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A research on straw bale and traditional external wall systems: Energy and cost-efficiency analysis

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Abstract

Rapid population growth and increased energy consumption along with urbanization led to many problems such as climate change and global warming. Sustainable building design and construction has become an essential concept. New construction technologies and the use of sustainable materials are quite significant in terms of energy efficiency in order to improve building envelope.

In the first step of the study, three of the most preferred external wall systems in low-rise buildings in Turkey construction industry have been selected and examined in detail. In the following step, timber-framed (infill) and load-bearing straw bale wall systems that have an ancient history and known as a traditional construction system have been selected in order to make a comparative analysis. In the evaluation part, five different wall systems are compared to each other in terms of their physical and thermal properties (density, weight, U and R values), embodied carbon/energy amounts and costs. The results are summarized in tables and figures. Straw bale construction is preferred in most continents like Europe, Asia, America because of its easy applicability, sustainability, good thermal insulation value, locality, economically applicable. However, these kinds of applications are very limited in Turkey due to the lack of knowledge about construction techniques. Besides, there has been no regulation or standards in Turkey about straw bale construction yet. With this research, it is aimed to emphasize the importance of straw bale construction in terms of energy efficiency and to discuss the applicability of straw bale buildings for Turkey.

Keywords
Energy efficiency, Low-impact building materials, Straw-bale construction, Sustainable construction techniques, Turkey.

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1. Introduction

With the increasing population over the years, the urbanization of cities has accelerated. It is known that there is a rapid increase in building production, especially after industrialization. Under this increasing demand, reinforced concrete system is mostly known to be preferred when building construction systems in Turkey are analyzed. According to TÜİK (Turkish Statistical Institute) data; 84% of low-rise buildings (one to three floor) which were constructed between 2010 – 2017 have reinforced concrete skeleton system (TÜİK, 2019). However, recent researches show that reinforced concrete has high embodied carbon/energy and its recycling process is limited in terms of sustainability (Purnell, 2013, Hammond, 2008, Concrete – Carbon Smart Materials Palette, n.d.). In this sense, use of environmentally friendly, low embodied carbon and recyclable materials in building construction is quite an essential issue in the context of achieving the determined building sector targets in 2011-2023 Turkey National Action Plan (Ministry of Environment and Urbanisation, 2012). One of these materials is straw, which is an agricultural by-product remaining after the harvest of grains such as rice, wheat, barley, oat, and rye. It is baled at a moisture content of less than 20 percent using mechanical baling equipment. Two and three-string bales are commonly used for building (Eisenberg & Hammer, 2014).

Strawbale buildings were first constructed in the USA in the late 1800s when baling machines were invented (Jones, 2002). The pioneers in the Sand Hills of western Nebraska started using bales of meadow hay to build everything from churches to houses. The oldest European straw bale house was built in France in 1921 (Steen, Steen, Bainbridge, & Eisenberg, 1994).

Many buildings are constructed with straw bale in Europe, too. According to the map which was prepared by Professor Burkard Rueger from the German Straw Bale Association, by the year 2010, there are approximately 700 straw bale dwellings in France, 150 straw bale dwellings in Germany and 104 straw bale dwellings in Austria (Atkinson, 2010).

1.1 Advantages/disadvantages of straw bale

Like other materials, straw bale has both advantages and disadvantages as a building material. The advantages are sustainability, renewability, low cost, having low embodied carbon, excellent thermal and sound insulation properties, contribution to achieving passive house standards and %100 biodegradability. On the other hand, tendency to decay by rot, potential infestation risk, significant wall thickness, difficulty to obtain building insurance due to perceived lack of robustness and impact resistance can be cited as disadvantages ("s construction," n.d.).

Straw is appropriate for creating healthy living environments and minimizing the ecological impact of the building process – from construction to disposal (Bocco, 2014). Using straw bale as a building material helps lifecycle instead of burning it as a waste. Two hundred million tons of straw are burned annually in the US ("Straw Bale Construction," n.d.).

Bale construction allows for architectural flexibility and aesthetic features such as smoothed corners and rounded edges around doors and windows (Midwest Renewable Energy Association, 1999). Besides, straw bale has quite good thermal insulation value. According to the Adedeji (2007) statement, the straw bale of width exceeds 450 mm have a U-value of 0.13 W/m^{2}K, which is considered the best value in comparison with other conventional wall materials such as brickwork of thickness 105 mm have U-value of 0.33 and concrete block of thickness 100 mm have U-value of 0.4 (Adedeji, 2007).

1.2 Current regulations about straw bale construction

Straw bale construction has spread all over the world, but it has rarely been standardized. There are several regulations and standards in the context of straw bale construction. Some of them are given below:

- BSF-112: Building Science for

Strawbale Buildings

- ICC- International Code Council, 2018 International Residential Code for One- and Two-Family Dwellings-Appendix S: Strawbale Construction
- 2011- Oregon Residential Specialty Code- Appendix R: Straw-Bale Structures
- IBC- International Building Code
- BS 4046: 1991 Specification for Compressed Straw Building Slabs (British Standard)

Several associations have worked on “straw bale construction” topic. Some of them are given below:

- ESBA (European Straw Building Association)
- FASBA (Der Fachverban Strohballenbau Deutschland e.V.)
- CASBA (California Straw Building Association)
- COSBA (Colorado Straw Bale Association)
- SBUK (Straw-Bale Building United Kingdom)
- Straw Bale Association of Nebraska
- Earth Building Association of New Zealand
- PAKSBAB (Pakistan Straw Bale and Appropriate Building Organization)
- Ontario Straw Bale Building Coalition
- Straw Bale Association of Texas

As it is seen, the organizations all over the world have been working on straw bale. In this context, Turkey has no standards or regulations on straw bale construction by now. However, the use of straw bale getting more and more critical because of its advantages for the construction industry. Therefore, it has to be taken a concrete step about this issue.

1.3 Straw-bale buildings in Turkey

Strawbale has been used firstly as a building material in the ecovillage experiment in Hasandede and Hocamköy in 1999-2000. Architects, academicians, and foreign specialist have been received support in the construction of the house. This settlement has a significance due to being the first community-supported agriculture trial in Turkey (Pedergnana, 2015). Güneşköy, which has been built in 2000, is one of the ecovillages that consist of straw bale houses. In 2002, the first eco-center in Turkey had been built again within the help of villagers and foreign specialists. Straw-bale has been used as a building material in this settlement. By now, there have been several straw-bale buildings which have been constructed in some workshops or also by self-builders. According to Pedergnana’s report (2015), there are at least 27 straw-bale buildings in Turkey (Pedergnana, 2015). However, if the population of Turkey is thought, this number will remain quite low. Due to the lack of knowledge, documentation, and standardization, the use of straw bale is not thought of as a building material in Turkey Construction Industry yet.

2. Methodology

The methodological framework of the study is based on literature review and comparative analysis. In the first part of the research, three of the most

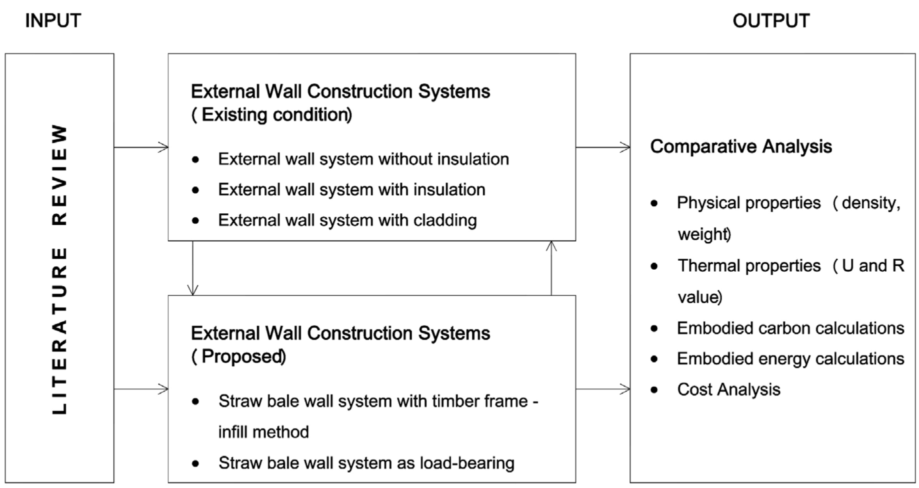

Figure 1. *The process model of the study.*

preferred external wall systems in Turkey been introduced and examined in detail. In the following step, two straw bale wall systems constructed with different techniques have been examined to make a comparison. Physical and thermal properties of the wall systems such as density, weight, U, and R values are determined and summarized in the table. Afterward, embodied carbon and energy amount of the wall systems have been calculated within the help of a report prepared by Prof. Geoff Hammond & Craig Jones from the University of Bath (Hammond & Jones, 2011). It has been benefitted from some websites in this context, too. Third and last part of the study, selected wall systems are compared to each other in terms of their costs. The process model of the study is given in Figure 1.

3. External wall construction system

In this chapter, five different external wall systems have been examined in detail. These are listed below:

- External wall system without insulation (Type 1)
- External wall system with insulation (Type 2)
- External wall system with cladding (Type 3)
- Strawbale wall system with timber frame – infill method (Type 4)
- Strawbale wall system as load-bearing (Type 5)

Type 1, 2, and 3 are commonly encountered walls systems in Turkey. Especially, Type 1 has quite a lot percentage- nearly %80- of total building stock (Atamer, 2010). Type 1, 2, and 3 have reinforced concrete as a load-bearing system. According to the TÜİK database, reinforced concrete structure is the most preferred as a loadbearing system in 2018. Also, brick is commonly used (%83) as fill material (TÜİK, 2019).

Type 4 and 5 have been assumed as a straw bale wall system. These sys¬tems are not conventional in Turkey, but they have been selected in order to make a comparative analysis. For the evaluation, some technical data of five different type wall systems are given. Each wall system has been summarized in a table with its heat transmission value, the R and U value calculations, thickness, and thermal conductivity of each component. The thickness of materials has been taken as commonly preferred values in the construction industry. Thermal conductivity and density values have been taken from TS 825 standard. According to the standard, R and U values are calculated as in formula 1 and 2 while the wall system is multilayered (Turkish Standards Institution, 2013).

$$R = \frac{d_1}{\lambda_{h1}} + \frac{d_2}{\lambda_{h2}} + \cdots + \frac{d_n}{\lambda_{hn}} \quad (1)$$

R: thermal transmittance value (m^2K/W),
d: thickness of building component (m),
LH: thermal conductivity value (W/mK)

For the calculation of U value, the formula below is used (Turkish Standards Institution, 2013):

$$R = 1/ U \quad (2)$$

In the next step, each external wall system is briefly introduced, and technical data that has been calculated is summarized in the table.

3.1. External wall system without insulation (Type 1)

In this study, the uninsulated external wall system is assumed as consist of three components: brick as fill material, cement plaster, and paint as a finish-

Table 1. *Properties and components of the uninsulated external wall system.*

Material	Thickness d (m)	thermal conductivity (λ)W/mK	R value (m^2K/W)	U value (W/m^2K)	Density kg/m^3	Weight Kg/m^2
paint (double coat) ext.	0.0001	0.023	0.00		1520	0.152
cement mortar	0.02	1.6	0.01		2000	40
vertically perforated lightweight brick	0.185	0.36	0.51		700	129.5
cement mortar	0.02	1.6	0.01		2000	40
paint (double coat)	0.0001	0.023	0.00		1520	0.152
Total	**0.23**		**0.55**	**1.83**		**209.80**

Table 2. *Properties and components of the insulated external wall system.*

Material	Thickness d (m)	thermal conductivity (λ)W/mK	R value (m^2K/W)	U value (W/m^2K)	Density kg/m^3	Weight Kg/m^2
paint (double coat) ext.	0.0001	0.023	0.00		1520	0.152
cement mortar	0.02	1.6	0.01		2000	40
thermal insulation (XPS)	0.05	0.03	1.67		25	1.25
vertically perforated lightweight brick	0.185	0.36	0.51		700	129.5
cement mortar	0.02	1.6	0.01		2000	40
paint (double coat)	0.0001	0.023	0.00		1520	0.152
Total	**0.28**		**2.21**	**0.45**		**211.05**

ing. From exterior to interior, double coat paint, 2 cm cement plaster, 18,5 cm vertically lightweight perforated brick, 2 cm cement plaster and double coat paint have been used. External wall system components are given with their thickness, thermal conductivity values, R and U values, densities, and weight in Table 1.

According to the calculations, the U value of the selected wall system is 1.83 W/m²K. It is quite a lot from the value, which is recommended as well for five climatic zones in TS 825 standard (Turkish Standards Institution, 2013). Weight in one square meter area has been calculated as 209.80 m².

3.2. External wall system with insulation (Type 2)

The insulated wall system is likely an uninsulated wall except for the insulation material. This system can be assumed as consist of four components: brick as fill material, cement plaster, thermal insulation material, and paint as a finishing. From exterior to interior; double coat paint, 2 cm cement plaster, 5 cm thermal insulation material (XPS), 18,5 cm vertically lightweight perforated bricks, 2 cm cement plaster and double coat paint are assumed. External wall system components are given with their thickness, thermal conductivity values, R and U values, densities, and weight in Table 2.

The calculations show that the U value of the selected wall system has been dramatically decreased when thermal insulation material is used (from 1.83 W/m²K to 0.45W/m²K). This value has quite a significance in terms of reducing the heating energy consumption of the building. Weight in 1m² area has been calculated as 211.05m².

3.3. External wall system with cladding (Type 3)

External wall systems with cladding are usually seen in Turkey construction industry as an alternative to house paints. In this context, wall claddings are entirely various; ceramic tile, granite, natural stone, composite panels, etc. can be an example. In the research, ceramic tile cladding has been supposed. This system can be assumed as consist of four components: brick as fill material, cement plaster, thermal insulation material, and paint as a finishing. From exterior to interior; 2 cm ceramic tile cladding, ceramic adhesive, 2 cm cement plaster, 5 cm thermal insulation material (XPS), 18,5 cm vertically lightweight perforated bricks, 2 cm cement plaster and double coat paint are assumed. External wall system components are given with their thickness, thermal conductivity values, R / U values, densities, and weight in Table 3.

According to the calculations, the R-value of the selected wall system is 2.24 m²K/W. A slight increase has been detected in comparison with the R-value of Type 2. Weight in one square meter area has been calculated as 250.90 kg/m². This value is more than Type 1 and 2 because of the weight of ceramic tiles and adhesives.

Table 3. *Components and properties of external wall system with cladding.*

Material	Thickness d (m)	thermal conductivity (λ)W/mK	R value (m²K/W)	U value (W/m²K)	Density kg/m³	Weight Kg/m²
ceramic tile cladding	0.02	1.3	0.02		1750	35
ceramic adhesive	0.005	0.44	0.01		1000	5
cement mortar	0.02	1.6	0.01		2000	40
thermal insulation (XPS)	0.05	0.03	1.67		25	1.25
vertically perforated lightweight brick	0.185	0.36	0.51		700	129.5
cement mortar	0.02	1.6	0.01		2000	40
paint (double coat)	0.0001	0.023	0.00		1520	0.152
Total	**0.30**		**2.24**	**0.45**		**250.90**

Table 4. *Components and properties of timber-framed straw bale wall system (infill method).*

Material	Thickness d (m)	thermal conductivity (λ)W/mK	R value (m²K/W)	U value (W/m²K)	Density kg/m³	Weight Kg/m²
lime plaster	0.03	1	0.03		1800	54
timber frame (studs)	0.04	0.13	0.31		600	24.00
straw bale	0.45	0.058	7.76		150	67.5
timber frame (studs)	0.04	0.13	0.31		600	24.00
lime plaster	0.03	1	0.03		1800	54
Total	**0.59**		**8.43**	**0.12**		**223.5**

3.4. Strawbale wall system with timber frame – infill method (Type 4)

Strawbale has been commonly used all over the world as building material after the invention of the baling machine in the 1800s (Jones, 2002). Although usage of this material rarely occurs in Turkey, any standards or regulation does not exist across the country.

In this part, the timber-framed straw bale wall system is examined. From exterior to interior, 3 cm lime plaster, 4 cm timber stud, 45 cm straw bale, 4 cm timber stud and 3 cm lime plaster have been used. External wall system components are given with their thickness, thermal conductivity values, R /U values, densities, and weight in Table 4.

According to the calculations, the U value of the straw bale wall system is 0.12 W/m^{2}K, which is quite great value in comparison with other wall types in terms of thermal performance. Weight in one square meter area has been calculated as 223.5 m^2.

3.5. Strawbale wall system as loadbearing (Type 5)

Strawbale walls constructed with this technique works as loadbearing. It is also named as 'Nebraska style.' Use of the technique in Nebraska, most widespread from about 1915 to 1930, appears to have ended by 1940 (Myhrman & MacDonald, 1997).

In the context of the study, 45 cm straw bales are used with 3 cm lime plaster on both sides of the wall. External wall system components are given with their thickness, thermal conductivity values, R and U values, densities, and weight in Table 5.

According to the calculations, the U value of the straw bale wall system is 0.13 W/m^{2}K, which is again quite well value in comparison with other wall types in terms of thermal performance. Besides, weight in one square meter area has been calculated as 175.5 m^2, which is also quite significant in terms of reducing the dynamic loads such as earthquakes on buildings.

According to the calculations, thermal transmittance values and weights of the researched wall systems are summarized in Figure 2. Calculations show that loadbearing straw bale wall (Type 1) has the best thermal transmittance value also the lowest weight.

4. Embodied carbon and embodied energy calculations

In this part, embodied carbon and embodied energy amount of the external wall systems have been calculated. First of all, embodied carbon amount (kg CO_2e/kg) and embodied energy (MJ/kg) equivalent to 1 kg have been found with the help of the ICE report (Hammond & Jones, 2011). Weight of the material in one square meter area has been calculated by using the thickness of the material(m) and density value (kg/m^3). The basic formula is below:

$$\textit{The material ratio in one square meter}\left(\frac{kg}{m2}\right) = \textit{Thickness of material }(m)\textit{ x Density of material }\left(\frac{kg}{m3}\right) \tag{3}$$

The density value of each material has been taken from TS 825 standard. The thickness of the material is assumed for the research. Finally, the material ratio (kg/m^2) and embodied carbon and embodied energy amount have been multiplied to reach the total amount of embodied carbon and energy. This calculation has been made for five external wall systems, and in the end, values have been compared to each other. The results are summarized in Table 6.

According to the table, Type 3 has the most embodied carbon and energy amount in comparison with other wall types because of released carbon in production ceramic tile. Besides, clay is available in nature, but brick is a processed material, and so it has high embodied carbon. In addition to this, the production of extruded polystyrene (XPS) for thermal insulation has high embodied energy and carbon.

Table 5. *Strawbale wall system (load-bearing) components and properties.*

Material	Thicknes s d (m)	thermal conductivity (λ)W/mK	R value (m^{2}K/W)	U value (W/m^{2}K)	Density kg/m^3	Weight Kg/m^2
lime plaster	0.03	1	0.03		1800	54
straw bale	0.45	0.058	7.76		150	67.5
lime plaster	0.03	1	0.03		1800	54
Total	**0.51**		**7.82**	**0.13**		**175.5**

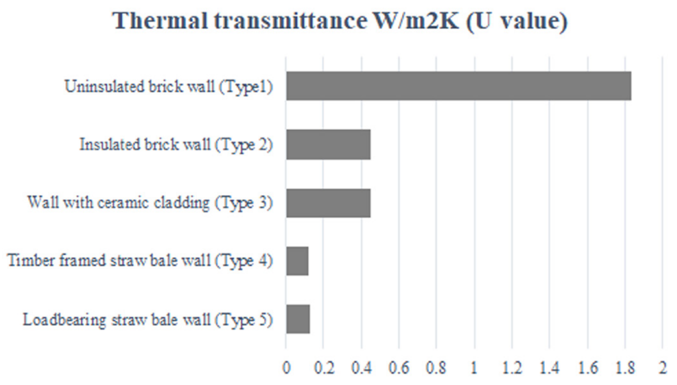

Figure 2(a). *Thermal transmittance (U value) of researched wall systems.*

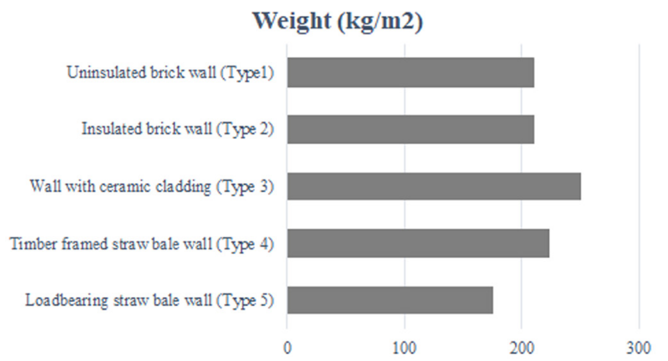

Figure 2(b). *Weight of the researched wall systems.*

Table 6. *Amount of embodied carbon and energy of five different wall systems.*

Material	d (m) thickness	kg/m³ density	kg/m² weight	kg CO_2e/kg embodied carbon	Total embodied carbon kg CO_2	embodied energy (MJ/kg)	Total embodied energy kg/m2 x MJ/kg
External wall system without insulation (Type 1)							
Paint (double coat) ext.	0.0001	1520	0.152	2.54	0.39	59	8.97
cement mortar	0.02	2000	40	0.221	8.84	1.33	53.20
vertically perforated lightweight brick	0.185	700	129.5	0.24	31.08	3	388.50
cement mortar	0.02	2000	40	0.221	8.84	1.33	53.20
paint (double coat)	0.0001	1520	0.152	2.54	0.39	59	8.97
Total					**49.53**		**512.84**
External wall system with insulation (Type 2)							
Paint (double coat) ext.	0.0001	1520	0.152	2.54	0.39	59	8.97
cement mortar	0.02	2000	40	0.221	8.84	1.33	53.20
thermal insulation (XPS)	0.05	25	1.25	3.29	4.11	88.6	110.75
vertically perforated lightweight brick	0.185	700	129.5	0.24	31.08	3	388.50
cement mortar	0.02	2000	40	0.221	8.84	1.33	53.20
paint (double coat)	0.0001	1520	0.152	2.54	0.39	59	8.97
Total					**53.64**		**623.59**
External wall system with cladding (Type 3)							
ceramic tile cladding	0.02	1750	35	0.78	27.30	12	420.00
ceramic adhesive	0.005	1000	5	0.74	3.70	4.51	22.55
cement mortar	0.02	2000	40	0.221	8.84	1.33	53.20
thermal insulation (XPS)	0.05	25	1.25	3.29	4.11	88.6	110.75
vertically perforated lightweight brick	0.185	700	129.5	0.24	31.08	3	388.50
cement mortar	0.02	2000	40	0.221	8.84	1.33	53.20
paint (double coat)	0.0001	1520	0.152	2.54	0.39	59	8.97
Total					**84.26**		**1057.17**
Strawbale wall system with timber frame – infill method (Type 4)							
lime plaster	0.03	1800	54	0.13	7.02	1.8	97.20
timber frame (studs)	0.04	600	24.00	0.123	-1.20	7.4	177.60
straw bale	0.45	150	67.5	-1.25	-84.38	0.0014	0.09
timber frame (studs)	0.04	600	24.00	0.123	-1.20	7.4	177.60
lime plaster	0.03	1800	54	0.13	7.02	1.8	97.20
Total					**-72.74**		**549.69**
Strawbale wall system as loadbearing (Type 5)							
lime plaster	0.03	1800	54	0.13	7.02	1.8	97.20
straw bale	0.45	150	67.5	-1.25	-84.38	0.0014	0.09
lime plaster	0.03	1800	54	0.13	7.02	1.8	97.20
Total					**-70.34**		**194.49**

On the other hand, the eco-friendliest wall system is Type 5, because straw bale has negative carbon value. Type 4 has straw bale too, but processing of timber studs increases the embodied carbon and energy amount.

The results are summarized in Figure 3.

5. Cost analysis

In this section, five different wall systems are examined in terms of their costs. Cost units which are defined as yearly by the Ministry of Environment and Urbanisation have been used in calculations. Cost unit defined in the list in TL/kg, TL/m² or TL/unit has been given for each component of the wall systems. Afterward, the data is summarized in Table 7.

According to the calculations, the most expensive wall system is Type 3. Claddings have a wide range of price scale in the construction industry. So, the cost can be dramatically changed according to the selection of cladding. Although straw bale material is cost-effective, Type 4 is the second most expensive wall system because of the installation of the timber frame system. Type 2 is more expensive than Type 1 because of the involvement of the thermal insulation layer. The most cost-effective wall system is Type 5 (It is almost more than 3.5 times of Type 3). Strawbale is a local material and readily available.

6. Conclusion

In this research, five different wall systems have been examined in detail in terms of their physical, thermal properties, embodied carbon and energy amounts and costs. The results show that the use of straw bale as a building material is quite significant in terms of energy efficiency and sustainability. Strawbale has low embodied carbon/energy and low cost. It is readily available in Turkey (local material). It is also proper to use in a passive house or zero energy building because of its excellent thermal properties. The weight of an external wall constructed with straw bale is lower than a traditional brick wall. Besides, seismic durability of a straw bale is proved by tests.

Some legal arrangements should be

made to popularize the use of straw bale as a building material across the country. In some of the world, countries have standards about strawbale construction techniques. These regulations and standards may be adapted for Turkey's local conditions. Though the application is seen as pure, some precautions should be taken for the conditions which may affect the performance of the wall such as fire and moisture.

For the next step of the study, it is aimed to determine the strawbale thickness and finishing material properties according to five different climatic regions of Turkey for helping to standardization.

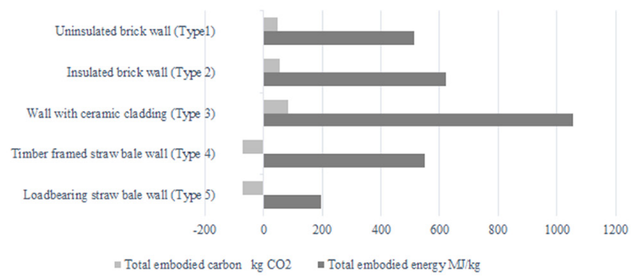

Figure 3. *Summary of embodied carbon and energy amount of researched wall types.*

Table 7. *Cost analysis of the researched wall systems.*

Material	Item number	Weight kg/m²	Cost (TL/kg)	Cost (TL/unit)	Cost TL/m²
External wall system without insulation (Type 1)					
paint (double coat) ext.	04.553/01	0.152	7.50		1.14 ₺
cement mortar	04.482	40	0.65		26.00 ₺
vertically perforated lightweight brick	04.016/F04	129.5		1.17	21.06 ₺
cement mortar	04.482	40	0.65		26.00 ₺
paint (double coat)	04.553/01	0.152	7.50		1.14 ₺
Total					**75.34 ₺**
External wall system with insulation (Type 2)					
paint (double coat) ext.	04.553/01	0.152	7.50		1.14 ₺
cement mortar	04.482	40	0.65		26.00 ₺
thermal insulation (XPS)	19.055/C1	1.25			38.63 ₺
vertically perforated lightweight brick	04.016/F04	129.5		1.17	21.06 ₺
cement mortar	04.482	40	0.65		26.00 ₺
paint (double coat)	04.553/01	0.152	7.50		1.14 ₺
Total					**113.97 ₺**
External wall system with cladding (Type 3)					
ceramic tile cladding	26.007/163C	35			28.58 ₺
ceramic adhesive	04.013/1	5	0.40		2.00 ₺
cement mortar	04.482	40	0.65		26.00 ₺
thermal insulation (XPS)	19.055/C1	1.25			38.63 ₺
vertically perforated lightweight brick	04.016/F04	129.5		1.17	21.06 ₺
cement mortar	04.482	40	0.65		26.00 ₺
paint (double coat)	04.553/01	0.152	7.50		1.14 ₺
Total					**143.41 ₺**
Strawbale wall system with timber frame – infill method (Type 4)					
lime plaster	27.511	54			9.51 ₺
timber frame (studs)	3001	24.00			45.44 ₺
straw bale	-	67.5	0.35		23.63 ₺
timber frame (studs)	3001	24.00			45.44 ₺
lime plaster	27.511	54			9.51 ₺
Total					**133.53 ₺**
Strawbale wall system as loadbearing (Type 5)					
lime plaster	27.511	54			9.51 ₺
straw bale	-	67.5	0.35	_	23.63 ₺
lime plaster	27.511	54			9.51 ₺
Total					**42.65 ₺**

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