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Fire Safety Evaluation of Dwellings In the Framework of Regulation

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Abstract

This research aims to analyze how Turkey's Regulation on Fire Protection influences fire safety precautions on housing design and construction in Turkey. Tokat province center, which is one of the less populated cities of the country, has been chosen as the study area. In the study; 5 residential buildings which were designed and built before 2002 in when Turkey's Regulation on Fire Protection entered into force and also 5 different residential buildings which were designed and built after 2002 have been analyzed comparatively according to 20 measurable criteria which are chosen among the provisions of Turkey's Regulation on Fire Protection (TRFP) and according to the architectural project, the studies done in the building site and interviews carried out with responsible persons. The influence of TRFP on the Protection of Buildings from Fire in the design and construction process of residential buildings constructed in Tokat has been evaluated concerning the results of this analysis. When the results of the analysis are examined, it has been determined that there has been an improvement, in terms of fire safety, in the houses which were designed after the TRFP entered into force but it has not reached the desired level. The housings which are selected in this research are built after the TRFP and they are among the high building group. It is thought that this situation makes it difficult to fulfill the provisions of the TRFP, and therefore several criteria are not fulfilled.

1. INTRODUCTION

Security, which is one of the basic requirements of people, also includes fire safety. Fire is a serious source of danger for buildings all over the world. The fact that fire disasters have caused so many lives and property losses from past to present, shows that the security measures are insufficient. Especially since these precautions are not taken into consideration during the design and planning stages, life and property losses rise increasingly. Applications performed, the technology used, the human-based approaches and solutions have administrative and legal aspects as well as technical aspects to provide fire safety in a building. The risk of fire and the devastating consequences of fire have formed the basis of the precautions taken throughout history. Experiences derived from adverse events that happened in past have determined the starting point of all current international and national legislation and regulations.

Fire safety researches have been carried out throughout history in developed countries. Organizations such as National Fire Protection Association (NFPA) in the United States, International Code Council (ICC) and private laboratories called Underwriters Laboratories (U.L.) have been particularly effective in the enacting of fire-related legislation and regulations.

Common features of regulations in developed countries are prevention of fire, ensuring safe escape from the building, preventing the fire from spreading inside the building, and preventing the fire from

reaching other neighboring buildings. In the regulations in developed countries, there is the provision that requires to take structural precautions at the design stage. These precautions have been supervised by the relevant institutions or authorities.

Until 2002 in Turkey, there was the Regulation of Istanbul Metropolitan Municipality on Protection from Fire and also the Regulation on Protection of Public Buildings from Fire which entered into force in 1994. The first regulation entered into force for all the country is "Turkeys Regulation on Fire Protection (TRFP)" published in Official Gazette dated 26.07.2002 and numbered 24827. This regulation also refers to the fire protection of buildings. However, the TRFP published in 2002 was amended and the new regulation was prepared in 2007 to reduce the problems encountered, to harmonize the regulation with the European legislation, to add provisions related to existing structures, to correct misinterpretations and writing errors, to simplify regulations, to reduce bureaucracy and to add technological developments.

In this study, residential buildings will be analyzed within the framework of TRFP. The reason for residential buildings was selected in a study is; when buildings are classified according to the purpose of use, residential buildings are the most common type of buildings in the world and Turkey and most fires occur in those buildings.

It is seen that residential buildings are the most common type among building stock when the researches related to the number of building in Turkey are examined which is shown in Table1.

Table 1. *Completed or partially completed new buildings according to ccupancy permits in Turkey (TurkStat,2021)*

Yıl Year		**Total**	One dwelling buildings	Two and more dwelling buildings	Non residential buildings
2015	Number of building	**110 204**	17 436	77 100	15 668
	Floor area (m²)	**143 105 650**	3 648 060	105 567 536	33 890 054
2016	Number of building	**111 383**	18 764	76 683	15 936
	Floor area (m²)	**151 305 780**	4 031 238	111 008 969	36 265 573
2017	Number of building	**118 802**	19 944	84 178	14 680
	Floor area (m²)	**163 356 035**	4 405 091	123 202 543	35 748 401
2018	Number of building	**127 117**	20 728	89 435	16 954
	Floor area (m²)	**174 607 255**	4 577 151	132 372 998	37 657 106
2019	Number of building	**93 882**	15 403	65 583	12 896
	Floor area (m²)	**150 097 152**	3 408 361	114 711 312	31 977 479
2020	Number of building	**77 721**	16 582	51 225	9 914
	Floor area (m²)	**122 079 251**	3 369 863	94 288 608	24 420 780
2021	Number of building	**61 183**	16 366	36 979	7 838
	Floor area (m²)	**85 219 370**	3 203 614	62 682 686	19 333 070

Note: The information for 2019, 2020 and 2021 are temporary. 2021 data are the first nine months.

According to the National Address Database data, as of the end of September 2021, the total number of residences in Turkey (housing, lodging, summer/seasonal residence, concierge, and residential constructions) reached 40.2 million. It is seen that, throughout Turkey, there are 15 million 514 thousand 953 housings, one million 427 thousand 860 private offices, 304 thousand 548 public offices according to 2008 data and that the number of households is 19,481,678 (TurkStat, 2013) according to the 2011 Population and Housing Survey in Turkey. It is also seen that the number of households in Turkey is 21 million 662 thousand 260 according to 2015 Turkish Statistical Institute data. [2]

2. FIRE SAFETY IN RESIDENTIAL BUILDINGS

Fire is one of the scariest dangers for any homeowner, and while the number of house fires in the World has steadily changed in recent years, these incidents still contribute to thousands of deaths and billions of dollars of damage each year.

For example, in the USA structure fires are categorized as residential and non-residential. In 2016, there were 371,500 residential structure fires, accounting for 78.1 percent of all structure fires, a decrease of 16,500 fires over 2015. Of these fires, 257,000 occurred in one- and two-family homes, accounting for 54.0 percent of all structure fires. Another 95,000 fires occurred in apartments (20.0 percent of the structure fire total). The total number of home fires for 2016 is 352,000. 81% of all fire deaths occur in home fires in the USA [3].

When the fires that occurred in Turkey have been analyzed according to building types, it is seen that most fires occurred in residential buildings.

The fire statistics bulletin for the province of Istanbul is published in certain periods by the Istanbul Metropolitan Municipality Department of Fire Brigade in Turkey. According to the fire statistics published in 2020, fires that occurred between 2015 and 2019 are classified as the building and non-building fires. When the total number of fires is examined, it is seen that 53 % of them are building fires and 36 % of the building fires are residential building fires which is shown in Table 2.

Table 2. *- Istanbul Metropolitan Municipality Fire Statistics.*

Fires (2015-2019)										
Year	Fire (Number)									
	Structure Fires					Non -structure fires				
	Residential buildings	Industrial buildings	Other buildings	Vehicle	**Total**	Weed	Garbage	Forest Shrub	**Total**	**Grand total**
2015	5.869	157	8.957	1.903	16.886	4.596	5.212	284	10.092	26.978
2016	5.910	153	8.891	1.935	16.889	6.110	5.431	156	11.697	28.586
2017	5.762	166	9.224	1.781	16.933	3.338	4.685	117	8.140	25.073
2018	4.875	164	7.377	1.558	13.974	2.329	4.051	62	6.442	20.416
2019	966	179	6.895	1.630	13.670	4.361	4.389	126	8.876	22.546

Approximately 45% of fires occurring in Turkey are residential fires. In other words, it can be said that about half of all the fires happen in the housings. At first glance, it was thought that there would be a decrease in the number of fires since there was a decrease in the number of wooden buildings. However, more use of plastic materials, an increase in the amount of energy consumed and new types of energy bring about the risk of fire. Every year a lot of people die because of residential fires and the majority of those people are children. The number of fires is directly proportional to the number of housings. No doubt, as the population and housings increase, the number of fires increases. 40% of housing fires result from kitchens, 20% from heaters i.e from stoves and electric heaters, 10% from cigarettes, and 5% from children and electrical installations. In other words, the majority of the fires in the housings are caused by electrical and heating devices [4].
Other international scientific researches on fire safety in housings are as follows: Himoto &Shinora & et al. [5] report on their investigations into the behavior of successive fire spread between multiple houses in an urban area.

Akashah, Baaki, Lee, [6] aims to determine the fire risk status of low-cost high-rise residential buildings in Kuala Lumpur through a fire risk assessment (FRA) approach. The study forms the exploratory phase of wider research to develop a fire risk indexing (FRI) methodology for low-cost high rise residential buildings in Kuala Lumpur.

Hardie, Green & He's [7] purpose is to identify potential faults in building fabric that may result in unacceptable fire safety risks to irreplaceable heritage streetscapes. Ploubidis, Edwards,& Kendrick's,[8] paper reports the development and testing of a construct measuring parental fire safety behaviors for planning an escape from a house fire.

The purpose of another paper is to investigate the design and operation factors that affect the provision of fire‐ safe student housing facilities and to present the development of a proposed operational framework for fire safety evaluation of student housing facilities [9].
A novel application of statistical analysis of structural fire hazards that were found in heritage housing stock in a metropolitan area has been made by He,& Park [10].
In the study of Hewitt, et al. [11] qualitative results are presented from the analysis of volatile and semi-volatile organic compounds (VOCs/SVOCs) obtained through a sampling of gaseous effluent and condensed particulates during a series of experimental house fires conducted in a real house.
Szumigała, & Polus [12], in their paper, presents a practical, engineering algorithm that may be used to analyze fire resistance of the Klein's ceiling after its renovation. The authors of another article present a building fire risk analysis model based on scenario clusters and its application in fire risk management of residential buildings. The purpose of Lehna, et al's[13] study was to describe the home fire safety quality improvement model designed to aid organizations in achieving institutional program goals. Butry [14], in his analysis, sprinkler performance is measured by comparing 'like' structure fires, while conditioning on smoke detection technology and neighborhood housing and socioeconomic conditions, using propensity score matching. A simplified risk-based decision-support tool, the Fire Risk Model (FRM), was developed for residential highrise buildings by Hansen [15]. The research of McDermott, Haslam, R., & Gibb [16] examined occupier behavior about self-closing fire doors. In another paper which belongs to Liu & Chow [17], a literature review was made on design fires and fire load survey methods for buildings. The concept of probabilistic modeling under uncertainty within the context of fire and rescue through the application of the Bayesian network (BN) technique is presented in Matellinis[18] study. Xiong, Bruck, & Ball's [19] study compares the odds ratio (OR) values of factors associated with accidental residential fires where an individual has died versus fires where all occupants have survived. The methodology used in the development of a fire safety evaluation scheme for patient areas in hospitals has been utilized and applied to dwellings in the study of Shields, et al [20]. In the first of 3 different articles by Başdemir, Demirel, and İşeri [21-22-23] that can contribute to the issue of fire safety in residences, national and international literature on fire safety was searched, in the second an automatic model was developed that evaluates the buildings according to the national fire regulations, in the third a hospital project was evaluated in terms of fire safety. In another study conducted by Başdemir [24], research was carried out on fire safety measures in all construction sites, including dwelling construction.

3. ANALYSIS OF SAMPLE RESIDENTIAL BUILDINGS

The aim of this research is to analyze how Turkey's Regulation on Fire Protection (TRFP) influence fire safety precautions in housing design and construction. Tokat province center, which is one of the less populated cities of the country, has been chosen as the study area. The reason for choosing Tokat is to see the effect of the TRFP on less populated cities. Since the research requires a lot of time and many assistant researcher, a limited number of residential buildings which have been designed and built in Tokat were selected as the sample.

According to the Disaster and Emergency Management Presidency Tokat Provincial Directorate's statistics there occurs lots of fire in Tokat city center every year which are shown in Table 3. Most of them are Structural fires and residential fires which are shown in Table 4.

Table 3. *The fire statistic of fires in Tokat city center from 2010 to 2019*

	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Tokat Center	388	563	449	724	675	684	693	648	696	719

Table 3. *The fire statistic of fires in Tokat city center from 2010 to 2019*

	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Tokat Center	388	563	449	724	675	684	693	648	696	719

3.1. RESEARCH METHOD

In the study, 10 residential buildings were analyzed according to 20 criteria selected from TRFP. Evaluation criteria were chosen from passive fire precautions. TRFP entered into force in 2002 throughout Turkey. For this reason, 5 of the residential buildings were chosen from those built before 2002, and the other 5 from those built after 2009. The reason for choosing 2009 is to make a more accurate assessment after the TRFP has been used and adopted for a while. In the study, firstly, architectural projects were examined, then on-site investigations were made. Finally, the project managers were interviewed. According to the data obtained, the effect of BYKHY on passive fire safety measures in new buildings was evaluated.

The five residential buildings selected for the study are buildings that were built before 2002 when the TRFP entered into force is given in Table 5.

Table 5. The information of analyzed residential buildings which were built before 2002

The information	1.Residential building	2.Residential building	3.Residential building	4.Residential building	5.Residential building
Total construction area	4037 m^2	1750 m^2	1485 m^2	3890 m^2	1275 m^2
Building height	20,30 m	17,60 m	12,80 m	14.50 m	14,60 m
Building Settlement	Detached building	Detached building	Contiguous building	Contiguous building	Contiguous building
Ground floor usage	Housing	Housing	Housing	Shopping	Shopping

The other five housings were selected from residential buildings which were designed and built after the amendments in the regulation in 2009 is given Table 6.

Table 6. The information of analyzed residential buildings which were built after 2002

The information	1.Residential building	2.Residential building	3.Residential building	4.Residential building	5.Residential building
Total construction area	12598 m2	4375 m2	4967 m2	25040 m2	7072 m2
Building height	37,74 m	39,16 m	38.60 m	54,50 m	39,60m
Building Settlement	Contiguous building	Detached building	Detached building	Detached building	Detached building
Ground floor usage	Shopping	Shopping	Shopping	Housing	Housing

When the existing residential buildings in Tokat City Center which were built before 2002 were examined, it has been seen that there were a few buildings that meet high building conditions. It has also been seen that the number of high buildings has increased after 2009.

The TRFP codes used to examine the sample buildings in the study and the subject headings in the TRFP are given in Table 7, Table 8 and Table 9.

Table 7. *20 criteria selected from TRFP for the analysis of the residential.*

Criteria No:	Article No:	Article Title
1	22.2	Access to Building
2	23.5	Stability of Building Bearing System
3	24.4	Fire Compartments
4	27.1	Facades
5	32.4	Escape Distance
6	33.1-2.	Escape Route Width
		Escape Route and Escape Route Stair Width in High Buildings
7	33.5b	Exit Door Width
8	34.2	Fire Resistance of Fire Safety Hall
9	34.3	Fire Safety Hall Area
10	39.1	Emergency Exit Obligation
11	41.3	Number of Steps of Escape Stairs
12	41.4	Landing Scales of Escape Stairs
13	41.5	Doors of Escape Stairs
14	41.7	Properties of Escape Stairs
15	41.8	Properties of Escape Stairs
16	45.1	Ventilation of Escape Stairs
17	47.1	Doors of Escape Route
18	48.5	Special Situations of Housings
19	72.3	Emergency Lighting System
20	97.1	Water connection for fire fighting

Table.8 *The analysis of 5 residential buildings which were built before the TRFP enters into force*

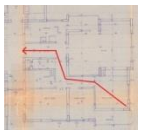
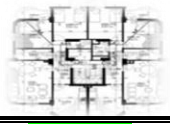
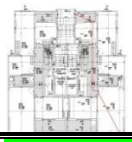
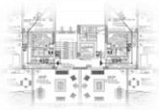
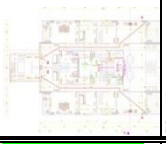
ARTICLE NO	THE ANALYZED CRITERIA AND TURKEY'S REGULATION ON FIRE PROTECTION (TRFP) ARTICLE NO	Before the year 2002 (Before the Turkey's Regulation on Fire Protection)				
		1. Residential building	2. Residential building	3. Residential building	4. Residential building	5. Residential building
						
						
1	Access To Building. **Article:**	SUITABLE	SUITABLE	SUITABLE	SUITABLE	SUITABLE
2	Stability Of Building Bearing System **Article: 23(5)**	UNSUITABLE	UNSUITABLE	UNSUITABLE	UNSUITABLE	UNSUITABLE
3	Fire Compartments **Article: 24(4)**	EXEMPT	UNSUITABLE	EXEMPT	EXEMPT	EXEMPT
4	Facades **Article: 27(1)**	SUITABLE	SUITABLE	SUITABLE	SUITABLE	SUITABLE
5	Escape Distance **Article: 32(4)**	SUITABLE	SUITABLE	SUITABLE	UYGUN DEĞİL	SUITABLE
6	Escape Route Width **Article: 33(1-2)**	SUITABLE	SUITABLE	SUITABLE	SUITABLE	SUITABLE
7	Exit Door Width **Article:: 33(5b)**	SUITABLE	SUITABLE	SUITABLE	SUITABLE	SUITABLE
8	Fire Resistance Of Fire Safety Hall **ARTICLE:34(2)**	EXEMPT	EXEMPT	EXEMPT	EXEMPT	EXEMPT
9	Fire Safety Hall Area **Article:34(3)**	EXEMPT	EXEMPT	EXEMPT	EXEMPT	EXEMPT
10	Emergency Exit Obligation **Article:39(1)**	UNSUITABLE	SUITABLE	UNSUITABLE	UNSUITABLE	SUITABLE
11	Number Of Steps Of Escape Stairs **Article:41(3)**	SUITABLE	SUITABLE	SUITABLE	SUITABLE	SUITABLE
12	Landing Scales Of Escape Stairs **Article:41(4)**	SUITABLE	SUITABLE	SUITABLE	SUITABLE	SUITABLE
13	Doors Of Escape Stairs **Article:41(5)**	EXEMPT	UNSUITABLE	SUITABLE	UNSUITABLE	SUITABLE
14	Properties Of Escape Stairs (Steps) **ARTICLE: 41(7)**	SUITABLE	UNSUITABLE	SUITABLE	SUITABLE	UNSUITABLE
15	Properties Of Escape Stairs **ARTICLE:41(8)**	SUITABLE	UNSUITABLE	SUITABLE	SUITABLE	SUITABLE
16	Ventilation Of Escape Stairs **ARTICLE:45(1)**	SUITABLE	SUITABLE	SUITABLE	SUITABLE	UNSUITABLE
17	Doors Of Escape Route **ARTICLE:47(1)**	SUITABLE	UNSUITABLE	SUITABLE	SUITABLE	SUITABLE
18	Special Situations Of Housings **ARTICLE:48(5)**	UNSUITABLE	EXEMPT	SUITABLE	SUITABLE	EXEMPT
19	Emergency Lighting System **Article:72(3)**	UNSUITABLE	EXEMPT	UNSUITABLE	UNSUITABLE	UNSUITABLE
20	Water Connection For Fire Fighting **ARTICLE:97(1)**	EXEMPT	EXEMPT	EXEMPT	EXEMPT	EXEMPT
NUMBER OF SUITABLE CRITERIA		11 (%55)	9 (%45)	13 (%65)	11 (%55)	11 (%55)
NUMBER OF UNSUITABLE CRITERIA		4 (%20)	6(%30)	3 (%15)	5 (%25)	4 (%20)
NUMBER OF EXEMPTED CRITERIA		5 (%25)	5 (%25)h	4 (%20)	4 (%20)	5 (%25)

Table.9 *The analysis of 5 residential buildings which were built after the TRFP enters into force*

ARTICLE NO	THE ANALYZED CRITERIA AND TURKEY'S REGULATION ON FIRE PROTECTION (TRFP) ARTICLE NO	After the year 2009 (After the National Fire Regulation)				
		1. Residential building	2. Residential building	3. Residential building	4. Residential building	5. Residential building
						
						
1	Access To Building. **Article:**	SUITABLE	SUITABLE	SUITABLE	SUITABLE	SUITABLE
2	Stability Of Building Bearing System **Article: 23(5)**	SUITABLE	UNSUITABLE	SUITABLE	SUITABLE	UNSUITA
3	Fire Compartments **Article: 24(4)**	UNSUITABLE	UNSUITABLE	UNSUITABLE	SUITABLE	SUITABLE
4	Facades **Article: 27(1)**	UNSUITABL	UNSUITABL	UNSUITA	UNSUITAB	UNSUITAB
5	Escape Distance **Article: 32(4)**	SUITABLE	SUITABLE	SUITABLE	SUITABLE	UNSUITABLE
6	Escape Route Width **Article: 33(1-2)**	UNSUITABLE	UNSUITABLE	SUITABLE	SUITABLE	SUITABLE
7	Exit Door Width **Article:: 33(5b)**	SUITABLE	SUITABLE	SUITABLE	SUITABLE	SUITABLE
8	Fire Resistance Of Fire Safety Hall **ARTICLE:34(2)**	SUITABLE	SUITABLE	SUITABLE	SUITABLE	SUITABLE
9	Fire Safety Hall Area **Article:34(3)**	UNSUITABLE	UNSUITABLE	UNSUITABLE	UNSUITABLE	SUITABLE
10	Emergency Exit Obligation **Article:39(1)**	SUITABLE	UNSUITABLE	SUITABLE	SUITABLE	UNSUITABLE
11	Number Of Steps Of Escape Stairs **Article:41(3)**	SUITABLE	SUITABLE	SUITABLE	SUITABLE	SUITABLE
12	Landing Scales Of Escape Stairs **Article:41(4)**	UNSUITABLE	UNSUITABLE	SUITABLE	SUITABLE	SUITABLE
13	Doors Of Escape Stairs **Article:41(5)**	UNSUITABLE	SUITABLE	UNSUITABLE	SUITABLE	SUITABLE
14	Properties Of Escape Stairs (Steps) **ARTICLE: 41(7)**	UNSUITABLE	UNSUITABLE	SUITABLE	SUITABLE	UNSUITABLE
15	Properties Of Escape Stairs **ARTICLE:41(8)**	SUITABLE	UNSUITABLE	SUITABLE	SUITABLE	SUITABLE
16	Ventilation Of Escape Stairs **ARTICLE:45(1)**	UNSUITABLE	UNSUITABLE	SUITABLE	SUITABLE	SUITABLE
17	Doors Of Escape Route **ARTICLE:47(1)**	UNSUITABLE	SUITABLE	SUITABLE	SUITABLE	SUITABLE
18	Special Situations Of Housings **ARTICLE:48(5)**	SUITABLE	SUITABLE	SUITABLE	SUITABLE	SUITABLE
19	Emergency Lighting System **Article:72(3)**	SUITABLE	UNSUITABLE	UNSUITABLE	SUITABLE	SUITABLE
20	Water Connection For Fire Fighting **ARTICLE:97(1)**	SUITABLE	UNSUITABLE	UNSUITABLE	SUITABLE	UNSUITABLE
NUMBER OF SUITABLE CRITERIA		11 (%55)	8 (%40)	14 (%70)	18 (%90)	14 (%70)
NUMBER OF UNSUITABLE CRITERIA		9 (%45)	12(%60)	6 (%30)	2 (%10)	6 (%30)
NUMBER OF EXEMPTED CRITERIA		-	-	-	-	-

4. FINDINGS

4.1. The Analysis Results of 5 Residential Buildings Which Were Constructed Before the TRFP

20 (100%) criteria were determined to analyze residential buildings. The analysis results are as follows; the first residential building is suitable for 11 (55%) criteria, is not suitable for 4 (20%) criteria, and is exempted from 5 (25%) criteria. The second residential building is suitable for 9 (45%) criteria, is not suitable for 6 (30%) criteria, and is exempted from 5 (25%) criteria. The third residential building is suitable for 13 (65%) criteria, is not suitable for 3 (15%) criteria, and is exempted from 4 (20%) criteria. The fourth residential building is suitable for 11 (55%) criteria, is not suitable for 5 (25%) criteria, and is exempted from 4 (20%) criteria. The fifth residential building is suitable for 11 (55%) criteria, is not suitable for 4 (20%) criteria, and is exempted from 5 (25%) criteria

Regarding the 5 residential buildings constructed before the Regulation enters into force, it was found that 5 buildings were suitable for a total of 55 criteria (55%), were not suitable for 22 criteria (22%), and were exempted from 23 criteria (22%). This information is shown in Figure 1.

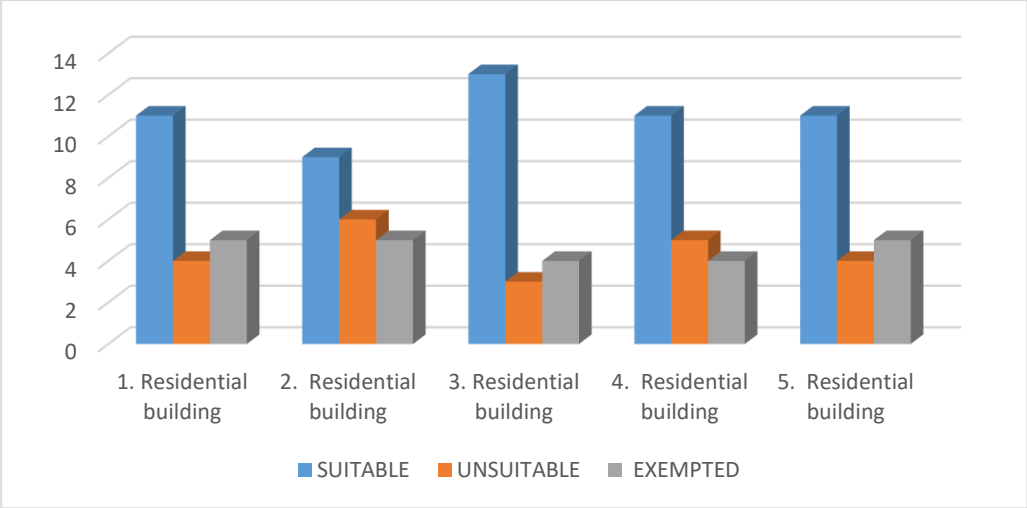


Figure 1. *The number of suitable and unsuitable criteria of the residential before TRFP*

The buildings examined in this part of the research are low-rise buildings. The total construction areas and the width and depth of the facade are not large. According to findings, unsuitable FTRP articles are as follows:

- Stability of Building Bearing System (Article: 23(5)) is not suitable. It was determined that the cover in the reinforcements was 2.5 cm in the columns and beams and 1.5 cm in floorings. However, according to TRFP, it should be 4 cm in columns and 2.5cm in floorings
- Emergency Exit Obligation (Article:39(1)) is not suitable. There aren't any exit signs on the escape routes.
- Emergency Lighting System (Article:72(3) is not available

4.2. The Analysis Results of 5 Residential Buildings Which Were Constructed After the TRFP Entered Into Force

20 (100%) criteria were determined to analyze residential buildings. The analysis results are as follows; the first residential building is suitable for 11 (55%) criteria and is not suitable for 9 (45%) criteria. The second residential building is suitable for 8 (40%) criteria and is not suitable for 12 (60%) criteria. The third residential building is suitable for 14 (70%) criteria and is not suitable for 6 (30%) criteria The fourth

residential building is suitable for 18 (90 criteria and is not suitable for 2 (10%) criteria. The fifth residential building is suitable for 14 (70%) criteria and is not suitable for 6 (30%) criteria.
Regarding the 5 residential buildings which were built after the Regulation entered into force, it was found that 5 buildings were suitable for a total of 65 criteria (65%) and were not suitable for 35 criteria (35%).This information is shown in Figure 2

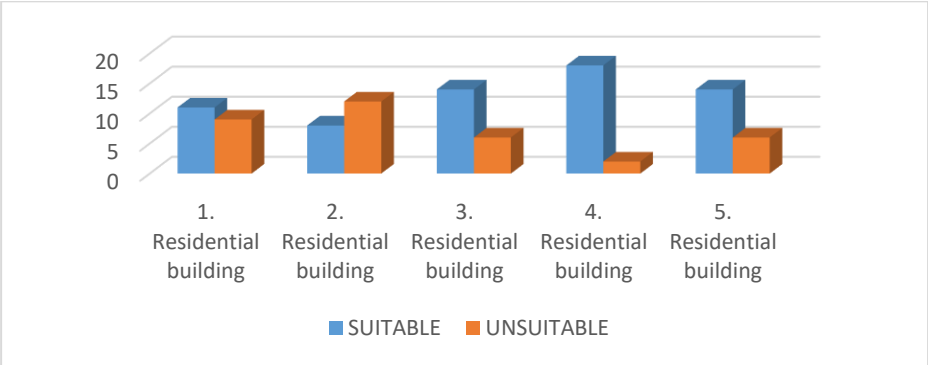


Figure 2. *The number of suitable and unsuitable criteria of the residential after TRFP*

The residences analyzed in this section are those that were built at least 7 years after the TRFP became official. Despite this, it is seen in figure 2 that there are deficiencies in fire precautions in the residential in this section.
The buildings examined in this part of the research are low-rise buildings. The total construction areas and the width and depth of the facade are large. According to findings, unsuitable FTRP articles are as follows:

- Stability of Building Bearing System (Article: 23(5)) is not suitable in two residentials in this part. It was determined that the cover in the reinforcements was 2.5 cm in the columns and beams and 1.5 cm in floorings. However, according to TRFP, it should be 4 cm in columns and 2.5cm in floorings
- Fire Compartments (Article: 24(4)) are not available. It has been determined that architects and engineers do not know what compartmentalization is. Therefore, this item is lacking.
- According to Article: 27(1) the façades of high-rise buildings should be made of hardly flammable materials, but It has been determined that easily flammable insulation materials have been used in all the five residentials in this part.
- Fire Safety Hall Area (Article:34(3)) are not suitable for four residential. Area dimensions are not appropriate, security hall entrance and exit directions are wrong.
- Water connection for fire fighting (Article:97(1)) is not available in three residentials.
- It has been evaluated that the deficiency in this section is because all of the examined buildings are high-rise residences. Fire prevention measures in high-rise buildings are more complex and costly. In addition, it is seen that engineers, architects, and contractors are not adequately audited to comply with TRFP provisions.

4.3. Comparison Of Findings In Pre TRFP (The Year 2002) And After TRFP (The Year 2009) Residentials

As seen in Figure 3 same deficiency in two groups of residents is the Stability of Building Bearing System (Article: 23(5)) that the cover in the reinforcements was 2.5 cm in the columns and beams and 1.5 cm in floorings. However, according to TRFP, it should be 4 cm in columns and 2.5cm in floorings
The other shortcomings vary. It can also be seen that according to the results of the comparison, an improvement has been determined in the fire safety of the residential buildings which were designed after Turkey's Regulation on Fire Protection (TRFP) which is shown in Figure 3. However, It has not reached the desired level yet.

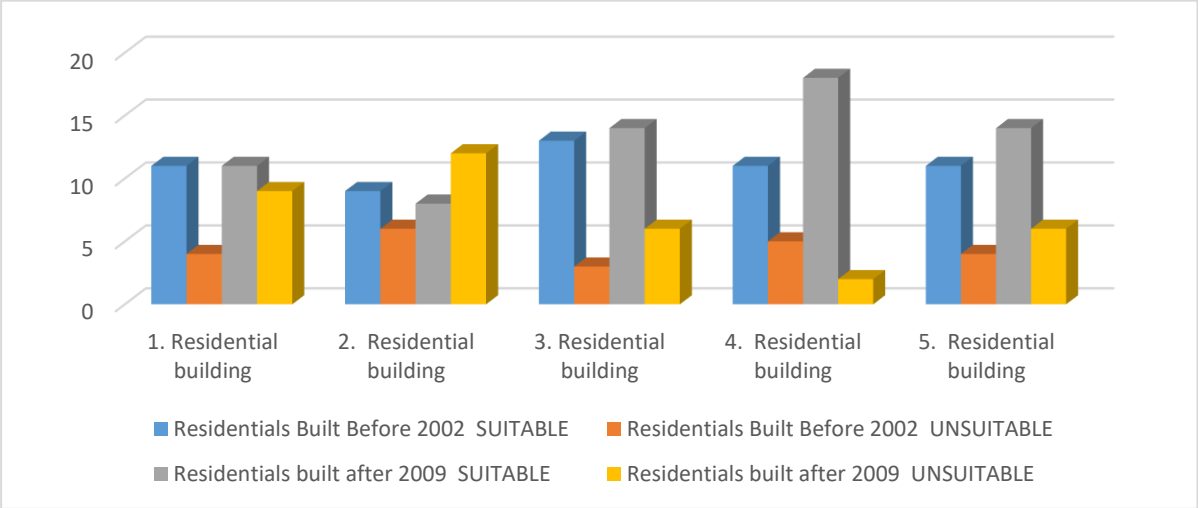


Figure 3. *Comparison of residentais findings which have been built before 2002 and after 2009*

The analyzed residentials which have been built after TRFP are highrise buildings. That property makes the fire safety precautions complicated, difficult, and more costly. Despite that, the fire safety precautions are better than the first group residential buildings.
If the fire regulations are well understood by architects, engineers, and contractors who design and build residentials in Turkey, fire safety in houses will be better. To achieve this, experts who took part in the preparation of the Regulation and know the regulation well should carry out the training, every where in Turkey.

5. CONCLUSION

Individuals, institutions, and organizations working in the field of fire and fire safety are all valuable separately. To make the work done more effectively, we should bring together the work of individuals, institutions, and organizations and combine them with the same goal. It is a vital need to initiate, develop and maintain a system that will protect our residential, cities and ensure the safety of its inhabitants all over the Turkey.

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