YEDITEPE UNIVERSITY FACULTY of ENGINEERING
DEPARTMENT of CIVIL ENGINEERING
Dr. Öğr. Üyesi Özgür Köylüoğlu
Dr. Öğr. Üyesi Erkan Senol

YEDITEPE UNIVERSITY – "THE CORNERSTONE OF TOMORROW'S SUCCES"

GRADUATION PROJECT ASSIGNMENT

PROJECT TITLE

MELISSA RESIDENCE / 16 Story Apartment, Four 3+1, Eight 2+1 Flats Per Floor

LAYOUT AND BASIC CHOICES

The layout and principal dimensions are as shown in the architectural drawings. As to design this structure in steel the following basic choices are made with regard to 16 floors apartment building;

FLOOR CONSTRUCTION

For speed of construction a composite flooring using hot rolled steel formwork is chosen together with MD60 metal decks are capable of spanning up to 3.0 m with normal weight of concrete. For a fire rating of 2 hours, mesh reinforcement type Q131 is recommended,

FRAME CONSTRUCTION

The design of a steel frame may use the method known as rigid design or simple design. In rigid design, the connections are assumed capable of developing the required strength and stiffness for full continuity. In simple design the connections are assumed not to develop significant moments, i.e. beams are designed assuming they are simply supported. It is advantageous to make the slab and beams act compositely, and such an arrangement is possible with cold rolled profiled steel sheets (metal decks).
Hot rolled Steel sections are chosen from European hot rolled IPE; HE sections with steel grade Fe 430 (ST – 44).
For the present design, Steel/Concrete Composite System with bolted connections is assumed - **EUROCODE 4.**

GENERAL INFORMATION ABOUT THE PROJECT

1.1 – TOPIC:

A steel residential structure will be built in earthquake disaster area Kahramanmaraş district.

RESIDENTIAL BUILDING DESIGN PARAMETERS

1- COMPOSIT FLOOR SLAB HEIGTH 120 MM

2- METAL DECK 1.2 MM - 6 MM HEIGHT

3- SHEAR STUDS 19/90 – 450 N/mm2

4- FLOOR TO FLOOR ZONE 3.0 M

5- GRIDS 6M OR 8M OR COMBINATIONS OF BOTH

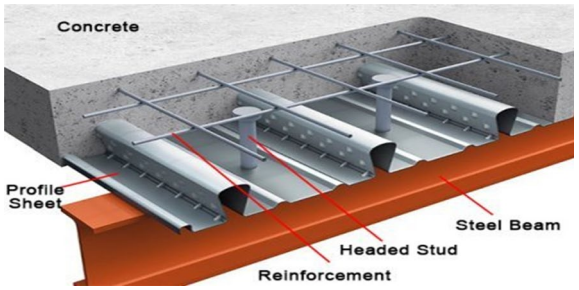
6- IMPOSED LOAD 3.0 kN/M2

7- PARTITIONS 1.0 kN/M2

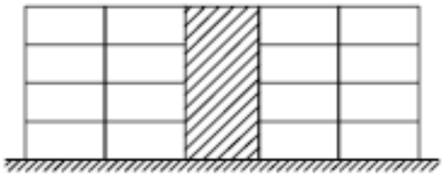
8- THERMAL INSULATION (WALLS)

U < 0.3W/m2 C.

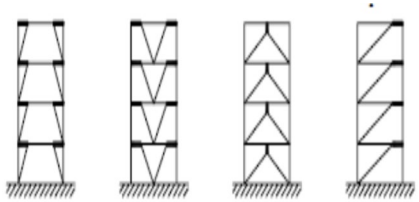
9- NATURAL FREQUENCY OF BEAMS > 5 Hz



A) Frames with concrete cores or concrete walls



B) Frames with eccentric bracings

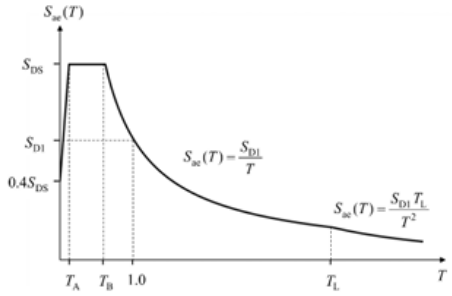


- Dissipative zones (bending or shear links)

TBDY (2018) Elastic Design Acceleration Spectrum

$T_B = \frac{S_{D1}}{S_{DS}}$

$T_A = 0.2T_B$

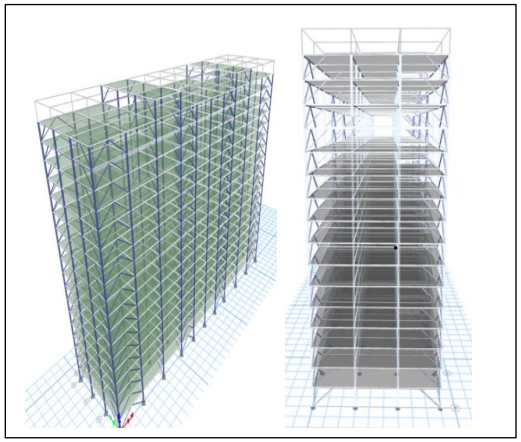


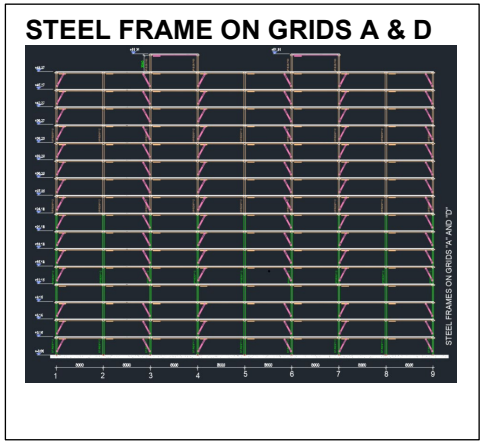
Earthquake Zone 1st degree earthquake zone
Ao = 0.4
Ground Class ZD, Ta = 0.15, Tb = 0.6
Building Importance Coefficient **I** = 1
Carrier System Behavior Coefficient Ry = 4
Live Load Participation Coefficient n = 0.3
Snow Load Participation Coefficient n = 0.3
Earthquake Load Comparison Coefficient β = 0.9
Modal Damping Ratio for Dynamic Analysis
ξ = 0.05

Architectural projects were examined, both in terms of detail and system selections and static and architectural Integration has been achieved in terms of structural analysis.

1.2 – STRUCTURAL ANALYSIS SOFTWARE

Structural analysis of the entire structure is done using ETABS which offers a user-friendly interface and step-by-step modeling process. This is perfect software for beginners focusing on steel/concrete composite building design. Each of the structural elements that make up the model cross-sections, materials, material mechanical properties (elasticity modulus, Poisson ratio, etc.) has been assigned.
Then, load types and load combinations together with earthquake seismic parameters are defined and analyzed.





1.3 – STRUCTURES WITH BRACINGS OR WITH IN-SITU CONCRETE WALLS

The building has a rectangular shape with orthogonal geometry in plan and gravity loads are transferred by plane frames to the foundation.
Wind and seismic horizontal forces are resisted by frames together with braces and in situ concrete shear walls.
(a) Frames with eccentric bracings, in which the horizontal forces are mainly resisted by axially loaded members, but where the eccentricity of the layout is such that energy can be dissipated in seismic links by means of either cyclic bending or cyclic shear.

(b) Frames with concrete cores or concrete walls, in which horizontal forces are mainly resisted by these cores or walls orces are mainly resisted by these cores or walls.

1.4 TBDY (2018) ELASTIC DESIGN ACCELERATION SPECTRUM

TBDY (2018) Elastic Design Acceleration Spectrum

Türkiye Earthquake Hazard Map, S_S and S_1 values are defined as the coefficient of Short Period Map Spectral Acceleration for 1 second period.

F_S and F_1 values are defined as local ground effect coefficients In TBDY (2018).

$S_{DS}= S_SF_s$, $S_{D1}= S_1F_1$

1.5 – GROUND SOIL PARAMETERS

Importance category = 4 (Residential building)

Local Soil Class = ZD (Medium Tight-Tight Sand, Gravel or Very Solid Clay Layers) This class describes soils with low bearing capacity.

Shear Vawe Velocity Vsv = 180-360 (m/s)

Ground Bearing Capacity = 20 t/m²

Ground Bearing Coefficient = 3500 t/m³

Bearing capacity of soil σz = 200 kN/m2 (20 t/m²)

1.6 – DEFINED LOAD COMBINATIONS

1) G + Q
2) G + Q ± Ex
3) G + Q ± Ey
4) 0.9G ± Ex
5) 0.9G ± Ey
6) G + Q ± Wx
7) G + Q ± Wy
8) 0.9G ± Wx
9) 0.9G ± Wy

1.7 – Code Of Practice

Eurocode 1: Actions on structures
Eurocode 3: Design of steel structures
Eurocode 4: Design of composite steel and concrete structures
Eurocode 8: Design of structures for earthquake resistance
TSE - TS 648 - Calculation and construction rules of steel structures
TSE - TS 498 - Design Loads for Buildings
TSE - (TBDY) 2018 Türkiye Building Earthquake Regulation

F_S Local Ground Impact Coefficient for Short Period

	$S_S \leq 0.25$	$S_S = 0.50$	$S_S = 0.75$	$S_S = 1$	$S_S = 1.25$	$S_S \geq 1.50$
ZA	0.8	0.8	0.8	0.8	0.8	0.8
ZB	0.9	0.9	0.9	0.9	0.9	0.9
ZC	1.3	1.3	1.2	1.2	1.2	1.2
ZD	1.6	1.4	1.2	1.1	1.0	1.0
ZE	2.4	1.7	1.3	1.1	0.9	0.8
ZF	**Site-specific soil behavior analysis is performed**					

Table 3: F_S Coefficients Depending on Local Soil Class(TDBY 2018)

F_1 Local Ground Impact Coefficient for 1 Second Period

	SS ≤ 0.10	SS =0.20	SS =0.30	SS =0.4	SS =0.50	SS ≥ 0.60
ZA	0.8	0.8	0.8	0.8	0.8	0.8
ZB	0.8	0.8	0.8	0.8	0.8	0.8
ZC	1.5	1.5	1.5	1.5	1.5	1.
ZD	2.4	2.2	2.0	1.9	1.8	1.7
ZE	4.2	3.3	2.8	2.4	2.2	2.0
ZF	**Site-specific soil behavior analysis is performed**					

Table 4: F1 Coefficients Depending on Local Soil Class (TDBY 2018)

MATERIAL PROPERTIES

Hot Rolled IPE, HEA, HEB, HEM Sections,

Steel Grade Fe430 (ST 44), f_y = 275 N/mm2

Elasticity Modulus E = 2100000 kg/cm²

Slip Module G = 7920 kg/cm²

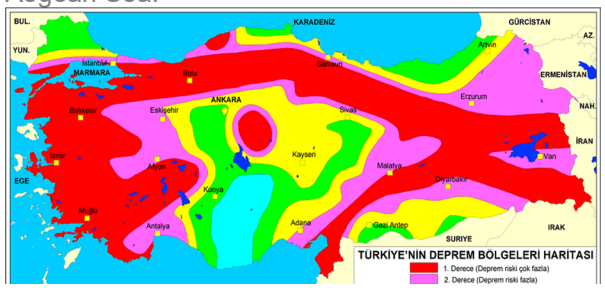
Poisson's Ratio υ = 0.3

DEFINED LOAD TYPES

1) G: Dead Load,
2) Q: Live Load,
3) S: Snow Load,
4) W: Wind Load (Wx, Wy),
5) E: Earthquake Load (Ex, Ey)

1.8 SEISMIC ZONES IN TÜRKİYE

Türkiye lies on a small tectonic plate that is called the Anatolian plate, and the country is located in an area with relatively high seismic activity.
The reason for this is that the country is squeezed between three large tectonic plates: The north-going African and Arabian plate to the south, and the south-going Eurasian plate to the north. The movement of these three plates causes the Anatolian plate to be pushed westward into the Aegean Sea.



Since Turkey is a large country, the risk from region to region is different. According to the determination of the Disaster and Emergency Management Presidency (AFAD), regions in Turkey are divided into 5 zones according to earthquake risk. If a region is placed in the 1st, 2nd or 3rd zone precautions must be taken, and 4th zone is therefore considered a safe zone where earthquakes are felt, but will not have any destructive effect. According to the new regulation, local soil classes are determined by taking into account the average shear wave velocity in the upper 30 meters of the soil layers, average undrained shear strength and standard penetration impact number (N60) values.

1.9 – BUILDING PROCESS IN TURKEY

To make earthquake-proof buildings, the design engineers have to be aware of the building's natural vibrations.
Earthquakes create strong lateral movements, so to minimize the amount of damage, buildings are constructed using rigid horizontal floors and vertical columns which will absorb the lateral load and lead it to the ground.
In Turkey there are clear rules for how to obtain building permissions and then carry out the construction based on the permission that is given.
During the building process, controls of the quality of the raw construction and compliance with the building permission are done by verified and independent controllers.
Only after these controls have been passed will the constructor be able to obtain the final permissions and documentation of completion.

2.0 – EARTHQUAKE RESISTANCE TESTS

Earthquake resistance tests are carried out by independent and licensed research companies or municipal teams and are used for old buildings in high-risk zones.
In regions where there is no high earthquake risk, earthquake resistance tests can be made by independent companies for a fee.
In general, there is no need to test newer buildings in any earthquake zones since they have been tested and approved during the construction period.

2.1 (TBDY) 2018 Türkiye Building Earthquake Regulation

The purpose of this Regulation is; It is to determine the necessary rules and minimum conditions for the design and construction of all or parts of all public and private buildings and building-type structures that will be rebuilt, replaced or enlarged, under the influence of earthquakes, and for the evaluation and strengthening of the performances of existing buildings under the influence of earthquakes. would normally be anticipated on a steel framed project.

WE CORDIALLY THANK TO

Dr. Erkan Şenol
&
PROJECT CONSULTANT
Nuri Işık
FOR THEIR VALUABLE CONTRIBUTION…

"OUR MISSION IS TO BECOME LEADING DESIGNER OF MODERN STEEL BUILDINGS"
Ozan Akveç, Furkan Aka, Kaan Çolak, Asil Kaan Özcan

YEDITEPE UNIVERSITY – "THE CORNERSTONE OF TOMORROW'S SUCCESS"