded polystyrene (XPS) otherwise known as a thermoplastic polymer has a closed cell structure and is often stronger, with a higher mechanical performance. XPS is a pressed material and is sold in different thicknesses ranging from 2 cm to 10 cm, thus having a weight that varies from 28 to 45 kg/m<sup>3</sup> due to the force and pressure exerted on it. In general, XPS material has very low thermal conductivity and is resistant to bending. This material obtains typical values of thermal conductivity between 0.025 and 0.040 W/m·K., which means that it is ideal for surfaces that have to withstand weight, continuous traffic, etc. It is also resistant to moisture absorption and has a homogeneous density. Other characteristics of the material are: good acoustic properties, easy assembly and high durability over time. It should always be kept in mind that the surface where the thermal insulation will be applied must be leveled, cleaned and dried. Primer is applied, before placing the thermal insulation on the surface. Then, XPS boards are placed on the surface, adhering to the corresponding mortar.

This paper will deal with different cases of application of XPS tiles in the city of Tirana. A closer look at the resistance of this material from the day of application until today will be analyzed. The results during the observations showed high thermal stability of the material and no mold surface.

EPS Expanded Polystyrene, otherwise known by the Dow Chemical trademark name STYROFOAM, is a lightweight product made from expanded plastic beads. It was first discovered by Eduard Simon in 1839 in Germany. EPS in its composition has 95% air and only about 5% plastic. This material is used because of its excellent properties, including good thermal insulation, good protective properties and extremely light weight. EPS is inert in nature and therefore does not result in any chemical reaction. EPS is durable, strong and lightweight and can be used as an insulated panel system for facades, walls, roofs and floors, as floating material in marine construction and as lightweight filler in road and railway construction.

Different examples from the city of Tirana, of buildings where XPS and EPS materials are applied, are going to be analyzed, drawing conclusions.

**KEYWORDS;**-Extruded polystyrene, building thermal insulation, testing, XPS; EPS; comparison

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## I. INTRODUCTION

Technology is constantly developing, so the debate on thermal insulators is deepening even more. Earlier this year, EPS-IA released two new documents related to moisture absorption. A discussion was raised to debate the sustainability of EPS. Not only that, but researchers have also claimed that extruded polystyrene (XPS) is the best alternative when it comes to deal with thermal insulation. EPS (expanded) and XPS (extruded) are both solid closed cell insulations made from the same base polystyrene resin but manufactured differently. EPS are beads that are molded or cut into different sizes and shapes while XPS is pressed sheet. During production, the blowing agent of EPS leaves the beads quite quickly creating thousands of tiny air-filled cells, while the blowing agent of XPS stays embedded in the material for years, reducing the ability to transfer air through the material. For the same 1-inch-thick sheet of the same density, XPS has a lower moisture absorption rating than EPS because of these differences. There are two variables, related to water; absorption and retention. The intrusion of moisture into building materials is sometimes unavoidable. It is important to evaluate the performance of the material when exposed to long-term environmental conditions. Insulation materials must resist moisture penetration, but equally important is being able to exhibit drying potential to maintain long-term thermal integrity. Furthermore, EPS outperforms XPS in keeping the home or building climate controlled. When exposed to extreme conditions EPS insulation exhibits severe drying potential while extruded polystyrene exhibits no drying potential when exposed to the same conditions. The drying potential for thermal insulation is

critical for maintaining thermal resistance (R-value) under severe long-term exposure conditions. There are many other technical differences between the two materials, so the debate will be detailed during the continuation of the study. [1]

## II. LITERATURE REVIEW

It is going to be study the comparative evaluation of insulating materials in the technical, environmental and health aspects. Studies show that during the last 30 years it has been an increase in the use of insulating materials and this has affected people's lives significantly. Different studies have been made on insulating materials. Great attention is paid to thermal conductivity, density, resistance to water vapor penetration, fire resistance, and price in determining the choice of insulation to install in an existing building. Furthermore, it is considered that EPS and XPS shows different characteristics. In terms of price, EPS dominates the European market with 27% relative to other insulating materials in general.

Material	Base materlals	Thermal conductivity ( $\lambda$ )(W/m k)	Density [kg/m3]	Fire class Nen-EN13501	Water vapour resistance factor ( $\mu$ ) [-]	Price when used in Rc=3.5 cavity wall [c/m2]
Expanded polystyrene (EPS)	Benzene,ethylene,pentane	0.032-0.045	10-80	E-F	20-100	8.60-17.35
Extruded polystyrene (XPS)	Benzene,ethylene,pentane	0.025-0.040	15-85	E-F	80-300	18.00-23.10

Figure 1. Insulation material properties. [2]

EPS is recycled without losing quality and this is a big advantage where recycling costs and manufacturers are required. Poor insulation contributes to high energy consumption. According to the studies carried out nowadays, it results that the specified thermal capacity is 3.5m2·K/W for panels with a thickness of 80-100 mm. [3]

## III. Tirana's case studies and technical characteristics of XPS

This study is going to analyze two different types of buildings with different EPS and XPS thermal insulation.Both materials offer very good thermal performance. EPS has a water vapor diffusion resistance of 30-70kpa, while XPS 80-250kpa. For surfaces with high moisture levels, XPS is the best alternative.

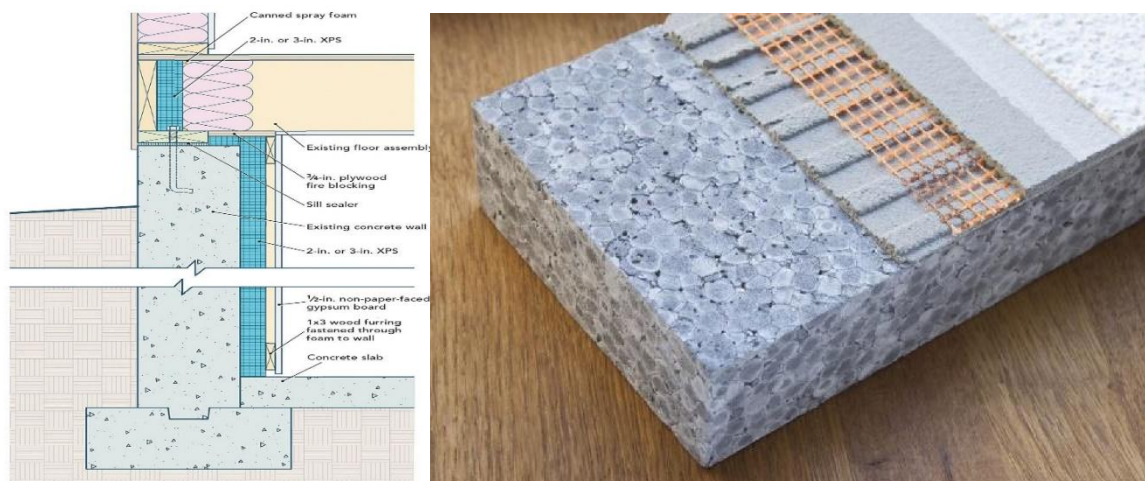


Figure 2. XPS insulation [4]

## IV. XPS and EPS implementation in Tirana. Case studies

### 1.1IBN complexes

The study is going to deal with different application cases of XPS and EPS tiles in the city of Tirana. It is going to be observed the resistance of this material from the day of application until today. The surfaces where the materials are applied should have high thermal stability and their surface should be free of mold marks. The first building that is verified is a residential building in the area of the former airfield, Tirana, the IBN complexes. The construction of the building started in 2018 and was completed in 2019. The terrace is insulated with EPS material and the parking lot with XPS. According to the observations, there was no sign of mold or compaction.



Fig 3 Photos of the building, A. Parking area; B. Terrace; C. Indoor Area; source: authors

### 2.1 Residential and service buildings

The next building is equipped with XPS thermal insulation. It is a residential and service buildings 1-2-6 floors with a basement floor on "Donald Tramp" Street, Neighborhood "Frutikultura, Kamez". There are observed no signs of moisture or mold, from the photos taken on the ground floor. This thermal insulation material (XPS) in the facade is applied directly to the bricks, using a toothed steel trowel and a metal spatula. The adhesive that is further used for this type of application is applied every 5 mm in three different points. The drying time of this adhesive in atmospheric conditions needs at least 2 days.

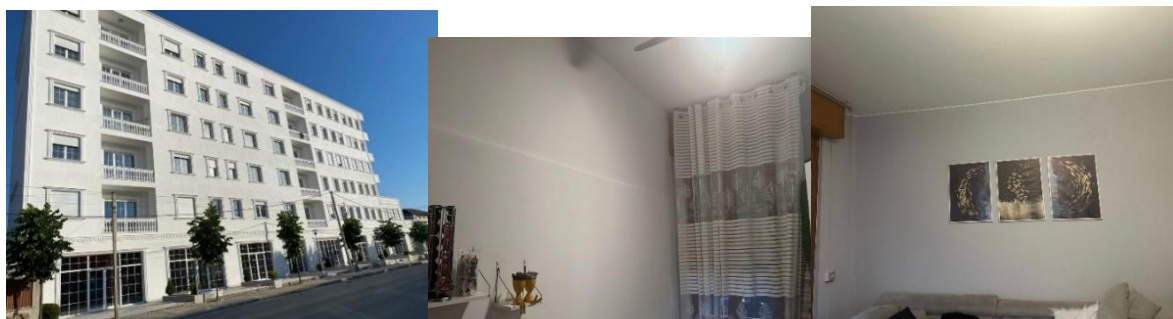


Figure 4. Photos of the building located in "Donald Tramp" Street; source: authors

### 3.1 The public parking

This project is one of the most magnificent in the city of Tirana. The square is located at the intersection of "BajramCurri" boulevard with Elbasani Street. It is bordered in the northern direction by "BajramCurri" boulevard, in the southern direction by "FatmirHaxhiu" street, in the western direction by the square with potential for future development, and in the eastern direction by Elbasani Street. It covers an area of 3087 m<sup>2</sup>. The public parking is designed with 2 underground floors and offers 146 parking spaces plus 2 parking spaces for individuals with different abilities. This project is coated with XPS thermal insulation material which is used on the entire surface of the parking lot, and the material used is called floor mate 500. Water-based Extracoat is applied to the concrete slab, which is a bituminous primer that is an adhesive for XPS Dow thermal insulation and acts as a vapor barrier. Subsequently, XPS DOW heat-insulating panels are placed and on top of them a layer of lightweight concrete "IzobetonAditivato". Afterwards, solvent-based bituminous primer and bituminous membrane were applied, where their adhesion was carried out with flame according to the traditional method. The final layer is a layer of mortar and then are applied the tiles.

#### Interior walls

At the beginning, the surface of the concrete walls is painted with bituminous primer. The thermal insulation panels are placed on the waterproofing membranes and fixed by gluing with solvent-free bituminous primer.





Figure 5. XPS implementation;source: Izoterm Albania [5]

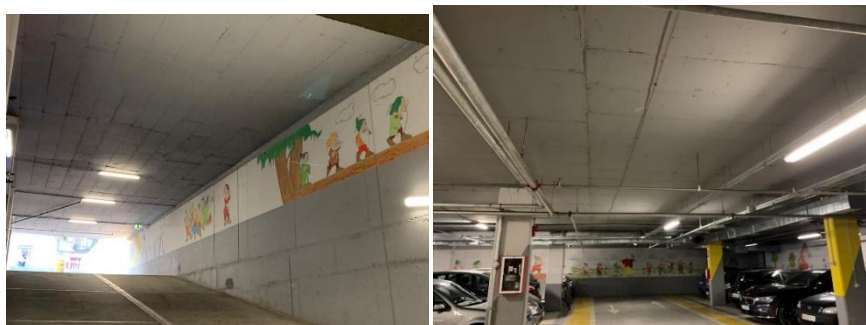


Figure 5.1 The public parking; source: authors

#### 4.1 Villa FeritRragami

The next building that is analyzed is the villa FeritRragami in Black Bird, Tirana. In the fasade of the building is implemented EPS 150 thermal insulation. The weight of the thermal insulation was 20 kg/m<sup>3</sup>. The placement of the EPS material and photos of the present situation of the building are showed in the Figure 6. According to the observations, the facade of the building had signs of moisture.



Figure 6.VillaFeritRragami during the application of EPS and the current situation; Luca Ndertim[6]

#### 5.1 Apartment in the village of Burel

The other building, that is considered in the study is a one-story apartment in the village of Burel, Tirana. The building was finished in 2015. This area has a slightly colder climate in comparison with the inner city due to heat island phenomenon. Furthermore, the temperatures are lower in winter. The thermal insulation material used is polystyrene EPS 150, 8 cm. The weight of the thermal insulation material is 20 kg/m<sup>3</sup> and it is implemented in the facades.



Figure 7. Villa in the village of Burel. During the placement of the thermal insulation material; source: Luca Ndertim[7]

## **V. Is XPS a good thermal insulation material?**

### **1.2 Disadvantages of XPS**

Fire classification is one disadvantage for XPS. XPS insulation has a value of Euroclass E. When the boards XPS insulation is used in one scenario inverted roof, with a ballast finish, the system can be classed as unlimited in the UK. While some green roof systems packed with cassettes, they will require independent testing BROOF (+4).[8]

### **2.2 Advantages of XPS**

Compared to other materials, XPS is thinner but it is quite good at protecting the object from external, internal and climatic factors. It is a material which can be worked easily but which can also save a lot of energy.

This material also, protects the object and building materials from condensation, correction and also protects buildings from outside temperatures, keeping them cool in summer and warm in winter. Another advantage is the protection of buildings from cracks caused by temperature changes. Finally, another advantage is related to the use of XPS as a layer for the construction of roofs and floors thanks to its durability. [9]

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## **VI. Technical characteristics of EPS and XPS**

### **1.3 What are EPS and XPS?**

With the help of advanced technology, new insulation techniques have been added. Thermal insulation made with EPS and XPS is one of the last points of thermal insulation technology, so it is one of the most preferred materials for external insulation. Eps is a thermal insulation material that stands for rigid expanded polystyrene foam. XPS is a thermal insulation material with a homogeneous cellular structure, which means rigid extruded polystyrene foam. [11]

### **2.3 Water absorption**

Since water is a good conductor of heat, it is a factor that reduces thermal insulation performance. This factor can be more hindering in the insulation done on the roof. Therefore, the water absorption rate of the insulating material should be low. XPS foams are distinguished from EPS foams by their low water absorption value. The closed-cell structure of XPS prevents water from entering the structure of the insulating board and therefore the rate of water absorption is low. The interconnected spaces between the beads in the EPS structure can allow water to penetrate. For this reason, XPS is usually chosen as a substitute of EPS in humid environments. [12]

### **3.3 Thermal conductivity**

Insulation is one of the most effective and cost-effective ways to increase the energy efficiency of buildings. A well-made insulation provides cost savings and savings in energy use. Both XPS and EPS provide good insulation performance due to their low thermal conductivity. When comparing EPS and XPS, the air trapped in the spaces in the EPS structure will transmit some heat. XPS can better insulate the heat. [13]

### **4.3 Compressive Strength**

Compressive strength is a requirement for insulation material used in many environments such as floors, footings, plazas, podium platforms, concrete floors and cold storage on a flat roof. The compressive strength of EPS is worse than XPS. In order to meet the same compressive strengths as XPS, EPS the foam density must be much higher and therefore more product must be used. [14]

### **5.3 Common features of XPS and EPS**

Both XPS and EPS are long lasting and durable insulation materials. Both are suitable for tile roof insulation. They have structures with low thermal conductivity suitable for insulation. These durable insulating materials are resistant to changes in air and moisture.[15]

## VII. CONCLUSION

According to the verifications the XPS material in terms of dimensional stability, it is recommended in facades, terraces and underground applications. Thanks to very low water absorption, it is observed that there is no impact on the errors that may occur during the application of the work. XPS has a high thermal insulation capacity thanks to closed pores and homogeneous cellular structures. It is also resistant to horizontal loads thanks to high compression resistance. It is noticed that maximum adhesion is applied on the material with optimal traction stability. This material can be easily processed during application during different weather conditions thanks to its easy and fast workability and physical properties.

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