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VARIANT SOLUTIONS FOR PARTITION WALLS IN HOSPITAL BUILDINGS

WARIANTOWANIE ROZWIĄZAŃ ŚCIAN DZIAŁOWYCH W BUDOWNICTWIE SZPITALNYM

A b s t r a c t

The planned hospital partition walls need to meet the requirements for spaces used to provide medical services specified in the relevant regulations and laws. A wide range of materials which meet these requirements are available in the construction market. During the design stage it is worth making a comparison of different solutions for the walls, analysing the cost, time taken to install and quality. This paper presents and attempts to assess three variants of partition walls for operating theatre spaces.

Keywords: partitions walls, hospital building, cost estimating

S t r e s z c z e n i e

Projektowane ściany działowe w budownictwie szpitalnym muszą spełniać wymagania dla pomieszczeń, w których wykonywane są świadczenia lecznicze zapisane we właściwych rozporządzeniach i aktach prawnych. Na rynku budowlanym oferowanych jest szereg materiałów spełniających takie wymagania. Podczas etapu projektowania warto dokonać porównania rożnych rozwiązań ścian, analizując ich koszt, czas, jakość. W artykule zaprezentowano i podjęto próbę oceny trzech wariantów ścian działowych pomieszczeń bloku operacyjnego.

Słowa kluczowe: ściany działowe, budownictwo szpitalne, kalkulacja kosztów

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1. Introduction

The Interior walls are one of the fundamental components in any building. In the case of construction of health facilities, they are used to divide the building into separate rooms, creating an architectural space to perform medical activities, work of the personnel, to maintain sanitary conditions. Selecting materials and design solutions for the construction of interior walls in health services constructions, we need to take applicable rules as well as factors such as durability, strength, properties of the finishing material in regard to disinfectants and resistance to biological material into account.

Currently, there are many manufacturers of building materials in the market that offer a large selection of materials for building walls in medical premises. The choice of manufacturing technology and materials should be made in the planning stage of the building. It is one of the key decisions, and changing this decision after work has commenced carries serious consequences. In the planning stage it is therefore worth analysing different design solutions taking the cost, quality, execution time, and the obtained parameters into account.

The purpose of this article is to present and evaluate selected variants of partitions walls used in the public health service premises. The proposed wall variants must meet the established requirements and be suitable for use in operating theatre spaces.

2. General requirements for internal walls

Internal partitions should have the highest possible sound insulation, durability and fire resistance. Depending on the type and quality of the materials used to erect the wall, it obtains a specified technical rating. In the case of sound insulation, the Regulation of the Minister of Infrastructure of 12 April 2002 on the Technical Conditions to Be Met by Buildings and Their Location (as amended) [3] requires the building to be designed and constructed in such a way that the noise levels are not a threat to health, and also to enable the the residents to work, rest and sleep under satisfactory conditions. This applies to both the occupants and people located in the vicinity. Specific sound insulation values are given in the Polish standard established under this regulation – PN-B-02151-3:1999 "Building acoustics – Protection against noise in buildings – Soundproofing barriers in buildings and acoustic insulation of building elements" [2]. Fire safety requirements are imposed on both the building envelope and internal partitions in the Regulation of the Minister of Infrastructure [3] depend on many factors. The most important are: occupancy type of the building, its usage, height and the number of floors. Depending on these factors, the fire zone of the building is specified, as well as the fire resistance of individual elements rated. Detailed definitions and values can be found in [3].

2.1. Detailed requirements for premises of an entity performing medical activities

Requirements for rooms used for medical services are defined in the Regulation of the Minister of Health of 26 June 2012, item 739 [4], including important information and

recommendations which must be met in order that medical services may be provided in the premises. The following sections discuss, among others, the general spatial requirements for the location of the premises, their shape, size and general construction requirements relating to the materials used, lighting requirements, requirements for air conditioning and ventilation. It is important to ensure adequate hygienic, sanitary and epidemiological conditions, whose aim is to eliminate the risk of contamination to the patient from pathogenic bacteria resulting from the hygienic conditions prevailing in the given room or across the whole area of provided health services. For individual hospital departments separate annexes to the Regulation have been issued in order to provide specific requirements for premises and equipment. In this article, the analysis of partition wall variants relates to the operating theatre.

3. Solutions variants for the operating theatre partition walls

The Annex to the Regulation of the Minister of Health of 26 June 2012 item 739 [4] on the detailed requirements for premises and equipment of the entity engaged in medical activities contains detailed information about operating theatres. Taking these rules into account, three variants of operating theatre partition walls have been prepared.

Variant I – commercial walls in the form of stainless steel panels

The first variant proposed includes commercial walls in the form of stainless steel panels. For individual components of the system, requirements should be defined in regard to:

- profiled brackets: made of high quality galvanised steel minimum thickness of 1.25 mm.
- floor and ceiling rail: made of high quality galvanised steel, minimum thickness of 1.5 mm, the floor rail is to the base for the implementation of the baseboard.
- connection rail: to be made as a profile connecting the wall with the ceiling, made of aluminium painted in the colour of the ceiling, in order to create a connection between the wall panels and ceiling.
- wall panels made of acid resistant stainless steel and painted (operating rooms): minimum panel thickness of 18 mm, multi-layered. Panel finish of stainless steel 1.4301. Documents authorising the use of steel panels in the operating theatre spaces are necessary.

Variant II – brick walls finished with wall lining – CORIAN

Variant II includes a brick wall made using Porotherm 11.5 cm breeze blocks finished with CORIAN wall lining. DuPont™ Corian was invented in 1967 by DuPont [4]. Corian is a solid, non-porous, homogeneous surfacing material, composed in ±1/3 of an acrylic resin (also known as PolyMethyl methacrylate, or PMMA), and in ±2/3 of natural minerals. Minerals are composed of aluminium trihydrate (ATH) derived from bauxite, the ore which contains aluminium. This material is presented on the manufacturer's website as a modern product that due to its antibacterial properties, ease of cleaning, resistance to most chemicals, no deformation under the influence of external factors (water, temperature, UV radiation) is ideal for use in equipping hospital interiors. It is non-porous, chemically inert and non-toxic, it does not discolour, does not accumulate static electricity, scatters the laser beam and is non-absorbent.

Variant III – brick walls finished with C/S Wallflex wall coating system

The third proposed variant is a brick wall similar to variant II, in this case finished with C/S Wallflex wall coating system. Information on the coatings is available on the website [5]. According to this information, the coatings are used in various types of health care facilities, but are also used in many other areas where durability, hygiene and ease of cleaning is important. The coatings are 99.5% solvent-free, virtually odourless and extremely durable. They also have all antibacterial properties. High resin content in products provides excellent coverage durability and lifetime spanning over 10 years. The basic properties include: resistance to chemicals, resistance to scrubbing and abrasion, resistance to the effects of radiation. Optionally, the coating can be reinforced using glass fibre wallpaper which increases durability and resistance to abrasion. Such reinforcement is assumed in this variant.

4. Calculation of the cost of the proposed variants of walls

Cost calculation were based on bills of quantities using books containing the standard expenditures: KNR, KNNR, KNNRW, ORGBUD, using them directly or by analogy.

Due to the limited volume of the paper, only selected items of the bills of quantities for subsequent variants I, II and III are presented.

Types and the amount of work to be implemented are presented respectively in Table 1, 2 and 3.

Table 1

Fragment of the bill of quantities for walls made in variant I

No.	Basis	Description	Unit	Amount of work
	Element	Variant I – Prefabricated commercial wall panels made of stainless steel	m^2	109.20
1	KNRW 202/2003/2	Partition walls made of panels on metal grating, 2-sided, 1-layer, construction by analogy	m^2	16.70
2	KNRW 202/2003/8	Lining made of single panels on the walls, on grating, construction by analogy, 1-sided 1-layer	m^2	3.50
3	KNRW 202/2004/2	Housing of structural elements using panels on metal grating, single columns, construction by analogy	m^2	49.00
4	KNNRS 7/502/2	Walls made of sheet steel panels using brushed stainless steel	m^2	121.10
5	KNNRS 7/502/2	Walls made of sheet steel panels using painted stainless steel	m^2	109.20

Table 2

Fragment of the bill of quantities for walls made in variant II

No.	Basis	Description	Unit	Amount of work
	Element	Variant II – brick walls finished with Corian wall lining	m^2	129.80
1	KNR 27/165/2	Partition walls for multi-storey building made of ceramic blocks Porotherm P+W (tongue and groove), wall thickness of 11.5 cm	m^2	199.10
2	KNRW 202/804/1 (1)	Ordinary plaster category IV, made mechanically, flat walls and pillars, buildings up to 8 storeys	m^2	157.80
3	individual calculation	Supply and installation of Corian lining – bonding	m^2	129.80

Table 3

Fragment of the bill of quantities for walls made in variant III

No.	Basis	Description	Unit	Amount of work
	Element	Variant III – brick walls finished with C/S Wallflex wall coating system		
1	KNR 27/165/2	Partition walls for multi-storey building made of ceramic blocks Porotherm P+W (tongue and groove), wall thickness of 11.5 cm	m^2	129.80
2	KNRW 202/804/1 (1)	Ordinary plaster category IV, made mechanically, flat walls and pillars, buildings up to 8 storeys	m^2	199.10
3	KNNR 2/1406/2	Finished with fibreglass wallpaper	m^2	168.50
4	KNR 202/1505/12	Priming of wallpaper for painting	m^2	168.50
5	KNR 202/1505/10	Painting of wallpaper with C/S Wallflex paint – primer	m^2	168.50
6	KNR 202/1505/10	Painting of wallpaper with C/S Wallflex paint – finish layer	m^2	168.50

Financial basis adopted for the estimate calculation:

- indirect costs – 65% (R+S),
- profit – 11% (R+S), Kp (R+S),
- labor – 16,25 zł/r-g.
- prices of materials taken from the market and the price publication "The prices of factors of production RMS". Sekocenbud for the fourth quarter of 2012. Costs of purchases of materials are included in the prices of materials.

All variants include the supply and installation of stainless steel powder-coated doors for the operating rooms: swing doors amount to 3.7 m^2 while sliding doors amount to 6.8 m^2 (total cost is PLN 52.700,41).

Table 4 summarises the costs of partition wall solution implementation, depending on the variant adopted and taking the contribution of each component in the price estimate into account. The results are shown in Figure 1.

Table 4

Summary of the cost of construction of the walls in different variants

VARIANT	Labor [PLN]	Materials [PLN]	Equipment [PLN]	Indirect costs [PLN]	Profit [PLN]	Estimated price [PLN]
VARIANT I stainless steel panels	31559,27	143397,64	2803,61	22335,88	6236,87	206333,27
VARIANT II lining CORIAN	9417,10	165347,69	1965,44	7398,66	2065,92	186194,81
VARIANT III C/s WALLFLEX	8547,80	70622,81	651,25	5979,38	1669,63	87470,87

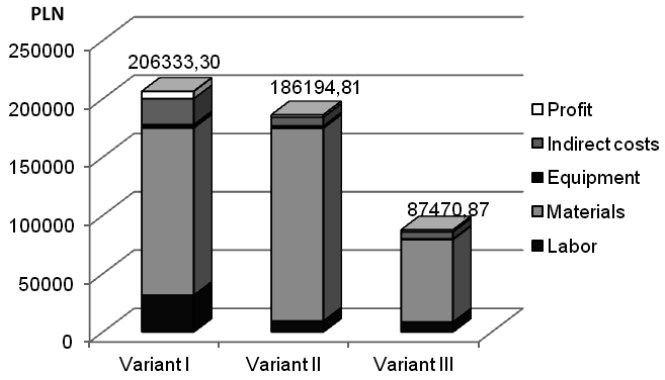

Fig. 1. The costs of the implementation of the considered variants of partition walls (source: own work)

Analysing the table and the graph it can be seen that the difference in cost is not significant between variants I and II, and amounts to 11%. By far the cheapest solution in the adopted assumptions is the brick wall finished with the C/S Wallfex wall coating system reinforced with fibreglass wallpaper.

Taking only the direct costs of the implementation of the walls into account it is worth noting that the proposed cost of materials is very high for all solutions. In variant I (stainless steel panels) it constitutes 80% of the costs, in the third variant (reinforced with Wallfex lining) – 88%, and in the second variant as much as 94% of all direct costs. Labour is at a level of from 5% to 18% in variant I. Thanks to the lightweight components used to erect the walls, most of the work is done by hand and doesn't involve any major construction equipment, whose share of the direct costs in this case is at a maximum level of 2%.

5. Advantages and disadvantages

The most important advantages and disadvantages of the various variants are shown in Table 5.

Table 5

Selected advantages and disadvantages of the proposed wall solutions

Variant	Adwantages	Disadvantages
Variant I Commercial wall made of stainless steel panels	✓ high resistance to mechanical shock ✓ high resistance to corrosion ✓ low cost of maintaining cleanliness ✓ the ability to quickly dismantle the walls to upgrade or repair the system ✓ easy installation of systems and equipment underneath panels ✓ no need for repairs and maintenance work ✓ the possibility of transferring the panel system in the event of changing the location of the operating theatre	✓ high implementation costs ✓ requires a lot of experience and precision in assembly
Variant II Masonry walls finished with Corian lining	✓ strong and durable, flameproof ✓ resistant to impact, stains and discolouration ✓ easy to maintain, easy to repair ✓ seamless, with invisible seams ✓ resistant to dirt, bacteria, moulds, etc. ✓ non-toxic ✓ mechanical damage can usually be removed on the spot, without the need for total replacement of components.	✓ high implementation costs ✓ requires specialised equipment
Variant II masonry walls with wall coating system C/s Wallfex	✓ permanent ✓ resistant to chemicals ✓ resistance to scrubbing and abrasion ✓ relatively low cost of implementation ✓ simple applications of coatings ✓ unlimited colours	✓ relatively low resistance to mechanical damage

Source: Own study based on data provided by the manufacturers on websites [4, 5].

In a comparison of variants we should pay attention to the duration of the partitions. If we were only to look at the labour-intensiveness of the implementation of variants, the most laborious would be variant I – stainless steel panels (1942.11 man-hours), while variants II and III (brick walls with lining and coating) are much less labour intensive and require respectively 579.51 and 526.02 man-hours. However, inference based on these values would not be correct. In the variants considered, the need for installation works, such as plumbing, electricity, medical gas, etc., was not taken into account. In the case of building walls using stainless steel panels, system run inside the wall, between the panels and profiles, eliminating the ‘wet’ trades (so that one can immediately proceed with finishing works at much faster turnaround time. In the case

of masonry walls, system can run in a specially profiled perforations inside the blocks or in chases made during masonry works. One should also take into account the time for evaporation of process water from both the wall itself as well as from finishing layers. In variant 3, one should also take the weeks needed to obtain full strength by the coatings on the walls into account. Ultimately, the difference in execution time between the variants will not be so drastic.

6. Conclusions

This paper is a comparative analysis of the three variant solutions for partition walls used in hospital construction for the operating theatre rooms.

All proposed variants for partition walls meet requirements imposed in regulations regarding fire resistance, resistance to detergents, microbicides, water, steam and agents used for the disinfection of operating theatres as well as the requirements relating to the preparation of the walls for decontamination using gases. The analysis indicated differences in costs. The implementation of vertical partitions in the traditional system with the use of coatings and linings is less costly than using commercial panels made of stainless steel. In the case of a variant of using the C/s Wallfex wall coverings system, the difference is more than double. When trying to assess the execution time, the need became apparent for a thorough analysis of the process of building the walls including a number of accompanying works (such as internal systems), technological gaps, the time needed to obtain full strength of the materials used.

When choosing partition wall technology, in addition to cost and time, the quality of the product obtained, as well as its use and functionality are taken into account. It is worth mentioning that in the case of the most expensive variant (commercial stainless steel panels) making changes to their arrangement, the possible need of dis assembly and access to the systems is much easier.

References

[1] Polska Norma PN-B-02151-3:1999 „Akustyka budowlana – Ochrona przed hałasem w budynkach – Izolacyjność akustyczna przegród w budynkach oraz izolacyjność akustyczna elementów budowlanych".

[2] Rozporządzenie Ministra Infrastruktury z dnia 12 kwietnia 2002 r. w sprawie warunków technicznych, jakim powinny odpowiadać budynki i ich usytuowanie (z późniejszymi zmianami).

[3] Rozporządzenie Ministra Zdrowia z dnia 26 czerwca 2012 r. w sprawie szczegółowych wymagań, jakim powinny odpowiadać pomieszczenia i urządzenia podmiotu wykonującego działalność leczniczą.

[4] http://www.dupont.com/industries/health-care-and-medical.html

[5] http://www.wallglaze.pl/42osy_cs_wallflex_cs_wallflex_w5.htm