The International Journal of Energy & Engineering Sciences, 2019, 4 (2) 19-25
ISSN: 2602-294X - Gaziantep University

COMPARISON OF 2018 AND 2007 TURKISH EARTHQUAKE REGULATIONS

Nihat Atmaca[1,*], Adem Atmaca [2], Seydi Kılçık[3]

[1]Civil Engineering Department, Engineering Faculty, Gaziantep University, Gaziantep, Turkey.
atmaca@gantep.edu.tr
[2]Energy Systems Engineering Department, Engineering Faculty, Gaziantep University, Gaziantep, Turkey.
aatmaca@gantep.edu.tr
[3]Civil Engineering Department, Engineering Faculty, Gaziantep University, Gaziantep, Turkey.

ABSTRACT

The new building earthquake regulation of Turkey has been published on 18 March 2018. There are two different methods in the new code: Linear and nonlinear earthquake analysis methods. In the present study, the different structural applications of a school project located in Gaziantep province of Turkey analyzed by using linear earthquake calculation methods. The structure has modeled with three different ways; only with Reinforced Concrete columns, with Reinforced Concrete columns and Shear Walls, only with Shear Walls. In analysis, 2007 regulation on buildings in earthquake zones are compared with the new Turkish 2018 earthquake code. The software SAP 2000 is used for the calculations and program outcomes are used for comparisons. Base shear forces, maximum displacement and force values and overturning moment findings are calculated in each structural configuration. The advantages and disadvantages of the new earthquake code are discussed in detail using earthquake analysis results.

Keywords: 2018 Turkish earthquake regulations, Base shear forces, Joint displacements, 2007 Turkish regulations on buildings in earthquake zones.

1. INTRODUCTION

Turkey is located on the active earthquake fault zones. There is a great effort to minimize risks in case of an earthquake in Turkey. If we look up a general history of the earthquake regulations in Turkey, it will give us an opportunity to commentate of earthquake regulations progress in Turkey.

The first earthquake regulation has been adapted from Italy earthquake regulations in 1940. However the regulations should have been revised and amended according to the technological and social developments in society. It is generally observed that Seismic performances had found to be unsuitable or significant design deficiencies due to revised and amended regulations during construction of many buildings [1].

Earthquake regulations in Turkey [2]:

- 1940 - Italian Building Instructions for Construction in Earthquake Districts,
- 1944 - Earthquake Districts Provisional Building Instructions,
- 1949 - Turkish Ground Movement Region Building Regulation,

- 1953 - Regulation on Structures to Be Built In Ground Movement Regions,
- 1962- Regulation on structures in disaster zones (ABYYHY),
- 1968 - Regulation on structures in disaster zones (ABYYHY),
- 1975 - Regulation on structures to be built in disaster zones (ABYYHY),
- 1998 - Regulation on structures in disaster zones (ABYYHY),
- 2007 - Regulation on buildings in earthquake zones (DBYBHY),
- 2018 - Turkey building earthquake regulation (TBDY) [3].

After 1999 Gölcük earthquake, a new earthquake regulation has been published in 2007 [4]. The new earthquake regulation has been inevitable after devastating earthquakes in last decade. The new building earthquake regulation of Turkey has been published on 18 March 2018. Similar to the 2007 earthquake regulations, there are two different methods in the new earthquake code: Linear and nonlinear earthquake analysis methods.

The main purpose of this study is to show the differences between the 2007 and 2018 earthquake regulation of the Turkey via changing the structural modelling types of a case study. A school project is chosen as a case study. The different structural configurations analysed individually by using linear earthquake calculation method. The equivalent seismic load method according to the 2007 and 2018 earthquake regulations has been applied and analysed for Reinforced Concrete (RC) column, with RC column and Shear Wall, only with Shear Wall frame models by using SAP2000 software.

2. DIFFERENCES IN 2007 AND 2018 TURKISH EARTHQUAKE REGULATIONS

The new building earthquake regulation of Turkey has been published on 18 March 2018. Similar to the 2007 earthquake regulations, there are two different methods in the new earthquake code: Linear and nonlinear earthquake analysis methods.

There are many differences between the two regulations.

There were four different earthquake zones in 2007 earthquake regulations. However the earthquake zone areas are defined in a different way in the new 2018 earthquake regulations. The new regulation focused on the specific site of earthquake risk and locational soil behaviour of structures. It is aimed to get precise results in predefined locations.

There are also changes related to earthquake ground motion. In 2007 earthquake regulation, the earthquake acceleration coefficient was taken as only a unit value according to the location of the structure. The new regulation takes different values such as the short and long period of earthquake acceleration coefficients.

There are also differences in definitions of soil classes. In the previous regulation the soil classes were divided into 4 classes (Z_1, Z_2, Z_3, and Z_4). In the new regulation the soil classes are divided into 6 classes. (ZA, ZB, ZC, ZD, ZE and ZF).There is also a change in the building importance coefficient. The building importance coefficient used in the previous earthquake regulation has been changed from 1.4 to 1.5 values. The new regulation includes criteria for earthquake design

classes and building height classes. One of the most important changes in the new regulation is the usage of the coefficient of behaviour and the coefficient of strength (D).

3. CASE STUDY

The structural models of the case study are analysed with linear methods according to the 2007 and 2018 earthquake regulations. The side and 3D views are given in Figures 1 and 2. There are many differences in design step for modelling of structures. Information about these parameters are explained in detail below.

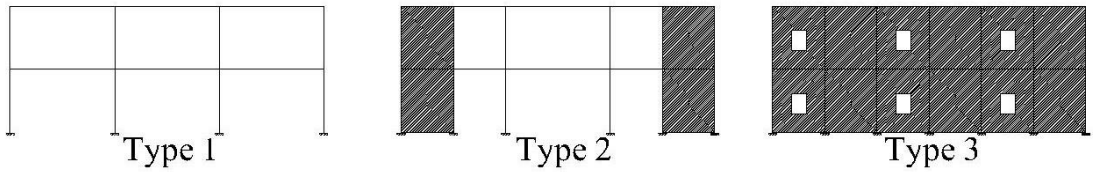

Figure 1. Frames with only (RC) columns (Type 1), with RC columns and Shear Walls (Type 2), only with Shear Wall (Type 3) side views

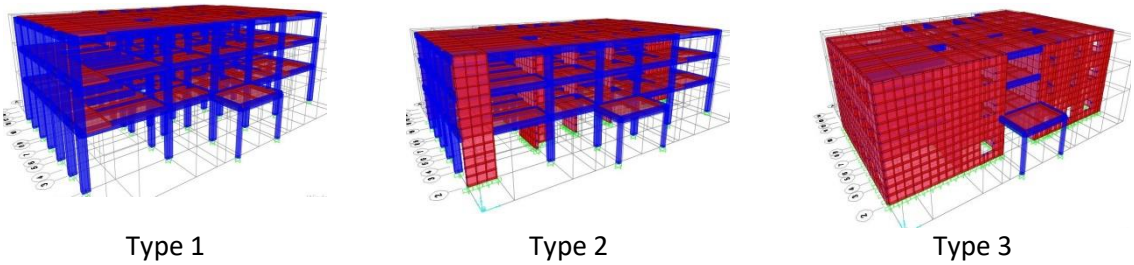

Figure 2. Frames with only (RC) columns (Type 1), with RC columns and Shear Walls (Type 2), only with Shear Wall (Type 3) 3D views

3.1 PARAMETERS USED IN 2007 EARTHQUAKE REGULATIONS

In the present study, project of a school building that is located in Gaziantep city has been selected as a case study. The school is located in the 3rd earthquake zone according to the 2007 earthquake regulation. The soil class has been taken as Z2 from the soil survey report. Since the structure is located in the 3rd earthquake zone, the effective ground acceleration coefficient A_o= 0.2 is taken from related Table (Table 2.2) of the 2007 earthquake regulation. The building significance coefficient is 1.4 for school building. The structural behaviour coefficient is R=7 for the frames columns with shear walls and with only RC column structures.

3.2 PARAMETERS USED IN 2018 EARTHQUAKE REGULATION

According to 2018 earthquake regulations, S_S = 0.395, S_1 = 0.143 values have been determined according to the location of the school building. Soil class is determined as ZC according to soil survey report. The structural behaviour coefficient is R=7 for the frames columns with

shear walls and with only RC column structures.The building importance coefficient 1.5 is taken from related Table (Table 3.1) of the 2018 earthquake regulation.

S_{DS} and S_{D1} values can be calculated as;

$$S_{DS}=S_S * F_S = 0.395*1.3=0.513$$
$$S_{D1}=S_1 * F_1 = 0.143*1.5=0.215$$

4. RESULTS AND FINDINGS

The results of the calculations according to the 2007 and 2018 earthquake regulations are given in the Figures 3,4,5 and 6. The results are obtained by using SAP 2000 Program.

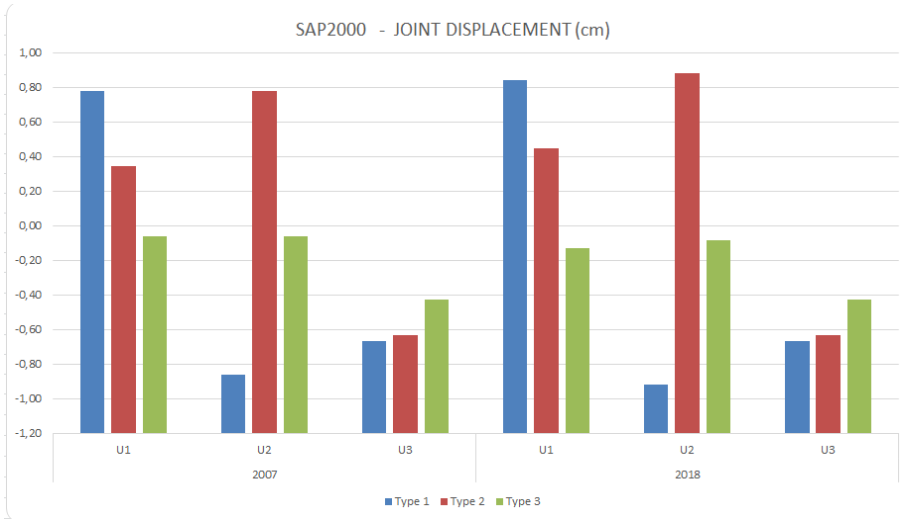

Figure 3. Joint displacement of structural types 1,2 and 3

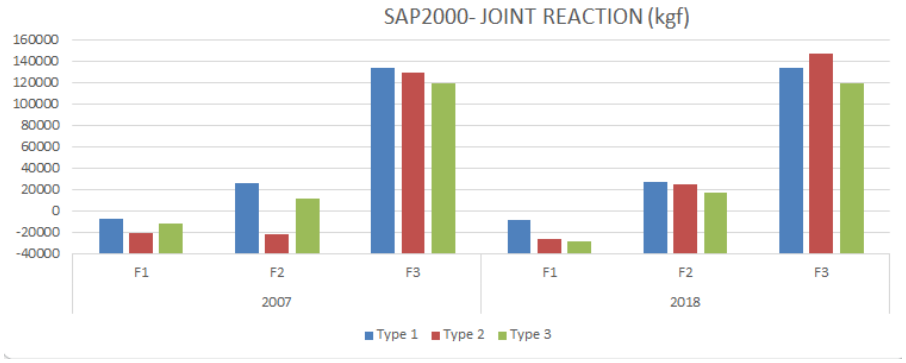

Figure 4. Joint reaction of structural types 1,2 and 3

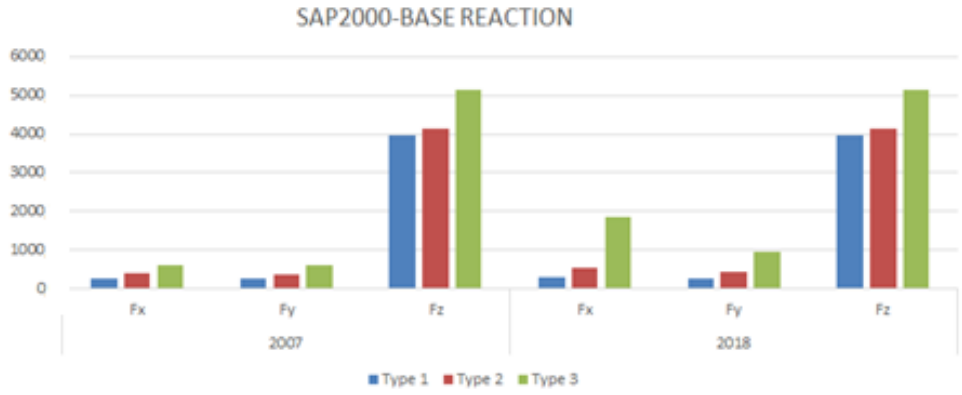

Figure 5. Base Shear Reaction forces of structural types 1,2 and 3

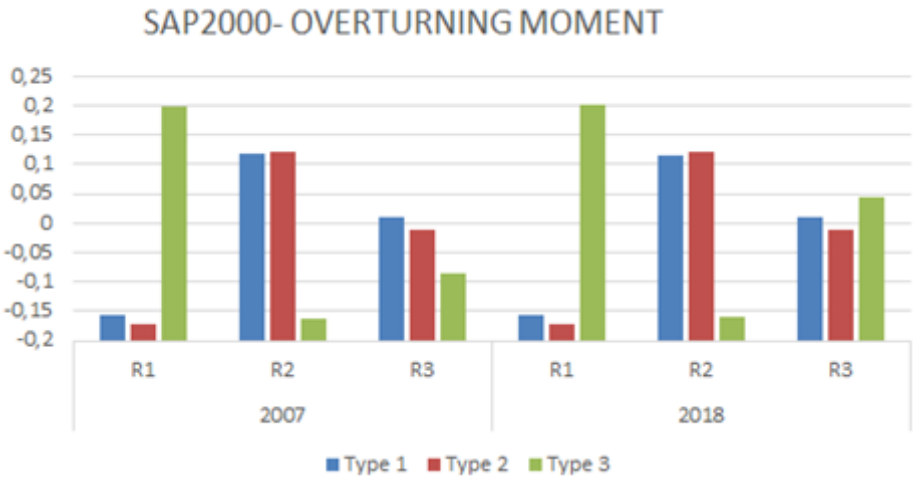

Figure 6. Overturning moments of structural types 1,2 and 3

The joint displacements, joint reactions, base reactions and overturning moments of three different types of structures have been analysed by using SAP 2000 according to 2007 and 2018 earthquake regulation rules. There is an increase in base shear forces in x and y directions. Further, the joint displacement and force values are changing according to the axes.

The joint displacements values (Fig. 3) in x and y directions are 0.44 cm and 0.88 cm for 2018 earthquake regulations. However, the values are decreasing as 0.34 cm and 0.78 cm in x and y directions for 2007 earthquake regulations. Therefore the joint displacement results are increasing in the new earthquake regulations according to the 2007 earthquake regulation.

The base shear forces are increasing in 2018 earthquake regulations too. The results are 20.2^t and 21.24^t for 2007 earthquake regulations and 25.91^t and 24.93^t for 2018 earthquake regulations in x and y directions respectively (Fig. 4).

The base reaction results are 541.96^t and 425.95^t for 2018 earthquake regulations but the values are decreasing as 408.75^t and 377.99^t for 2007 earthquake regulations in x and y directions respectively (Fig. 5).

The overturning moment results are very close to each other for R1 and R2 values in both earthquake regulations. But R3 values have an increasing effect in Type 3 structure (Fig. 6). The values are -0.17 rad in x direction and 0.12 rad in the y direction.

5. CONCLUSIONS

There are many differences between 2018 and 2007 earthquake regulations. These differences are directly related with accurate and reliable theoretical results. The building importance coefficient, behaviour coefficient of structure, earthquake acceleration coefficient, soil type and some other parameters have been changed in the new earthquake regulation. These parameters have a significant impact on the linear and nonlinear earthquake analysis. In the present study;

- It is observed that, there is an increase in joint displacement and base shear forces in x and y directions according to 2018 earthquake regulations.
- There is a 25% and 12% increase in base reaction values for 2018 earthquake regulations in x and y directions respectively.
- The overturning moment results are stable except for R3 in Type 3 structural configuration.

The results are showing that 2018 earthquake regulations more conservative deformation and loading limits rather than 2007 earthquake regulations. However, effectiveness and impact of the theoretical background and main considerations in 2018 earthquake regulations will be observed in real life field applications.

REFERENCES

[1] Ellul, F., Dina, D., The Bingol, Turkey Earthquake of the 1st of May 2003, University of Bath Architecture and Civil Engineering Department, England, 2003; pp. 10-38.

[2] Alyamaç, K. E. and Erdoğan, A. S., "Geçmişten Günümüze Afet Yönetmelikleri ve Uygulamada Karşılaşılan Tasarım Hataları', Deprem Sempozyumu, 2005; pp. 707–715.

[3] Türkiye Bina Deprem Yönetmeliği, Afet ve Acil Durum Yönetimi Başkanlığı, Resmi Gazete, Sayı: 30364 (Mükerrer), 18 Mart 2018.

[4] T.C Bayındırlık ve İskân Bakanlığı, Deprem Bölgelerinde Yapılacak Binalar Hakkında Yönetmelik, Ankara, 2007.