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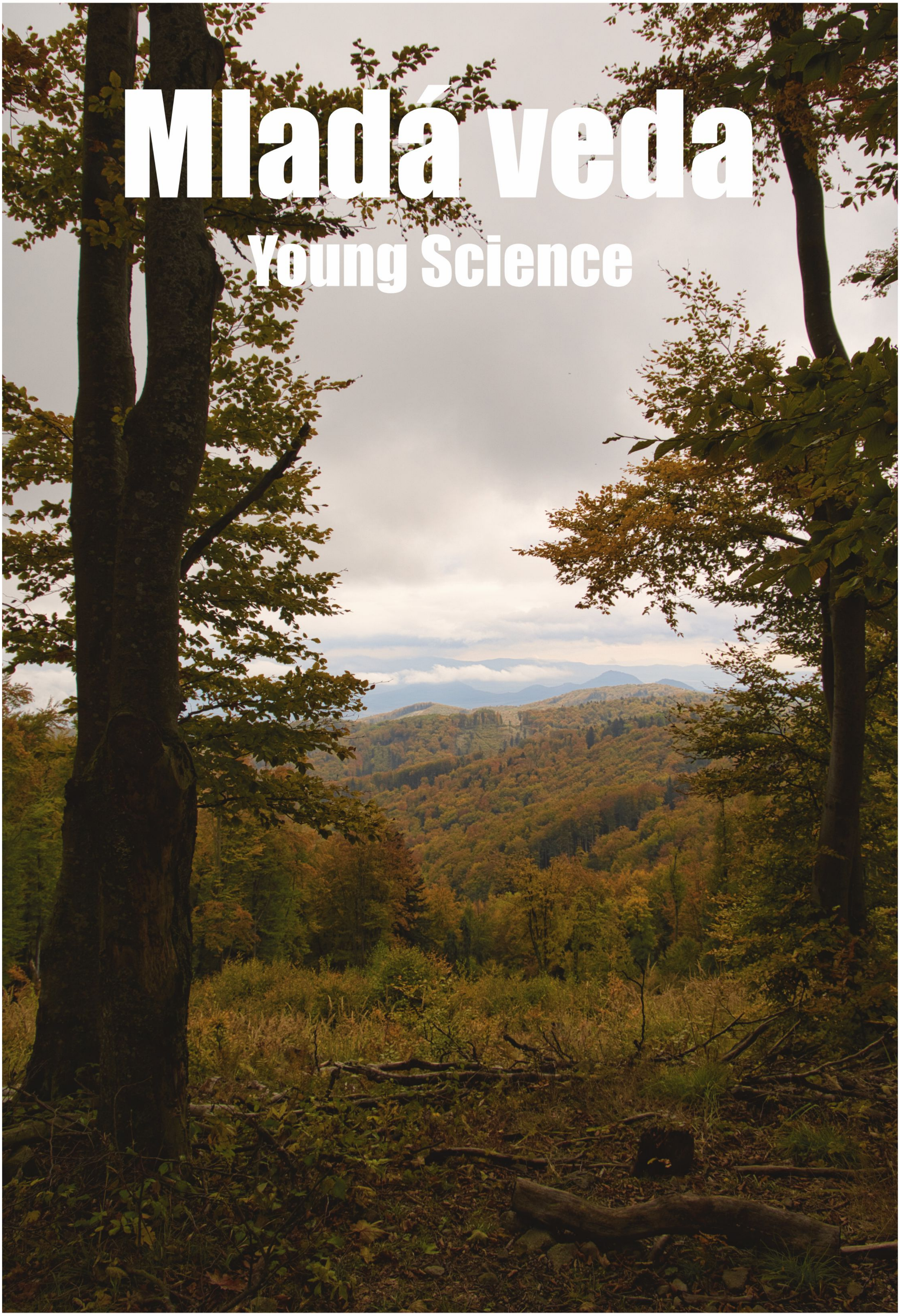

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TECHNICAL AND ECONOMIC COMPARISON OF BRICK CLADDINGS FOR EXTERNAL THERMAL INSULATION COMPOSITE SYSTEMS WITH DIFFERENT AREAL WEIGHTS

TECHNICKO-EKONOMICKÁ KOMPARÁCIA TEHLOVÝCH OBKLADOV KONTAKTNÉHO ZATEPĽOVACIEHO SYSTÉMU S ROZDIELNOU PLOŠNOU HMOTNOSŤOU

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Silvia Ďubek pôsobí ako odborná asistentka na Ústave súdneho znalectva na Stavebnej fakulte na Slovenskej technickej univerzite v Bratislave. V oblasti výskumu sa venuje problematike kalkulovania nákladov zariadenia staveniska, návrhu modelu hodnotenia nákladov zariadenia staveniska, ale aj podnikateľskej etike v stavebníctve a cenotvorbe. Sabína Bóková je absolventkou inžinierskeho stupňa v odbore Technológia stavieb na Stavebnej fakulte na Slovenskej technickej univerzite v Bratislave. V rámci svojej diplomovej práce sa zaoberala návrhom zariadenia staveniska a optimalizáciou nákladov v realizácii.

Abstract
The paper focuses on the technical and economic comparison of brick claddings used as the finishing layer of external thermal insulation composite systems (ETICS) with different areal weights. The analysis compares two groups of brick claddings: claddings with an areal weight of up to 25 kg/m² and claddings with an areal weight exceeding 25 kg/m² and up to 45 kg/m². The aim is to assess the differences between the selected variants from the perspective of technological requirements, material consumption, labour intensity, construction costs, and

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overall economic efficiency. Particular attention is paid to the influence of the cladding areal weight on the composition and implementation of the ETICS, including the requirements for fixing, reinforcement, and associated technological operations. The comparison is based on a quantitative assessment of selected technical and economic parameters of the individual variants. The results provide a basis for evaluating the suitability of different brick cladding solutions in relation to their areal weight and for supporting decision-making during the design and preparation of building projects. The findings can contribute to the more efficient selection of façade finishing solutions while considering both technical requirements and economic aspects of construction.
Key words: facade cladding, mechanical fixing, duration

Abstrakt
Článok sa zaoberá technicko-ekonomickým porovnaním tehlových obkladov používaných ako povrchová úprava kontaktných zatepľovacích systémov s rozdielnou plošnou hmotnosťou. Predmetom hodnotenia sú dve skupiny tehlových obkladov – obklady s plošnou hmotnosťou do 25 kg/m² a obklady s plošnou hmotnosťou nad 25 kg/m² do 45 kg/m². Cieľom je posúdiť rozdiely medzi jednotlivými variantmi z hľadiska technologických požiadaviek, materiálovej a pracovnej náročnosti, nákladov na realizáciu a celkovej ekonomickej efektívnosti. Pozornosť je venovaná najmä vplyvu plošnej hmotnosti obkladu na skladbu a realizáciu kontaktného zatepľovacieho systému vrátane požiadaviek na kotvenie, výstužné vrstvy a súvisiace technologické operácie. Porovnanie vychádza z kvantitatívneho hodnotenia vybraných technických a ekonomických parametrov jednotlivých variantov. Výsledky umožňujú identifikovať rozdiely medzi hodnotenými riešeniami a vytvoriť podklad pre výber vhodného typu tehlového obkladu v závislosti od jeho plošnej hmotnosti. Získané poznatky môžu prispieť k efektívnejšiemu rozhodovaniu pri návrhu a príprave stavebných projektov so zohľadnením technických a ekonomických aspektov realizácie.
Kľúčové slová: fasádny obklad, kotvenie, trvanie

Introduction
External Thermal Insulation Composite Systems (ETICS) represent an important solution for improving the thermal insulation properties of building envelopes and reducing the energy performance of buildings. ETICS is a system solution consisting of several mutually compatible components, whose function and resulting performance depend on their interaction. In Slovakia, the requirements for the installation of ETICS are primarily specified by STN 73 290 – Execution of External Thermal Insulation Composite Systems (ETICS) (STN 732901, 2023). The standard applies to systems using thermal insulation materials based on expanded polystyrene (EPS), mineral wool (MW), and, accordingly, other types of thermal insulation. It also covers systems with a final surface finish consisting of render or cladding without a ventilated air cavity (STN 732901, 2023).

Although render systems represent the traditional surface finish of ETICS, alternative solutions, including ceramic and brick claddings, are also applied in current construction practice. The use of discontinuous claddings on ETICS represents a specific system solution, the requirements and assessment methods of which are addressed by the European

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Assessment Document EAD 040287-00-0404. This document applies to ETICS kits incorporating a board thermal insulation product and discontinuous cladding as the external skin (EAD 040287-00-0404:2017, 2017). Therefore, brick cladding needs to be assessed as an integral part of the entire system rather than independently of the other ETICS components. One of the significant parameters affecting the design and installation of such a system is the areal weight of the cladding. An increase in areal weight may result in higher requirements for mechanical fixing, the load-bearing capacity of individual system layers, and the transfer of loads to the substrate. The requirements for the design and execution of mechanical fixing of ETICS are specified in STN 73 2902. Therefore, the design must consider not only the properties of the cladding itself but also the mechanical properties of the thermal insulation, reinforcement layer, fixing elements, and substrate (STN 73 2902, 2025). From a technical and economic perspective, the selection of a suitable cladding type represents a complex decision-making problem. Differences in areal weight may affect material consumption, the number and type of fixing elements, labour intensity of individual technological operations, construction duration, and overall costs. Therefore, the assessment of individual variants should not be limited to comparing the procurement cost of the cladding material alone but should also consider the complete installation process and the requirements for individual system layers. The paper focuses on the technical and economic comparison of brick claddings for ETICS with different areal weights. Two groups of claddings are assessed: claddings with an areal weight of up to 25 kg/m² and claddings with an areal weight exceeding 25 kg/m² and up to 45 kg/m². The aim of the paper is to identify differences between these variants in terms of technological solution, mechanical fixing, material and labour intensity, construction duration, and costs. The results of the comparison provide a basis for assessing the suitability of individual variants and supporting decision-making in the design and preparation of construction projects.

Technical description of the structure

The technical and economic comparison of brick façade cladding variants is applied to Phase 3 of the Ranta Barrandov residential development project, located in Prague 5, in the cadastral area of Hlubočepy. The project site is situated within the built-up area of the City of Prague and comprises an irregularly shaped plot with a gentle to moderate terrain slope of approximately 6% towards the south. The area of Phase 3 is bounded by Schránilova Street, Wassermanova Street, and K Barrandovu Street. The northern boundary of the site is formed by Schránilova Street, while the southern boundary is adjacent to land owned by the Order of the Knights of the Cross with the Red Star and a petrol station complex. The eastern boundary adjoins undeveloped land designated for the implementation of Phase 4 of the project, while the western boundary is formed by privately owned plots. Access to the site is provided via Schránilova and Wassermanova Streets, which are connected to K Barrandovu Street.

Several types of building envelope systems are designed within the project, differing in their structural solution and final surface finish. For the purposes of this analysis, façade system F1 is considered, consisting of an external thermal insulation composite system (ETICS) with a brick-slip finish. The other façade systems, namely F2 – ETICS with a thinlayer silicone render finish, and F3 – a ventilated façade with Swisspearl fibre-cement cladding, are not included in the subsequent assessment.

Technological Solution of the Brick Facade Cladding

The brick facade cladding is designed to be installed on the completed ETICS. Installation of the brick slips commences after a technological curing interval of approximately 1 to 2 weeks following completion of the reinforced base coat. The exact duration of this interval depends primarily on climatic conditions and the drying process of the individual system layers.

Before installation of the brick slips, the substrate must be inspected to verify its readiness. The substrate must be dry, even, cohesive, and free from impurities or other substances that could adversely affect the adhesion of the bonding mortar. Local surface irregularities are removed by sanding with abrasive paper or a sanding mesh. Under standard installation conditions, priming of the substrate is not required. Primer may be applied in the case of a substrate that has remained dry for an extended period or where a longer technological interval has occurred between completion of the reinforced base coat and installation of the brick slips. When designing and installing the system, particular attention must be paid to the areal weight of the brick cladding, which represents an important parameter in terms of the mechanical loading of the ETICS and the design of its fixing system. A change in the areal weight of the cladding affects the requirements for mechanical fixing and may also influence material consumption, labour intensity, and the duration of individual installation operations.

Variants of Brick Facade Cladding

For the purposes of the technical and economic comparison, two groups of brick facade claddings were defined according to their areal weight. The first group consists of brick slips with an areal weight of up to 25 kg/m². The second group comprises brick slips with an areal weight exceeding 25 kg/m² and up to 45 kg/m².

The classification of the claddings according to areal weight makes it possible to assess the influence of this parameter on individual components of the technological and economic solution. The assessment focuses primarily on the type and extent of mechanical fixing, consumption of basic materials, labour intensity, installation duration, and resulting costs per unit area and for the total façade cladding area.

The defined variants are subsequently applied to the façade areas of the Ranta Barrandov Phase 3 project. The comparison therefore considers not only the differences between the individual cladding materials but also their impact on the overall technological installation process. The resulting assessment provides an evaluation of the technical and economic implications of selecting brick cladding with different areal weights under the conditions of a specific residential development project.

Material Solution and Input Data

For the technical and economic comparison, two variants of brick façade cladding integrated into the ETICS were defined. Both variants use the same thermal insulation system and auxiliary components. The main differences between the variants are the type and areal

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weight of the brick slips and the method of mechanical fixing. The common material components used in both variants include a 200 mm-thick aluminium starter base profile, stone wool insulation boards with vertically oriented fibres, glass-fibre reinforcing mesh, corner reinforcement profiles with integrated mesh, flexible system adhesive mortar, jointing mortar, window head profiles with drip edges, closing discs, and surface modules. The thermal insulation layer consists of stone wool boards with vertically oriented fibres, measuring 1,200 × 333 mm. The boards are supplied in packages containing 14.39 m² per pallet. The reinforcing layer is formed using VERTEX R267 glass-fibre mesh with an areal weight of 314 g/m². Corner reinforcement is provided by profiles with integrated reinforcing mesh and a length of 2.5 m.

The adhesive and reinforcement system is based on quick-mix RKS flexible system adhesive mortar. The specified consumption is 4.0 kg/m² for bonding the insulation boards and 5.0–5.5 kg/m² for bonding the brick cladding. The mortar is supplied in 25 kg packages. The joints between the brick slips are filled with quick-mix FM jointing mortar, with a specified consumption of 4.5–7.5 kg/m² and a package weight of 30 kg.

Additional system components include window head profiles with drip edges, closing discs STR U, and PM70 surface modules. The specified minimum consumption of both the closing discs and surface modules is 8 pcs/m².

Variant 1 – Brick Slip with Lower Areal Weight

Variant 1 represents a brick cladding with an areal weight of up to 25 kg/m². The cladding is installed on a completed external thermal insulation composite system (ETICS) with stone wool insulation boards. Within this weight category, the standard technological procedure for installing the brick cladding is applied. The installation of the brick slips begins after a technological curing interval of approximately 1 to 2 weeks following completion of the reinforced base coat. The actual duration of the interval depends on the climatic conditions and the drying of the individual system layers. Prior to installation, the substrate is inspected to ensure that it is dry, even, cohesive, and free from impurities that could adversely affect the adhesion of the bonding mortar. Local irregularities are removed by sanding. Under standard conditions, priming of the substrate is not required. The brick cladding consists of structured Parma clinker brick slips with dimensions of 215 × 23 × 65 mm and a unit weight of 0.40 kg. At a specified consumption of 58 pcs/m², the nominal areal weight of the standard brick slips is approximately 23.2 kg/m². This value refers exclusively to the brick slips and does not include the weight of the adhesive mortar, jointing mortar, corner elements, or other system components.

Mechanical fixing of the mineral wool insulation boards is provided by EJOT H3 plate anchors. The minimum specified consumption is 8 fixing elements per square metre. The selected fixing system is designed for the lower-weight cladding category and forms an integral part of the ETICS. The remaining components of the system, including the insulation boards, reinforcing mesh, reinforcement profiles, adhesive mortar, and jointing mortar, remain identical to those used in Variant 2.

From a technological perspective, Variant 1 represents the reference solution for the subsequent comparison. Its lower cladding weight results in lower permanent loading of the

ETICS and allows the use of the specified plate fixing system. The technological sequence of façade installation remains unchanged throughout the assessed area, subject to compliance with the requirements for the particular ETICS and the manufacturer's system documentation. For the purposes of the technical and economic assessment, Variant 1 is therefore defined as an ETICS with brick-slip cladding having a nominal areal weight of the brick slips of 23.2 kg/m², corresponding to the category of claddings with an areal weight of up to 25 kg/m².

Variant 2 – Brick Slip with Higher Areal Weight

For brick cladding with an areal weight exceeding 25 kg/m² and up to 45 kg/m², the cladding may be installed to a maximum height of 9.0 m above the surrounding ground level. For such a solution, a structural assessment of the complete ETICS is required. The structural assessment verifies the combined effects of wind loading and shear loading resulting from the self-weight of the brick cladding and the other layers of the ETICS. The installation procedure for the higher-weight cladding is generally identical to that of Variant 1. The main difference concerns the mechanical fixing of the mineral wool insulation boards. Due to the higher load resulting from the cladding, Variant 2 uses a different type of fixing element, namely the Spiral Anksys SA injection anchor with a diameter of 14 mm. The minimum specified consumption is 8 fixing elements per square metre. The fixing system is supplemented with SAF3 expanding filling material. The selected brick cladding consists of rustic Abote PR421 clinker brick slips with dimensions of 215 × 23 × 65 mm and a unit weight of 0.50 kg. At a specified consumption of 58 pcs/m², the nominal areal weight of the standard brick slips is approximately 29.0 kg/m². This value represents the weight of the brick slips only and does not include the weight of the adhesive mortar, jointing mortar, corner elements, or other system components.

Compared with Variant 1, the higher areal weight of the cladding represents an increased permanent load acting on the ETICS. Consequently, the selection of the mechanical fixing system becomes a significant design parameter. Although the technological sequence of the façade installation remains essentially unchanged, the different fixing system may affect material consumption, installation procedures, labour intensity, and construction duration.

For the purposes of the technical and economic assessment, Variant 2 is therefore defined as a system with a brick-slip areal weight exceeding 25 kg/m² and up to 45 kg/m², subject to the specified height limitation and structural verification of the complete ETICS.

Comparison of the Material Solutions

The principal difference between the two variants is the combination of brick slip type, areal weight, and mechanical fixing system. While the Parma clinker brick slips used in Variant 1 have a unit weight of 0.40 kg, the Abote PR421 brick slips used in Variant 2 have a unit weight of 0.50 kg. At the specified consumption of 58 pcs/m², this corresponds to an increase in the nominal mass of the brick slip layer from approximately 23.2 kg/m² to 29.0 kg/m².

The mechanical fixing systems also differ. Variant 1 uses EJOT H3 plate anchors, whereas Variant 2 uses Spiral Anksys SA injection anchors supplemented with SAF3 expanding filling material. Both variants require a minimum of 8 fixing elements per square metre; however, the different fixing technologies may affect material consumption, installation procedures, labour requirements, and construction duration.

Technical-economic evaluation

To prepare the economic evaluation, budgets are prepared for both variants. They are processed in the Cenkros 4 program in the current version for the given period. The unit prices and totals are stated without VAT. The price is the amount of money agreed upon when buying and selling goods. A price agreement is an agreement on the price or an agreement on the method by which the price is created, provided that this method sufficiently determines the price. When agreeing on the price, the definition of the goods by name, possibly also by the customs tariff code or by the code according to a special regulation, by the unit of quantity, by the qualitative and delivery conditions or by other conditions agreed upon by agreement of the parties is binding. (Act No. 18/1996 Coll. on prices)

A bill of quantities is a detailed description of a building object, including items of construction work, assembly work and supplies of building materials. This description includes units of measurement and a calculation of quantities, with the aim of providing a clear idea of the future construction work for both parties – the investor and the contractor. (Ellingerová, 2013)

The budget does not include the items for the transportation of materials and components (HSV and PSV), as these costs would differ only marginally between the individual variants.

No.	Description	Unit	Quantity	Unit price	Total price
1	External thermal insulation composite system with mineral wool, 200 mm thick, EJOT H3 fixing anchors	m²	320.000	89.36	28,595.20
2	Aluminium starter base profile, 200 mm wide	m	62.000	13.02	807.24
3	Aluminium corner reinforcement profile with integrated mesh	m	15.700	3.28	51.50
4	Window head profile with drip edge	m	19.500	3.77	73.52
	HSV subtotal				**29,527.46**

No.	Description	Unit	Quantity	Unit price	Total price
5	Installation of external wall cladding using brick slips bonded with mortar and jointing mortar, size 215 × 65 mm	m²	320.000	36.31	11,619.20
6	Brick slip cladding, size 215 × 65 × 23 mm, standard	pcs	18,560.000	1.10	20,416.00
7	Brick slip cladding, size 215 × 65 × 23 mm, corner element	pcs	702.000	2.70	1,895.40
	PSV subtotal				**33,930.60**

Tab. 1 – Budget for option no. 1
Source: authors

No.	Description	Unit	Total Quantity	Unit Price	Total Cost
1	External thermal insulation composite system with 200 mm mineral wool, Spiral Anksys SA/PM 14 × 270 mm injection anchors	m²	320.000	89.36	**28,595.20**
2	Aluminium starter base profile, 200 mm wide	m	62.000	13.02	**807.24**
3	Aluminium corner reinforcement profile with integrated mesh	m	15.700	3.28	**51.50**
4	Window head profile with drip edge	m	19.500	3.77	**73.52**
	HSV subtotal				**29,527.46**
5	Installation of external wall cladding using brick slips bonded with mortar and jointing mortar, size 215 × 65 mm	m²	320.000	36.31	**11,619.20**
6	Brick slip cladding, size 215 × 65 × 23 mm, standard	pcs	18,560.000	1.10	**20,416.00**
7	Brick slip cladding, size 215 × 65 × 23 mm, corner element	pcs	702.000	2.70	**1,895.40**
	PSV subtotal				**33,930.60**
	TOTAL				**63,458.06**

Tab. 2 – Budget for option no.2
Source: authors

A construction schedule, or also a construction timetable, is a schedule of individual activities that should take place within a planned time frame when building anything. For larger contracts, it is necessary to submit a schedule along with other documentation for assessment by the building authority. For smaller-scale construction, such as family houses, it is not necessary to have a plan, but it is always better to draw up at least a small schedule. It is not necessary to follow it to the letter, but a construction schedule can make work much more efficient and often cheaper. (HOBBYTEC.sk, 2025) When compiling the schedule, the standard hours listed in the Cenkros 4 program were used. In order for these schedules to be comparable, the same work shift time was chosen, as well as the number of workers. The sequence of activities was chosen with regard to the technological procedure that should be followed in the selected implementation processes.

Fig. 1 – Timeline variant no. 1
Source: authors

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Execution of ETICS, cladding with surface weight above 25 kg/m² up to 45 kg/m²	0	0	0	1,070 hours	0	27 days
Activity	Quantity	Unit	Unit output (per worker)	Total output (man-hours)	Number of workers	Duration
Installation of starter base profile	62	m	0.19	11.78	1	1 day Mason [300%]
Mineral wool insulation system, 200 mm thick	320	m²	1.15	368.00	3	13 days Mason [300%]
Installation of brick slip cladding	320	m²	1.54	492.80	5	10 days Tiler [500%]
Jointing of brick slip cladding	320	m²	0.40	128.00	2	3 days Tiler [500%]

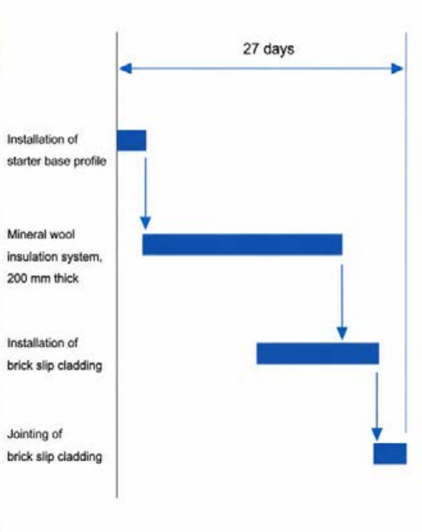

Fig. 2 – Timeline variant no. 2
Source: authors

Evaluation

All prices presented in this section are stated excluding VAT. The economic comparison is based on cost data processed using the CENKROS 4 software and applies to the assessed façade area of 320 m². The results of the economic comparison indicate a difference between the two analysed brick façade cladding variants. The total implementation cost of Variant 1 amounted to €60,619.66 excluding VAT, whereas the total cost of Variant 2 was €63,458.06 excluding VAT. Variant 2 is therefore more expensive by €2,838.40 excluding VAT, representing an increase of approximately 4.68% compared with Variant 1. When converted to the unit area of the assessed façade, the total cost of Variant 1 is approximately €189.44/m² excluding VAT, while Variant 2 reaches €198.31/m² excluding VAT. The difference between the two variants is therefore approximately €8.87/m² excluding VAT. The difference in total costs is primarily reflected in the main construction works (HSV), which include the implementation of the external thermal insulation composite system. The HSV costs for Variant 1 amount to €26,689.06 excluding VAT, whereas for Variant 2 they amount to €29,527.46 excluding VAT. The difference is therefore €2,838.40 excluding VAT. The costs classified under PSV, comprising the installation of the brick façade cladding, are identical for both variants and amount to €33,930.60 excluding VAT. The higher cost of Variant 2 is mainly associated with the use of a different mechanical fixing system for the thermal insulation boards. Variant 1 uses EJOT H3 plate anchors, whereas Variant 2 uses the Spiral Anksys SA/PM injection fixing system due to the higher areal weight of the brick cladding. Although both systems have a minimum specified consumption of 8 fixing elements per square metre, their material and technological requirements differ. From an economic perspective, Variant 1 therefore represents the more cost-effective solution. Variant 2 results in higher implementation costs, which are associated with the requirements arising from the higher areal weight of the cladding and the corresponding mechanical fixing solution.

From a time perspective, differences between the two variants were identified primarily in the implementation of the external thermal insulation composite system. The total duration of the assessed activities for Variant 1 is 24 working days, whereas Variant 2 requires 27 working days. Variant 2 therefore results in an extension of the implementation period by 3 working days, corresponding to an increase of approximately 12.5%. The total labour input for Variant 1 amounts to 980 hours, while Variant 2 requires 1,070 hours. The difference is therefore 90 working hours, representing an increase of approximately 9.18% compared with Variant 1. The technological sequence is identical for both variants. The works begin with the installation of the starter base profile, followed by the installation of the 200 mm mineral wool ETICS, installation of the brick façade cladding, and finally grouting of the brick slips. The difference in total duration is primarily caused by the implementation of the thermal insulation system. For Variant 1, the installation of the 200 mm mineral wool ETICS is scheduled for 10 working days, whereas for Variant 2 the corresponding activity requires 13 working days. The installation of the brick façade cladding takes 10 working days for both variants, while grouting requires 3 working days. Installation of the starter base profile takes 1 working day in both cases. From the time perspective, Variant 1 therefore provides a more favourable solution. For the assessed façade area of 320 m², the difference of three working days represents a 12.5% extension of the overall technological process. However, Variant 2 represents a technically more demanding solution designed for cladding with a higher areal weight, for which structural verification and a specific mechanical fixing system are required.

The results of the technical and economic comparison demonstrate that Variant 1 is more advantageous in terms of both implementation cost and construction duration. The total cost of Variant 1 is €2,838.40 lower, while its implementation period is three working days shorter.

Parameter	**Variant 1**	**Variant 2**	**Difference**
Total cost excluding VAT	€60,619.66	€63,458.06	+€2,838.40
Cost per m² excluding VAT	€189.44/m²	€198.31/m²	+€8.87/m²
Total labour input	980 h	1,070 h	+90 h
Implementation duration	24 days	27 days	+3 days
Increase in cost	–	–	**4.68%**
Extension of duration	–	–	**12.50%**

Tab. 3 – Economic and time comparison
Source: authors

The results indicate that an increase in the areal weight of the brick façade cladding above 25 kg/m² has a direct impact not only on the technical solution of the mechanical fixing system but also on the economic and time-related parameters of the construction process. Therefore, when selecting Variant 2, the higher implementation cost and longer construction duration should be assessed in the context of the technical requirements and benefits associated with the use of a brick cladding with a higher areal weight.

Conclusion

The comparative analysis confirmed the importance of a comprehensive assessment of construction variants during the planning phase of a building project. The results indicate that

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the selection of an appropriate solution should not be based solely on direct costs, as the overall efficiency of a variant is influenced by economic, time-related, organizational, and technical factors. The analysis demonstrated that differences in technological procedures, material requirements, and labor intensity affect both the economic and time performance of the evaluated alternatives. The results therefore support the use of multi-criteria assessment as a suitable decision-support approach, enabling a more objective and transparent comparison of construction variants. The proposed approach provides a basis for linking cost estimation with construction scheduling and other relevant evaluation criteria. Its application can support investors, designers, and contractors in selecting solutions that achieve an appropriate balance between economic efficiency and implementation requirements. Further research may extend the methodology by incorporating environmental impacts, construction risks, resource utilization, and life-cycle costs.

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