

Synthetic building materials for transport buildings and structures

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Abstract. The most effective building materials account for the highest growth not only in construction of residential and public buildings, but also other capital projects including roadways, bridges, drainage, communications and other engineering projects. Advancement in the technology of more efficient and ecologically responsible insulation materials have been a priority for safety, minimal maintenance and longevity of finished construction projects. The practical use of modern building materials such as insulation, sound reduction and low energy consumption are a benefit in cost and application compared to the use of outdated heavier and labor-intensive materials. The most efficient way for maximizing insulation and sound proofing should be done during the design stages of the project according to existing codes and regulations that are required by Western Government. All methods and materials that are used need to be optimized in order to reach a high durability and low operational and maintenance cost exceeding more than 50 years of the life of the building, whether it is for public, industrial or residential use. Western construction techniques and technologies need to be applied and adapted by the Russian Federation to insure the most productive successful methods are being implemented. The issues of efficient insulation materials are outlined in this article.

1. Introduction

According to the Russian Federation the annual specific size of the expense of energy resources for buildings since January 1, 2016 through 2020 the allowable class of buildings that are required must be rated "B" or better. In some cases, requirements of energy efficiency can be lower to class "D" due to the type of construction that is recommended.

Assignment of class "A" and "B" buildings need to include power balance of renewable or secondary energy resources, such as solar panels, recirculating heating and air conditioning systems along with modern computer control, lighting and communication systems. The introduction of modern technologies should be established during the design, construction to ensure the costs benefits associated with the longevity of the building.

It is important to consider all practical methods and modern materials during the design phase of the building. Initial construction cost of using new technologies which translates into increased material cost. This material cost will be offset due to lower labor cost because of the minimal time used in during installation. However, the extra expenditures will decrease due to the energy efficiency, low maintenance and longevity of the structure. The use of minimal materials and labor cost will result in higher energy consumption, maintenance expenditures and rapid building deterioration. These new



insulation materials are classified by weight, heat conductivity, sound proofing, minimal water and vapor absorption and air and frost resistant durability. The comprehensive use of existing updated insulation technologies can meet or exceed Government regulations if current design or methods are used to complete modern advanced projects.

2. Methods

The development of domestic and foreign research in the field of studying construction projects, and forecasting of the behavior of energy efficient construction materials in various service conditions has become the theoretical and methodological basis of this research.

The research is based on the result of the analysis of heat insulating materials that are available to the Russian market according to existing standards.

The research of the use heat insulating materials includes comparative characteristic of the properties of insulation materials.

The qualities of these materials are:

- 1) reliability and service for construction projects
- 2) energy consumption during the severe inclement weather
- 3) reliability and service life of the construction projects
- 4) ecological preservation and safety
- 5) optimal engineering design of interior space.

According to the insulation industry the most effective insulation materials for construction are synthetic foam, cellular, polyurethane for mechanical, electrical and other various ducts consequently the use of these technologies can benefit multiple construction projects creating more efficient and prolong life span. [2,3]

3. Results

The use of the above-mentioned methods and materials can result in the reduction of weight of the structures from 500-600 to approximately 100 kg/m³. For instance, the weight loss for insulation of the interior panels can be 60 times greater than the use of existing of outdated insulation materials. Another example is weight reduction of exterior insulating panels which can be 10 time less than concrete or brick panels.

Further benefits of using synthetic heat and sound insulation materials are costs. The factors that reduce the costs of modern insulation materials are ease of installation and efficient curing properties that allow for further work to continue without any impediments.

Heat and sound synthetic materials belong to the class of highly efficient materials. These modern materials can be divided into the following groups:

- light weight insulation materials
- medium weight materials (35 kg/m³)
- least desirable and heavy materials that weigh more than 100 kg/m³

Other physical and mechanical factors regarding the synthetic heat and sound insulation materials can be classified into the following groups:

- rigid materials
- semi-fixed or flexible materials
- elastic materials (soft, non-hardening)

The last classification is:

- fibrous (non-adhesive)
- contained fibrous
- self-foaming fibrous (adhesive). [4,5]

The main advantage of the synthetic insulating materials is the combination of proficient insulation and the highest heat shielding (that are minimal to heat and cold transference). The longevity and stability of synthetic construction materials can be optimal because of the lack of maintenance required during the life span of the modern products.

Heat and sound insulation materials should meet following requirements:

- constancy of volume, structure and properties
- low volume weight (less than 100 kg/m³ per project)
- low heat and cold transference
- high sound proof (0,3-0,9)
- low water absorption (low than 5%)
- frost resistance
- ecologically safe
- air and gas containment
- installation safety
- minimal installation and maintenance
- anti-corrosive
- fire proofing
- sufficient durability and heat resistance
- product availability
- compliant to Government standards and specifications. [6]

It is important to manage modern design and construction techniques in order to maximize the synthetic heat and insulation products. Modernization of existing construction regulations need to adapt new construction methods and technologies to build public and private efficient energy saving buildings.

The use of such progressive materials such as foam and plastics in modern construction has the most effective heat insulation for the existing mechanical equipment being used such as, water pipes, gas pipes and cooling and heating system ducts, communication and technology conduits, wall coverings, partitions, doors and acoustic materials for false ceilings.

Engineers, architects and builders that use modern heat and sound insulation materials have the advantage of using new technologies that improve time and savings which translate into lower design and construction cost.

The polyfoams that are currently used in large panels and are suitable in the construction design contain PS-1, PS-4, PVH-1, PVH-2 elements that are found in modern foams which can fill large cavities during building construction are desirable for the structure durability and improved fire-resistant properties. [7]

The use of light weight polyfoams in the construction of metal buildings is not recommended due to the fact that metal panels exposed to the sun can exceed temperature higher than 80°C will damage the light weight polyfoams. Therefore, in such cases polyfoams with a higher volume weight should be installed in order to avoid heat damage to the insulation. The construction of metal buildings presents a problem for synthetic building materials due to heat and cold conductivity of the metals used for wall and roofing panels. The use of organic fibrous materials is a more efficient insulator due to its resistance of cold and heat transference. The construction of metal buildings is not recommended in inclement weather conditions because of the impact weather has on the properties of metal construction. Metal is a highly conductive to heat or cold transference, this causes a continual movement of the metal structure. Therefore, the longevity of metal buildings is limited due to continual stress of constant movement on the structure which causes metal fatigue and will lead to structural failure.

The application of polyfoams in the building structure can have:

- the cells filled with gas, insulated from each other;
- polyfoams with closed cells have high steam and air resistance that prevent both heat or cold insulation transference;
- low moisture capacity polyfoams keep high heat insulation properties that decrease humidity within building environment.

Poly foam are divided according to how they are installed:

- where the foam is liquid and is applied using pressure between walls, cavities, around ducts and mechanical and gas pipes;

- self-foaming where the foam is applied from canisters filled with gas to fill cavities, joints around windows, wall openings, subflooring and other small openings;
- solid polyfoam where the foam is manually cut to fit and insulate large areas.
- Solid and self-foaming polyfoams make it possible to fill cavities, joints and other openings during construction that reduce labor and insulation costs for builders and building owners. [8,9]

4. Discussion

The main purpose of this discussion is to inform designers, builders and construction inspectors of energy efficient materials.

The contribution and implementation of state programs in the field of modern construction materials improve the quality and performance of residential and public buildings.

The quality and performance of public work projects can also benefit with use of improved building techniques and advanced materials.

Consumers should look for the best construction practices and materials in order to benefit over a longer life span and low maintenance of modern heat insulation materials needed to create a market that promotes efficient heat cost savings materials. Henceforth, consumers have an opportunity to purchase modern materials to meet their budget and construction need. Private designers, builders and investors that build multistoried buildings have benefited from the use of updated technologies and modern materials for the past 30 years. They continue to take advantage further cost savings as the technologies in both design and material advancement.

There are the many modern insulating materials available on the market. The best practice is to research and determine which of these efficient materials will suit your project and budget needs. There are many factors which can determine the quality of a finished building project, such as:

- environmental impact studies;
- design process;
- engineering process;
- architectural process;
- the research of efficient and durable modern building materials;
- effective management of subcontractors;
- optimized scheduling of materials, equipment, labor and inspections;
- experienced supervision and project management;
- quality control to minimize labor and materials cost;
- management and control of design errors which can result into additional or excessive expenses;
- effective control to minimize construction pollution, such as dust, noise, air quality monitoring and control;
- effective job sight recycling;
- succeeding target deadlines to avoid unnecessary penalties;
- final inspections;
- rapid completion of the deficiencies from the final inspection.

These aspects will guarantee a successful building project that will provide the builder and owners with a profitable, long lasting and low maintenance building.

Most new buildings are still using older time proven construction techniques and materials. Consideration are lower cost for design, construction and traditional materials. These types of structures have height restrictions due to the weight of the materials that are used in the construction of these projects. [10,11]

With the introduction of modern technology, such as insulation, adhesives, light weight wall panels and exterior and light weight architectural requirements. Adding modern methods during the construction of these building projects can improve the energy efficiency over the life span of the structure.

Unfortunately, these projects are still being completed without inclusion of new existing technologies. Owners are more concerned with profitability over the building of energy efficient

structures. Other factors that are a deterrent are the lack of research, implementation and absence of new technologies in the market place. Government regulations should be changed and amended to force owners to use new efficient energy saving materials and construction techniques for small to medium buildings. The benefit of the new regulations will result in the construction of high energy efficient buildings that will save 10 to 15 times more than traditional buildings.

Crucial factors of modern synthetic construction materials are:

- environmental impact
- product safety
- competent construction installation
- qualified inspections
- proven fire safety standards.

Current synthetic insulators and construction materials possess a superior fire-resistant history.

These materials have been used in Western Countries for more than 50 years.

During this time technology has advanced and improved the properties of synthetic building materials to decrease cost and installation. These materials have virtually become fire proof when applied according to current building practices and regulations. High-riser projects use the most up-to-date synthetic materials to prevent fire from spreading into different compartments that result in fire containment and reduce damage. The same design techniques and materials are also implemented in all public and private building projects because of the reduced fire prevention traits found in synthetic materials. [12,13]

The significance of fire prevention is crucial in order to prevent loss of life, property damage and restoration cost. Fire is the leading cause of death and property damage in building constructed before modern fire proofing was developed (buildings large amounts of flammable materials). There are still many buildings both public and private that are currently in use that need to be updated to existing fire code.

The use of synthetic materials has increased among countries seeking to update their material and construction techniques in order to meet their essential environmental and climate requirements. The different climate regions include cold to freezing, warm to hot, from heavy precipitation to dry or desert, humid to scorched and diverse climate zones. These are the advantages of using the latest synthetic building materials to optimize against above-mentioned climates that are found in different regions of the world. For instance, the same building can be constructed to meet different severe climate conditions by using the same synthetic building materials and construction techniques.

These are practical applications and diverse examples of the flexibility and use of efficient synthetic materials. That should be implemented and considered in order to ensure the advancement of long-term, low cost, efficient modernized public and private structures. [14-16]

5. Conclusion

Variety of diverse synthetic building materials can be applied to various construction projects, such as:

- roadways;
- high traffic roadways;
- urban roadways;
- airport runway systems;
- both heavy and high traffic bridges;
- drainage systems;
- sewage systems;
- potable water systems;
- irrigation systems;
- communication systems;
- high and low speed railway systems;
- railway signaling and communication systems;
- railway truss and bridging systems;

- air conditioning systems;
- heating systems.

These synthetic materials are not limited to building construction as demonstrated above. In every type of construction synthetic materials are used to improve the quality and longevity of infrastructure projects. In some cases, new technologies have been developed to rehabilitate older existing underground water, sewer systems. These systems can be restored without any interruption above the ground. The use of synthetic pipelining materials has been in successful practice for more than 20 years. The cost saving associated with synthetic pipelining material, such as urethane and liquid polymers that are attached to the old existing pipelines and underground structures are considerable compared to removal and replacement cost, such as:

- limited loss of service
- minimal demolition of existing pipelines and underground structures
- no traffic disruption
- no disposal or transportation cost of construction refuse
- no roadway replacement costs
- durable life span

The manufacturers and distributors need to expand synthetic materials into global market. This will benefit countries with limited resources that are still constructing outdated and inefficient buildings and public infrastructure. Countries that control manufacturing exports of modern synthetic materials should release restrictions limiting the amount of new technologies that would benefit countries with limited availability of modern construction materials. This will insure a global ecological benefit due to the construction of energy efficient buildings that will provide the reduction of pollution and energy waste. Countries need to work together to reduce the use of our limited existing energy resources and decrease the amount of pollution that is being released into our environment.

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