

**PRODUCTS OF SEPARATION OF BUILDING CONSTRUCTIONS
ELEMENTS MADE BY EXPANDED POLYSTYRENE
AT THE EFFECT OF CONFLAGRATION
AND THEIR INFLUENCE TO ONE'S ORGANISM**

UDC 699.87

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Abstract. *Application of expanded polystyrene (EPS) into modern conceptual erection housing and other objects, beside of unquestionably good sides, at the terms of conflagration is followed by its destruction and liberation of certain toxicity outputs. In this work are given in detailes results of assay unit constructive construction done by expanded polystyrene over temperature with 840 degrees from duration with 86 minutes.*

Key words: *Expanded polystyrene, wall panel, divisional panel, and panel mezzanine construction.*

1. INTRODUCTION

Expanded polystyrene, commercially denominative of polystyrene is obtained by polymerization of polystyrene monomial (product of coal derivates of oil) with presence of peroxide as catalyst. As the result of such way of production, there are produced grains in the form of granules, or infinitesimal pearls in the distinction between 0,2 and 3,0 milimetres, which are then classifying to form into fractions with different dimensions, depending on the aim of production.

EPS is firmly, miniature-jaw and cavited structure, which consists of equally, arranged microscopic cells filled with about 98% of vaccum air, and only about 2% of firmly material. Into 1 cm³ of EPS, there are 3×10^4 ÷ 3×10^5 of infinitesimal cells (with dimensions between 0,01 and 0,2 milimetres) impregnated with air.

The volume of EPS is usually 10 to 30 kg/m³, for different assortments, that is:

- 10 to 20 kg/m³ for slices and materials for putting aside, and
- 20 to 30 kg/m³ for the ingots and constructive materials for construction.

2. APPLICATION INTO CONSTRUCTION

Erection of constructional constructions with technology, which is using elements of EPS, is representing modern concept into construction. This kind of erection is getting a maximum of possible from its elements with their advantages in respect with other constructional elements. These advantages are:

- completely eliminated weather stripping of concreting
- the high mechanical resistance
- the high resistance to conflagration's effect
- elimination of thermic bridges
- elimination of risk in respect on significant accidence of stucco and walls-curtains in the dangerous from earthquake (they are ferroed and connected with head construction), and
- carrying monolith concrete construction, which is not prefabricated by dry procedure.

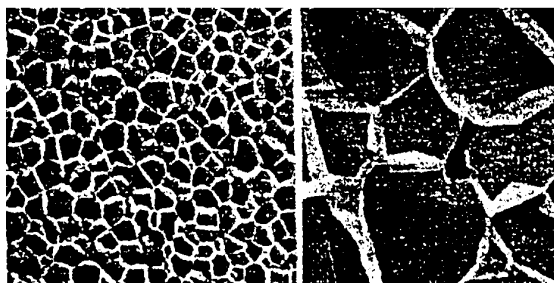
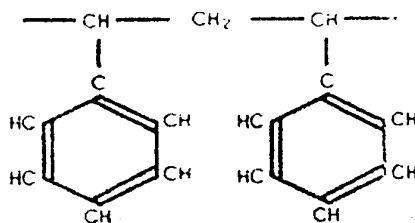


Fig. 1. Structural formula and appearance of EPS

In regard to traditional way of building erection, with this system will be achieved a saving in constructional labors (without handicrafts) over 20 % in some cases even 40 %, and saving in power consumption is 30÷35 %.

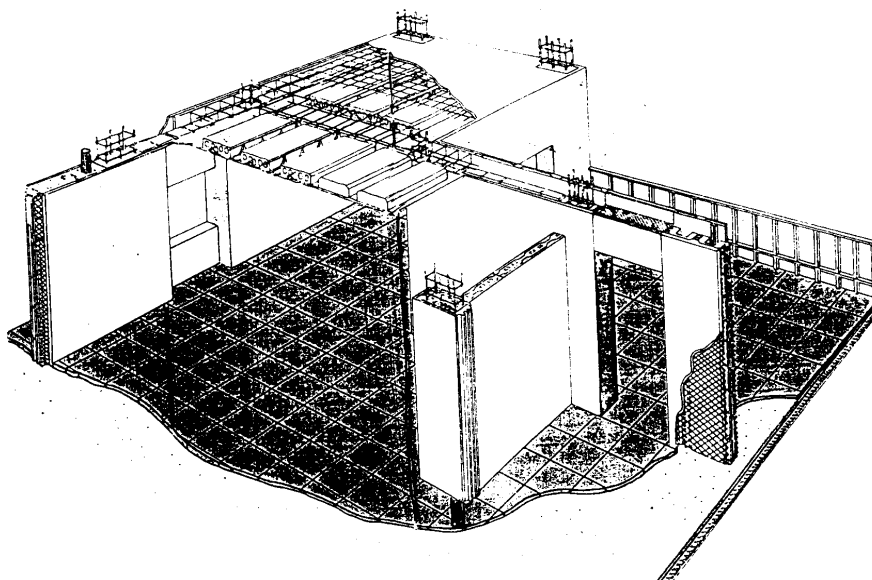


Fig. 2. Appearance of construction system of building by elements of EPS

For construction of buildings three constructional components are mostly used:

- the wall
- mezzanine construction, and
- division.

2.1. The wall panel

Conventional characteristics of wall panel are:

- thickness of panel 260 millimetres (20+220+20)
- width of panel 2400 millimetres (or less)
- length of panel depends on necessity
- module 300 millimetres, and aperture 160×160 millimetres
- weight:
 - 108 kg/m² with normal stucco;
 - 48 kg/m² with reprieved stucco; and
 - 8 kg/m² without stucco
- thermic isolation $K = 0,35 \text{ W/hm}^2\text{°C}$
- resonant isolation $/ = 42 \text{ dB}$
- resistance on conflagration:
 - class of 45 minutes (with normal stucco), and
 - class of 60 minutes (with reprieved stucco).

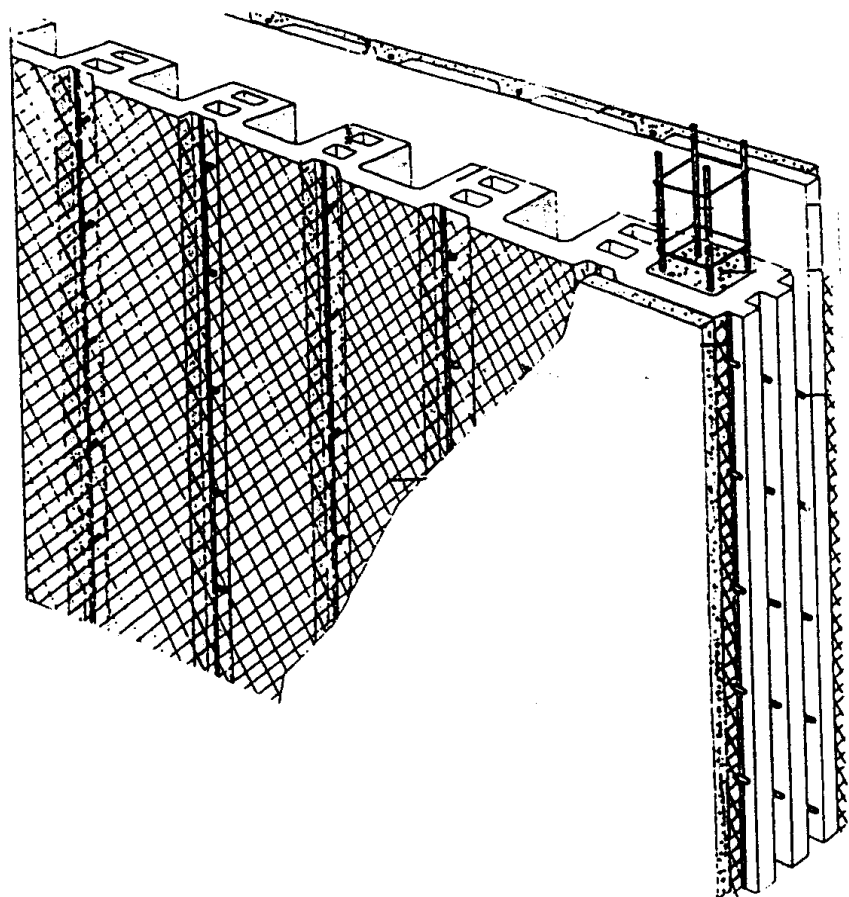


Fig. 3. Appearance of wall panel

2.2. Divisional panel

Divisional component of EPS system is as well similar as wall panel. Usual characteristics of divisional panel are:

- thickness of panel 120 millimetres (20+80+20)
- width of panel 1200 millimetres (or less)
- length of panel depending on necessity
- weight:
 - 80 kg/m² with normal stucco
 - 35 kg/m² with relieved stucco, and
 - 5 kg/m² without stucco.

2.3. Panel mezzanine construction

The self-carried panel mezzanine construction has a demanded portability in the phase of mounting and concreting, thankfully to concreted armature beam in the middle of panel, and plastered panel armature made by galvanized steely net from the lower side.

Conventional characteristics of the panel mezzanine construction are.

- height of panel 200 milimetres (20+180), that is 240 milimetres with concrete-cemental slice
- width of panel 600 milimetres
- length of panel depending on necessity
- weight:
 - 50 kg/m² before concrete foundry
 - 220 kg/m² after concrete foundry
 - thermic isolation $K = 0,69 \text{ W/hm}^2\text{ }^\circ\text{C}$
 - resonant isolation $I = 67 \text{ dB}$, and
 - resistance on conflagration 180 minutes.

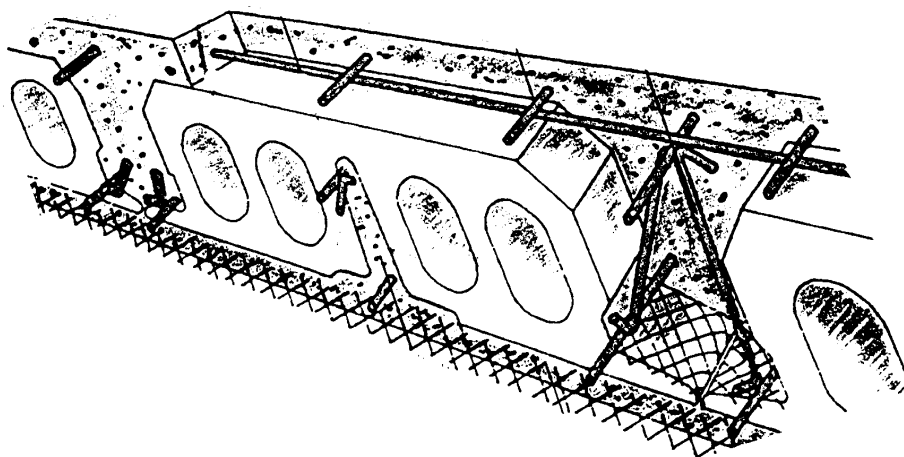


Fig. 4. Appearance of panel mezzanine construction

3. PRODUCTS OF EPS SCANNING

In the table below are given results of quantity testing of components gaseous composite made by destruction of EPS with volume of 22 kg/m³ into the terms of conflagration, covered with stucco stratum 25 milimetres thickness by increasing temperature to 840 °C from duration with 86 minutes.

As the measurement component of admixture of EPS burning products technically complexed task before all because of numerous components that are considered in poised, or aqueoused condition, as well as facts that numerous components have been overtaken by ash or resolved into droplets of water, results from the table 1. are measured

by complex of photometrical method for measuring gaseous environments, at the high temperatures. Operative analysis of poised components gaseous admixture has used a gaseous analysator.

Table 1. Components of EPS destruction on the temperature of 840 °C

Component, Empirical structure	Unit	Time period since beginning of experiment						
		14	16	28	33	57	68	86
Oxygen, O ₂	%	1,44	0,72	0,72	0,72	0,72	0,72	0,72
Carbondioxide, CO ₂	%	1,02	0,64	0,74	0,98	1,28	1,28	0,84
Carbonmonoxide, CO	ppm	364	180	216	192	264	264	180
Methane, CH ₄	ppm	190	90	80	60	40	45	20
Acetylene, C ₂ H ₂	ppm	34	30	28	33	15	10	10
Etylene, C ₂ H ₄	ppm	25	30	45	20	89	110	110
Eten, C ₂ H ₆	ppm	10	10	25	57	70	70	70
Propylene, C ₃ H ₆	ppm	35	45	40	35	20	10	10
Methanol, CH ₃ OH	ppm	110	120	180	140	80	60	10
Aceldehyde, C ₂ H ₄ O	ppm	25	20	15	10	10	10	10
Butadyene, C ₄ H ₆	ppm	30	35	30	15	10	10	10
Butane aldehyde, C ₄ H ₈ O	ppm	15	15	15	10	5	5	5
Acetone, C ₃ H ₆ O	ppm	55	70	130	80	60	30	10
Benzene, C ₆ H ₆	ppm	260	280	220	200	220	290	340
Toluene, C ₆ H ₅ CH ₃	ppm	110	130	150	240	200	200	280
Xyloule, C ₆ H ₄ (CH ₃) ₂	ppm	120	160	190	220	200	360	330
NitricOxide, N ₂ O	ppm	3,0	3,5	4,0	4,5	5,0	5,3	5,5
Cyclopentadyne, C ₅ H ₆	ppm	145	159	88	64	38	30	10
Styrole, C ₆ H ₅ C ₂ H ₃	ppm	80	110	180	260	380	550	580
Benzene Aldehyde, C ₆ H ₅ CHO	ppm	50	66	80	130	180	290	310
Steam	%	13,2	18,0	18,0	18,0	18,0	18,0	25,0
Ash	g/m ³	1,2	1,6	1,4	1,4	1,3	1,6	1,9

On the base of literature data for maximal allowable concentration which do not irritate harm effect on organism, human or animal death for the period lower than 60 min, are show in the table 2.

4. CONCLUSION

Into the conditions of conflagration within gas air admixture of products, mostly is rating a quantity of carbonmonoxide, carbondioxide and oxygen.

– Carbonmonoxide represents the most dangerous component for human life at the conflagration period. Inhalation of air with concentration of CO on 0,15% during the period of one hour, or 0,05% during the tree-hours period, is very dangerous for human life. Concentration of CO in the air of 0,4% for period lesser than one hour is fatal for human's organism. When CO achieved a consideration in the air from

1,3%, after 2÷3 inhalations one dies for few minutes. Rating demands for quantity of CO into the rooms during the period of evacuation of people at the conflagration are between 0,15 and 0,2%. For the period of experimental searching, the highest concentration of CO measured, has been 0,364 %, which means that it is significantly lower than allowable one.

Table 2. Maximal allowable concentration that do not irritate harm effect on human

Component, Empirical structure, Unit of measure	Contents in 28 min.	Contents in 57 + 86 min.	Maximal permission contents with literature fact	
			Effect to man	Effect to animal (white mouse)
Oxygen O ₂ (%)	0,72	0,72	15	10
Carbonmonoxide CO (%)	0.0216	0.0264	0.15	0,20
Carbondioxide CO ₂ (%)	0,74	1,28	5	10
Methane CH ₄ (ppm)	80	45	25 × 10 ⁴	50 × 10 ⁴
Acetylene C ₂ H ₂ (ppm)	28	33	–	20 × 10 ⁴
Etylene C ₂ H ₆ (ppm)	45	110	25 × 10 ⁴	80 × 10 ⁴
Eten C ₂ H ₆ (ppm)	25	70	–	3,1 × 10 ⁴
Propylene C ₃ H ₆ (ppm)	40	20	10 x 10 ⁴	50 × 10 ⁴
Methanol CH ₃ OH (ppm)	180	80	–	3,9 × 10 ⁴
Aceldehyde C ₂ H ₄ O (ppm)	15	10	78	1600
Butadyene C ₄ H ₆ (ppm)	30	10	3400	6400
Butane aldehyde C ₄ H ₃ O (ppm)	15	5	–	–
Acetone C ₃ H ₆ O (ppm)	130	60	930	31000
Benzene C ₆ H ₆ (ppm)	220	290	780	11600
Toluol C ₆ H ₅ CH ₃ (ppm)	150	280	1000	6200
Xyloule C ₆ H ₄ (CH ₃) ₂ (ppm)	190	360	764	7750
NitricOxide N ₂ O (ppm)	4.0	5.3	–	–
Cyclopentadyne C ₅ H ₆ (ppm)	88	38	178	1050
Styrole C ₆ H ₅ C ₂ H ₃ (ppm)	180	550	2600	7750
Benzene Aldehyde C ₆ H ₅ CHO (ppm)	80	290	–	10 × 10 ⁴

- Carbondioxide is less dangerous for human's life under the terms of conflagration. Contents of CO₂ from 1 to 3% in the air evokes frequent breathing, at the 5 % it is becoming difficult, while at the 10% it could bring to the human's death for the less than 5 minutes. It has taken that the lowest allowable density of CO₂ in the air for the period of evacuation at the conflagration 5,0%. During the experimental searching period, the highest measured concentration of CO₂ has been 1,28%, which means it is significantly lower than allowable one.
- Oxygen O₂, and decreasing of its concentration for the period of evacuation at the conflagration can also lead to serious consequences on one's organism. At decreasing concentration of O₂ for the period of evacuation at the conflagration (from conventional 21% to 15 %), it affects on human with contraction of skin's tissue (so called anoxic condition). At the further decreasing of oxygen from 14 %

to 10 % one is getting a bad look, and at the 10 to 6 % is losing his mind, but it is very easy to bring him in the normal condition with inhaling of fresh air. Critical allowable density of O₂ adopted, during the period of people's evacuation at the conflagration is 15 %. Within case searched, the lowest measured density of oxygen, has been 1,44 % which is significantly less than allowable one.

– Densities of other searched hydrocarbon, are also during the whole period of searching moved under the critically allowable densities.

On the base of results which are got and comparative literature data, it could be concluded that destruction of EPS on the temperature of searching on 840 °C, in the time of 60 minutes (maximal time of evacuation), nowise brings in the question a health of people.

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PRODUKTI RAZLAGANJA ELEMENATA GRAĐEVINSKIH KONSTRUKCIJA URAĐENIH OD EKSPANDIRANOG POLISTIRENA PRI DEJSTVU POŽARA I NJIHOV UTICAJ NA ORGANIZAM ČOVJEKA

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Primjena ekspandiranog polistirena u savremenom konceptu izgradnje stambenih i drugih objekata, pored neosporno dobrih strana, u uslovima požara praćena je njegovom destrukcijom i oslobađanjem određenih toksičnih produkata. Na to ukazuju u radu detaljno izloženi rezultati ispitivanja elemenata građevinske konstrukcije urađene od ekspaniranog polistirena na temperaturi od 840 °C u trajanju od 86 minuta.

Ključne riječi: *ekspanirani polistiren, zid panel, pregradni panel, panel međuspratne konstrukcije.*