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# An Approach For Determination of Risky Buildings And Building Energy Performance Concerning Urban Renewal In Türkiye

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**Abstract**

In May 2012 "Urban Renewal Law" for reducing the expected seismic risk for existing buildings was published. Depending on this law, existing old buildings should have stability tests for the decision; if it should be demolished or strengthened. This article is mainly concentrating on the earthquake stability and energy performance of a case building regarding the physical and environmental dimensions of urban renewal. Case building is a deficient structure that couldn't catch the static regulations and so demolished. Regarding the urban renewal process a new building was constructed following the energy performance regulations. In this framework structural and energy performance analysis of the existing deficient building are done to present the conditions first. Then the energy performance of the new building is analyzed to be compared with the demolished building. For the static analysis of the existing building ideCAD, for the energy performance analysis BEP-TR 2 programs are used. As a result of this study, the structural performance of the case building is examined to display the need of a new construction and then the development of the energy performance is presented by the comparison between demolished and new buildings.

**Keywords:** Urban Renewal, Building Energy Performance, Building Structural Analysis

## 1. Introduction

Urban renewal, apart from being a periodic definition, it is proposed to be a process of changes affecting the physical structure and fabric of urban areas [1]. In other words, it is a particularly physical change, as the inevitable "outcome" of the action of economic and social forces upon urban areas, especially as a powerful force for urban change and predominantly a market-led process [1]. According to conceptual terminology, urban renewal is a continuous process of remodeling older parts of urban areas, including their central business district (CBD) areas by means of rehabilitation, conservation, and redevelopment [2]. With urban renewal, particular sections of the city change their nature and its structure being evolved [3]. In Eurocities (1996) it is noted that urban renewal is about the sustainable development of cities which is holistic in approach, and targeted at economic and cultural redevelopment, social cohesion and physical rehabilitation of cities [4].

Five basic laws that comprise the legal framework regarding urban transformation in Turkey can be cited.

• "Mass Housing Law" no 2985
• "Municipality Law" no 5393
• "North Ankara Entrance Urban Transformation Project Law" no 5104 (Special Law)
• "Law no 5366 on the Renewal and Preservation and Usage by Sustenance of Worn-out Urban Fabric"
• "Law no 6306 on the Transformation of Areas under Disaster Risk"

Turkey's urban regeneration projects emerged with the approval of law 5366, called "Renovation, Protection, Cherishing, and Use of Worn Historical and Cultural Immovable Properties". This law gives extensive authorization to municipalities for implementing projects, including the declaration of areas as regeneration areas, expropriation, eviction, and demolishment of properties in case of disagreement between municipality and house owners (Turkish Grand National Assembly, 2005). (1)

Turkey is located on a seismically active zone stroked by Alpine-Himalayan Belt, which generates 17% of all earthquakes in the world. Turkey faced Marmara earthquake in 1999 that caused the demolition of many buildings and death of more than 10000 people. After this big disaster lot of changes in the construction sector are done by the government for reducing the vulnerability of possible future earthquakes.

In our country, the issue of urban transformation has become one of the most discussed and disputed topics with the problems of urbanization and settlement that became more visible specifically following the catastrophes in 1999 Marmara and Düzce earthquakes, (5). The "Disaster Law", which is the latest legislation in the context of urban renewal policies, is also shown as a solution to the disaster risk reduction by creating better physical environment and better housing, (6).

It is known that a single structure-based transformation approach is acted upon by the fact that it forms the body of Law No. 6306, and a method is built on the relation of strength. Urban transformation in Turkey; the structures in existing built environments are destroyed and new structures are made in accordance with the 2007 Earthquake Regulation due to the fact that natural disasters play a dominant role [9].

Law No. 6306 refers to the buildings at a risk of damage or serious damage. According to the Law 6306; the structures that either have completed their economic life or under risk of collapse and heavy damage within or outside risky area, determined on the basis of scientific and technological evidence is called as a risky building. The risky buildings cannot resist physical or geological disasters. So, for reducing the risk of risky buildings from being collapsed these buildings must be replaced with new ones according to the Law 6306.

Urban renewal has physical, social, economic, and environmental dimensions. Physical dimensions of the urban renewal are about the physical conditions of the building such as infrastructure, resistant to the forces like earthquake and also urban fabric. Social dimension of the urban renewal is about demography concerning the profile, education level, income, health of the people and is for improving community in that region. Economical dimension of the urban renewal is about the effects of urban renewal on the people's profit and loss in case of urban renewal and also new generation of employment. Environmental dimension of the urban renewal is about the ecological effects of the buildings. Physical and environmental dimensions of urban renewal are taken into account in this paper.

## 2. Materials and Methods

In order to reduce probable losses under the risk of physical and geological disasters, the risky buildings must be determined so that they can be replaced with new ones or can be retrofitted according to the regulations. So that the buildings can stand still against natural hazards.

This research is based on determination of risky buildings through directive of Law 6306 and designing a new building instead of the risky one. After that energy performance analysis of both risky building and newly built one is done by using the national energy performance certification tool of Turkey; BEP-TR. Therefore, benefits of constructing new building in respect to energy performance is put forward. The steps for the approach of this research are defined as follows;

- Risky building detection,
- Energy performance analysis,
- Design of the new building,
- Comparison of existing and new buildings.

### 2.1. Risky Building Detection

For risky building detection analysis general information about the building must be collected. These are; the construction date, address, layout, geographic coordinates, earthquake zone, dimensions of the building, structure information and also load bearing element of the building.

If the statical and architectural project of the building cannot be found, then existing building's dimensions of the columns and beams, opening dimensions, width and length of the wall, dimensions of the building and height of the floor can be measured on the existing building on site and the architectural project can be drawn.
After that core sampling and reinforcement evaluation is done for the critical floor for determining the concrete elements quality. According to the regulations, core sampling must be applied to more than 20% of all columns and strength tests should be done on these core samples. By using stripping and monitoring methods stirrup frequency and reinforcement are defined. The next step is preparing soil survey report of the building site which is showing the load carrying capacity analysis of the soil. Based on the RBTYE regulations accepted 2 July 2013, for the performance analysis of the current situation ideCAD building performance analysis program can be used than.

### 2.2. Building Energy Performance Analysis

'Code for Energy Efficiency' was published on 2nd of May 2007 by Turkish Government. Ministry of Environment and Urbanisation first published 'Building Energy Performance Regulations' on 5th of December 2008; based on 'Energy Performance of Buildings Directive (EPBD) 2002/91/EC' of the European Union and 'Code for Energy Efficiency' of Turkey. National energy performance calculation tool: Bep-TR was presented as a certification system grounded on EN ISO 13790 and national specifications. (ISO, 2008) To present the energy certificate level; whole building's total energy consumptions are calculated according to the primary energy usage and CO2 emissions caused by climate conditions, indoor environment needs, regional priorities, and boundary conditions. The online software had been in use from July 2010 till November 2017 by registered professionals under a governmental network. Ministry of Environment and Urbanisation published repeating "Declaration on Building Energy Performance Calculation Methodology" on 1st of November 2017 to present the new calculation tool.

For energy performance analysis of the buildings firstly the building is identified in the offline operation platform of BEP-TR 2 by entering general location and construction information. Than in the two-dimensional drawing interface building energy model is generated as a plan geometry. After that all the details for floors and thermal zones are defined as; construction materials, mechanical systems and lighting systems. When the energy model is completed software runs the offline simulation to calculate the energy consumptions of the building. In this process the system generates a reference building to compare and give an energy consumption class to the evaluated building. Energy classes are determined according to the energy performance (Ep) range as; A: 0-39; B: 40-79; C: 80-99; D: 100-119; E: 120-139; F: 140-174; G: 175-... Generated reference building is accepted as it is over the energy class D. So if the evaluated building has the same results with the reference building, then the Ep value is 100. At the end of all this process, the software requires username and password for the server connection to create an 'Energy Identity Certificate' (Figure 1). Regarding to the regulations; all the new buildings constructed after 01.01.2011; should have an energy identity certificate with minimum energy class C.


**Figure 1.** Energy identity certificate (Republic of Turkey Ministry of Environment and Urbanization, 2017)

If the building's energy class is lower than C that means more precautions concerning energy savings must be taken into account. And also, it shows that the building's energy expenses are too much. For decreasing the energy expenses heating methods with lower greenhouse emission, such as thermal insulation can be done according the climate, lighting systems can be energy efficient and façade elements such as windows must have high insulation.

## 3. Examination of the existing building

The existing building (Figure 2) was constructed in 1970 in Karaçam, Bornova, İzmir (latitude: 38.5156766° N, longitude: 27.2702750° E). It is a single floor reinforced concrete building as one independent living space. It has totally 58.26 m2 closed area (6.00 m*9.71 m) with a 2.72 m floor height.

**Figure 2**. Existing building

Since the building has no application projects; each element of the building such as; column and beam section dimensions, door- window openings, wall thickness, floor plan dimensions and building height are measured for the architectural relievo drawings. (Figure 3)

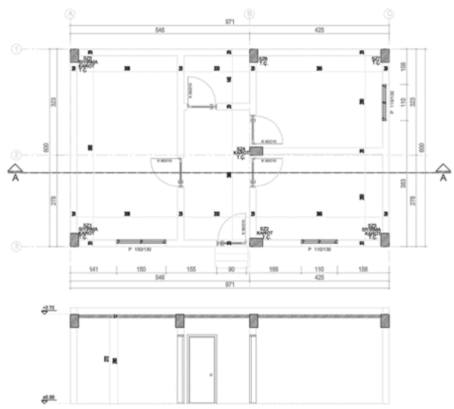

**Figure 3**. Plan and section relievo drawings, existing building

### 3.1. Risky Building Detection

The required information about the existing building is collected through site visits. According to the analysis; building's structural system is reinforced concrete. The load bearing system consists of 7 (*) columns with a 12 cm reinforced concrete flat slab which is the roof of the building. Exterior walls are composed of 0.19 m brick elements. (Table 1).

Celal Bayar University Journal of Science
Volume 19, Issue 1, 2023, p 97-106
Doi: 10.18466/cbayarfbe.1108873


**Table 1.** Construction elements, existing building

| Construction Element | Material | Thickness (m) |
|---|---|---|
| Slab (Basement) | Reinforced Concrete (L:2.500-05.01.01) | 0.12 |
| | Gypsum Plaster (L:0.510-04.04) | 0.02 |
| | Concrete (L:1.650-05.01.02) | 0.03 |
| | Lime, Lime- Gypsum Mortar (L:1.000-04.01) | 0.02 |
| | Phanerocrystalline Volcanic and Metamorphic Stone (L:1.650-05.01.02) | 0.02 |
| Column-Beam | Gypsum Plaster (L:0.510-04.04) | 0.03 |
| | Reinforced Concrete (L:2.500-05.01.01) | 0.25 |
| | Gypsum Plaster (L:0.510-04.04) | 0.02 |
| Exterior Wall | Gypsum Plaster (L:0.510-04.04) | 0.03 |
| | Brick_TS EN 771-1 (L:0.810-07.01.01.01) | 0.19 |
| | Gypsum Plaster (L:0.510-04.04) | 0.02 |
| Flat Roof | Reinforced Concrete (L:2.500-05.01.01) | 0.12 |
| | Gypsum Plaster (L:0.510-04.04) | 0.02 |
| | Concrete (L:1.650-05.01.02) | 0.05 |
| | Bitumen Waterproofing Sheet (L:0.190-09.02.02.01.01) | 0.05 |

Following the RBTYE regulations (02.07.2013); core sampling and reinforcement evaluation for defining stirrup frequency and reinforcement is done for the critical floor (basement) (figure 4). 5 different columns' sections and reinforcements were evaluated.

More than 20% of all the columns were reinforced but not with the ribbed iron (S220) and also used stirrups were not tightened as it should be done (Table 2). Existing concrete endurance was also lower than the accepted standards.

**Table 2.** Defining coloumn's and beam's reinforcement with stripping method

| NO | Coloumn | Longitudunal Reinforcement (S220) | Stirrup Reinforcement (S220) | Densifi-cation |
|---|---|---|---|---|
| 1 | SZ01 | 4Ø14 | Ø8/21-25 | - |
| 2 | SZ03 | 4Ø14 | Ø6/24-28 | - |
| 3 | SZ05 | 4Ø14 | Ø8/24-45 | - |

**Figure 4.** Column stripping and core concrete, existing building

Core concrete samples from 5 columns located at the ground floor are taken and strength tests are done. The results of unconfined compressive strength are given at Table 3. According to RBYTE regulation accepted on 2nd July 2013, the average strength of core concrete samples should be *85*85.

**Table 3.** Compressive strength

| Ground Floor | | | | | |
|---|---|---|---|---|---|
| Columns | SZ01 | SZ02 | SZ03 | SZ04 | SZ05 |
| Compressive Strenght | 16,90 | 11,13 | 12,16 | 9,14 | 12.83 |
| Average | 12,43 | 12,43 | 12,43 | 12,43 | 12,43 |
| *0.85*0.85 | 8,98 | 8,98 | 8,98 | 8,98 | 8,98 |
| Selected concrete strength (Mpa) | 10 | 10 | 10 | 10 | 10 |

Location of the case building is within the earthquake region 1, so the structural importance coefficient of the building is accepted as Z1 and the parameters used for the calculations are given in Table 4.

For the structural analysis of the building all the collected data is used as input data for IdeCAD simulation (Figure 5). IdeCAD database is based on "Mod Merge Calculation Method" which is compatible with RBYTE regulations. Using the output data of IdeCAD simulation process, structural elements can be examined by their collapse failure value.

Celal Bayar University Journal of Science
Volume 19, Issue 1, 2023, p 97-106
Doi: 10.18466/cbayarfbe.1108873 

**Table 4.** Parameters for the calculation

| | | | |
|---|---|---|---|
| Building importance coefficient | 1 | Earthquake region | 1st degree |
| Movable Loads | 0,5/0,35/0, 2 t/$m^2$ | Knowledge level (Min) | 0,90 |
| Structural System | Frame | Local Floor Class | Z1 |
| Construction System | Reinforced concrete | Floor group | A |
| R behaviour coefficient | 8 | Ground bearing strength | |
| Spectrum characteristic periods | Ta=0.10 s Tb=0.30 s | Coefficient of soil reaction | |
| Bearing columns compressive strength | | Ao | 0,4 |

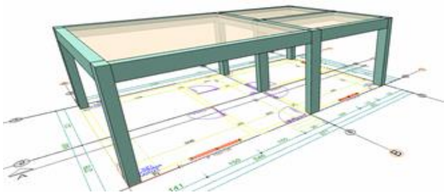

**Figure 5.** Structural analysis model, existing building

Through the results of the structural performance analysis, existing building seems not to be able to provide the safety requirements of earthquake regulations. So that it may collapse under the risk of any moderate earthquake and it may cause loss of lives. This situation may affect our country's and also surrounding societies' sociology, economy and psychology in negative way and so may cause damages. Consequently, the existing building is defined as "risky".

### 3.2. Energy performance analysis of the existing building

For energy performance analysis of the buildings firstly the building is identified in the offline operation platform of BEP-TR 2 by entering general location and construction information. Than in the two-dimensional drawing interface building energy model is generated first as a plan geometry. After that all the details for floors and thermal zones are defined as; construction materials, mechanical systems and lighting systems. At the end of the process building energy performance is calculated and 'Energy Identity Certificate' (Figure 1) is obtained through the server of the ministry.

First the case building is identified in BEP-TR 2 as a detached low-rise residential building located in Bornova, İzmir. Than the plan geometry is generated regarding to the relief drawings given in Figure. According to the outline given in BEP-TR 2; ground floor is entered with the height of 2.72, the only thermal zone is defined as a climatized residential zone with a 27m2 kitchen and living room space. Than 5 glow lamps with 40 W are entered as the lighting detail of this thermal zone and the only mechanical system is defined as a coal burning stove for heating. Following the information given in Table, walls, columns, beams, slabs and roof are defined by their materials and thickness. Also, the metal entrance door and 3 openable PVC windows (U-value: 3.3) are defined. After the completion of the building energy model (Figure 6) with no errors, simulation is started for the energy performance calculations.

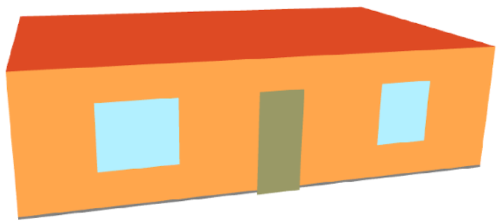

**Figure 6.** Energy model, existing building

**Table 5.** Energy performance analysis results, existing building.

| Systems | Annual Electricity Consumptions | | | | Renewable Energy/ Cogeneration Energy | | Energy Class |
|---|---|---|---|---|---|---|---|
| | Final (kWh/ year) | Primary (kWh/ year) | Per Unit Area (kWh/$m^2$.year) | Per Unit Area ($kgCO_2/m^2$.year) | Primary (kWh/ year) | Per Unit Area (kWh/$m^2$.year) | |
| Total | 12035,11 | 14021,28 | 240,67 | 69,69 | 0 | 0 | F 147 |
| Heating | 9431,70 | 9431,70 | 161,89 | 47,05 | 0 | 0 | F 144 |
| Hot Water | 763,53 | 777,34 | 13,34 | 3,15 | 0 | 0 | D 104 |
| Cooling | 1565,06 | 3242,80 | 55,66 | 16,57 | 0 | 0 | F 160 |
| Lighting | 274.83 | 569.45 | 9.77 | 2.91 | 0 | 0 | G 300 |

Celal Bayar University Journal of Science
Volume 19, Issue 1, 2023, p 97-106
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As a result of the calculations, annual electricity consumptions of heating, hot water and cooling system usages are given in kWh and kgCO2 units (Table 5). Since there is no renewable energy usage there is no value calculated. Through the evaluation of BEP-TR 2 database, case building is qualified in F energy class.

## 4. Design of the new building

As the existing building cannot provide requirements of the earthquake regulations, it can collapse under the stress of a probable moderate earthquake. So that there are two actions to be taken; to strengthen the construction and retrofit or to demolish and construct a new building.

Considering the energy performance analysis and the spatial requirements of the householder, constructing a new building is preferred and new building is designed. It is a detached house with ground and first floors as seen in (Figure 7). It has totally 220 $m^2$ closed area with a 2.73 m ground and 3.22 m first floor height.

The building has a timber frame construction designed with 20*20 cm columns, 20*15 cm beams carrying the suspended hipped roof and Osb slab seated on 10*15 cm minor beams. The interior walls are 10 cm and exterior walls are 20 cm matched timber. The details of all the construction elements are given in Table 6.

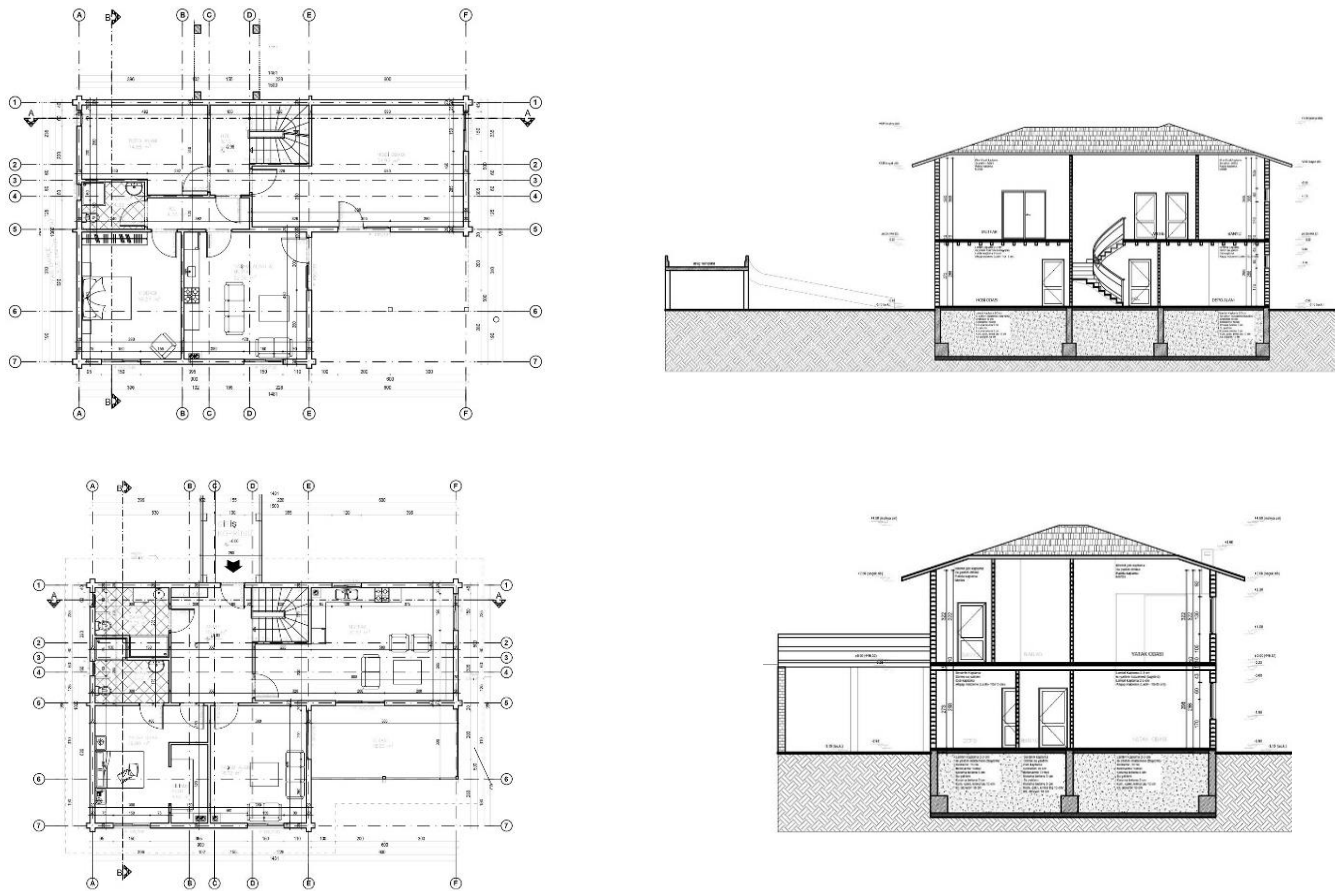

**Figure 7.** Architectural drawings, new building

**Table 6.** Construction elements, new building

| Construction Element | Material | Thickness (m) |
|---|---|---|
| Slab (Basement) | Cast Stone (L: 1.300-01.08) | 0.01 |
| | Cement Screed (L: 1.400-04.06.01) | 0.03 |
| | Reinforced Concrete (L:2.500-05.01.01) | 0.12 |
| | Cement Screed (L: 1.400-04.06.01) | 0.05 |
| | Extruded Polystyrene Foamboard (L: 0.030-10.03.02.01.01) | 0.05 |
| | Bitumen Waterproofing Sheet (L:0.190-09.02.02.01.01) | 0.003 |
| | Concrete (L:1.650-05.01.02) | 0.1 |
| | Gravel (L: 0.700-03.01) | 0.1 |
| | Clay, Alluvion (L: 1.500-02.02.01) | 0.1 |
| Slab (First floor) | Coniferous Sawn Timber (L: 0.130-08.01.01) | 0.03 |
| | Mineral and Plant Fiber Heat Insulation Materials (L: 0.035-10.05.01) | 0.05 |
| | Coniferous Sawn Timber (L: 0.130-08.01.01) | 0.03 |
| Column- Beam | Coniferous Sawn Timber (L: 0.130-08.01.01) | 0.20 |
| Exterior Wall | Coniferous Sawn Timber (L: 0.130-08.01.01) | 0.20 |
| Hipped Roof Covering | Brick (L: 1.500-02.02.01) | 0.03 |
| | Bitumen Waterproofing Sheet (L:0.190-09.02.02.01.01) | 0.002 |
| | Beech Wood (L: 0.200- 08.01.02) | 0.05 |
| | Mineral and Plant Fiber Heat Insulation Materials (L: 0.035-10.05.01) | 0.5 |
| Hipped Roof Slab | Coniferous Sawn Timber (L: 0.130-08.01.01) | 0.03 |
| | Bitumen Waterproofing Sheet (L:0.190-09.02.02.01.01) | 0.03 |
| | Mineral and Plant Fiber Heat Insulation Materials (L: 0.035-10.05.01) | 0.07 |

**Figure 8.** New building photos

New building is completed on July 2018. It stands as a good example for the sustainable structures with its all timber construction elements and all timber finishings. Also it is compatible with the site by using the slope to create different levels. (Figure 8)

The new building is identified in BEP-TR 2 as a detached low-rise residential building located in Bornova, İzmir. CAD drawings (Figure 7) are imported for creating the plan geometry. The floor height is entered; as 2.73 m for ground floor, 3.22 m for first floor. 2 thermal zones are defined for the for the ground and first floor of the whole building with totally 50m$^2$ kitchen and living room space. Than 9 led lamps with 20 W power are entered as the lighting detail of these thermal zones. The building has a heat pump system with a 21 kW power heating and 10 kW power cooling capacity. Materials and thickness of the walls, columns, beams, slabs and roof are defined in the system as given in Table. Timber doors and timber framed windows with reflected insulated glass (U:2.6) are also defined and the building energy model is completed. (Figure 9)

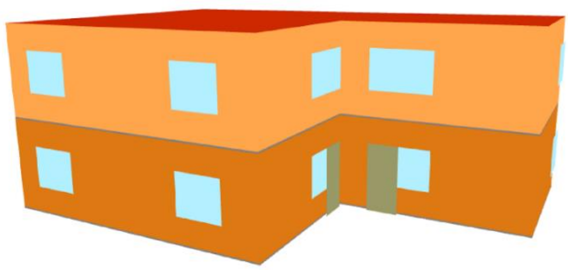

**Figure 9**. Energy model of new building

**Table 7.** Energy performance analysis results, new building

| Systems | Annual Electricity Consumptions | | | | Renewable Energy/ Cogeneration Energy | | Energy Class |
|---|---|---|---|---|---|---|---|
| | Final (kWh/ year) | Primary (kWh/ year) | Per Unit Area (kWh/m$^2$.year) | Per Unit Area (kg$CO_2$/m$^2$.year) | Primary (kWh/ year) | Per Unit Area (kWh/m$^2$.year) | |
| Total | 9994,26 | 17217.67 | 71.74 | 20.50 | 8857.57 | 36.91 | B 65 |
| Heating | 3771.21 | 7813.96 | 32.56 | 9.70 | 8857.57 | 36.91 | B 50 |
| Hot Water | 3311.89 | 3371.80 | 14.05 | 3.32 | 0 | 0 | D 105 |
| Cooling | 2517.97 | 5217.24 | 21.74 | 6.47 | 0 | 0 | B75 |
| Lighting | 393.18 | 814.68 | 3.39 | 1.01 | 0 | 0 | D 100 |

Calculated values for the annual electricity consumptions of heating, hot water and cooling system usages are given in kWh and kgCO2 units. Also, the renewable energy usage through the heat pump system is calculated. (Table 7) As a result of the evaluation, the new building is qualified in B energy class in total.

## 5. Results and comparisons

Existing building is a single floor reinforced concrete structure. According to the structural analysis, it is seen that the existing building cannot provide the safety requirements and it is classified as a 'risky building'. Besides the structural analysis energy performance analysis of the existing building is also done. The results show that the building is the energy class F. So, it is decided to design a new building which is structurally resistant and energy efficient.

Instead of reinforced concrete structure system as in the existing building, timber framed structure system is preferred to be used in the newly designed building. The new building is designed according to the structural regulations up to date as it is stable and safe. And from the energy performance point of view, the new designed building is qualified in energy class B. That means building is energy efficient and sensitive to the environment.

The comparison of two buildings according to the building materials, structural performance and energy performance can be seen on Table 8.

## 6. Conclusion

Urban renewal from an economic, physical, functional or environmental point of view of a degraded urban area, the state, policy, plan, implemented for improvement with integrated approaches, is an implementation process that covers all of the programs and projects. This implementation process has effect on the people living there and structure of the city therefore it is a multi-disciplinary integrated work.

Within this framework both structural and energy deficient building is demolished and instead of it new building is designed and constructed. And a method put forward. According to this method both structural and energy performance of the existing building is evaluated. For structural performance analysis site visits were done and by sampling methods the stability of the building is tested. For this purpose, in the laboratory pressure tests for taken samples were done and also after relief of the building was drawn by using simulation program called ideCAD the structural performance of the building was analysed. Besides the structural performance analysis, energy performance analysis was also done by using BEP-TR programme.

This paper gives recommendations to urban renewal professionals which they can use all through the process of urban renewal. In this concept besides structural improvement energy efficient approaches are taken in account.

### Author's Contributions

**Ebru Alakavuk:** Drafted and wrote the manuscript and interpreted analysis.
**Hande Odaman Kaya:** Drafted and wrote the manuscript and interpreted analysis.

### Ethics

There are no ethical issues after the publication of this manuscript.

**Table 8.** Comparison of existing and new buildings

| | | | Existing Building | | New Building | |
|---|---|---|---|---|---|---|
| | | **Construction Element** | **Material** | **Thickness (m)** | **Material** | **Thickness (m)** |
| **Structural performance** | Construction Element | **Slab (Basement)** | Reinforced Concrete (L:2.500-05.01.01) | 0.12 | Cast Stone (L: 1.300-01.08) | 0.01 |
| | | | Gypsum Plaster (L:0.510-04.04) | 0.02 | Cement Screed (L: 1.400-04.06.01) | 0.03 |
| | | | Concrete (L:1.650-05.01.02) | 0.03 | Reinforced Concrete (L:2.500-05.01.01) | 0.12 |
| | | | Lime, Lime- Gypsum Mortar (L:1.000-04.01) | 0.02 | Cement Screed (L: 1.400-04.06.01) | 0.05 |
| | | | Phanerocrystalline Volcanic and Metamorphic Stone (L:1.650-05.01.02) | 0.02 | Extruded Polystyrene Foamboard (L: 0.030-10.03.02.01.01) | 0.05 |
| | | | | | Bitumen Waterproofing Sheet (L:0.190-09.02.02.01.01) | 0.003 |
| | | | | | Concrete (L:1.650-05.01.02) | 0.1 |
| | | | | | Gravel (L: 0.700-03.01) | 0.1 |
| | | | | | Clay, Alluvion (L: 1.500-02.02.01) | 0.1 |
| | | **Slab (First floor)** | | | Coniferous Sawn Timber (L: 0.130-08.01.01) | 0.03 |
| | | | | | Mineral and Plant Fiber Heat Insulation Materials (L: 0.035-10.05.01) | 0.05 |
| | | | | | Coniferous Sawn Timber (L: 0.130-08.01.01) | 0.03 |
| | | **Column-Beam** | Gypsum Plaster (L:0.510-04.04) | 0.03 | Coniferous Sawn Timber (L: 0.130-08.01.01) | 0.20 |
| | | | Reinforced Concrete (L:2.500-05.01.01) | 0.25 | | |
| | | | Gypsum Plaster (L:0.510-04.04) | 0.02 | | |
| | | **Exterior Wall** | Gypsum Plaster (L:0.510-04.04) | 0.03 | Coniferous Sawn Timber (L: 0.130-08.01.01) | 0.20 |
| | | | Brick TS EN 771-1 (L:0.810-07.01.01.01) | 0.19 | | |
| | | | Gypsum Plaster (L:0.510-04.04) | 0.02 | | |
| | | **Roof** | Reinforced Concrete (L:2.500-05.01.01) | 0.12 | Brick (L: 1.500-02.02.01) | 0.03 |
| | | | Gypsum Plaster (L:0.510-04.04) | 0.02 | Bitumen Waterproofing Sheet (L:0.190-09.02.02.01.01) | 0.002 |
| | | | Concrete (L:1.650-05.01.02) | 0.05 | Beech Wood (L: 0.200- 08.01.02) | 0.05 |
| | | | Bitumen Waterproofing Sheet (L:0.190-09.02.02.01.01) | 0.05 | Mineral and Plant Fiber Heat Insulation Materials (L: 0.035-10.05.01) | 0.5 |
| | | | | | Coniferous Sawn Timber (L: 0.130-08.01.01) | 0.03 |
| | | | | | Bitumen Waterproofing Sheet (L:0.190-09.02.02.01.01) | 0.03 |
| | | | | | Mineral and Plant Fiber Heat Insulation Materials (L: 0.035-10.05.01) | 0.07 |
| | | **Structural stability** | Risky Building | | Complying with regulations | |
| **Energy Performance** | Energy Class | **Total** | F 147 | | B 65 | |
| | | **Heating** | F 144 | | B 50 | |
| | | **Hot Water** | D 104 | | D 105 | |
| | | **Cooling** | F 160 | | B75 | |
| | | **Lighting** | G 300 | | D 100 | |

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