

## *Full Length Research Paper*

# **A method for the cost estimation in strengthening school buildings in Turkey**

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**Major damage and collapse occurred, especially, in the public buildings, due to the earthquakes in Turkey. According to evaluations carried out after the earthquake, the main reason of damage situation is seen to originate from the structural deficiency. As is in the whole world, the building sector also requires costly investments in Turkey. Six percent of the Gross National Product is spent to building investments in Turkey. Because of this share reserved from the limited country sources, sufficient source to other investment sectors cannot be transferred. Consequently, the buildings that are for the use of the public are needed to complement their productive physical service life by bringing them to resist against the earthquake. This study was carried out to establish an estimation of method for the source management in strengthening of school buildings which are public buildings. The cost of 11 different school buildings, which are within the Konya Province of Turkey and in the first degree earthquake zone and for which earthquake strengthening decisions are taken was found out, the supplementary reinforced concrete shear walls and column jacketing were determined by carrying out strengthening analyses of these schools and the construction costs of the strengthening was calculated. Concerning the estimation of the strengthening cost, the construction and strengthening costs were subjected to simple regression analyses. The outcomes have shown by using the construction cost that the strengthening cost can be estimated with -0.0201% accuracy.**

**Key words:** School buildings, earthquake, construction cost, strengthening, strengthening cost, regression analysis.

## **INTRODUCTION**

Three major earthquakes that caused life and property losses were experienced in Turkey in the last 10 years. The first of these earthquakes occurred in Marmara on 17th August, 1999, the second one in Düzce on 12th November, 1999, and the third one in Bingöl on 1st May, 2003. Many people lost their lives in these earthquakes; many buildings were collapsed and damaged. According to the investigations made after, most of the collapsed and damaged buildings were seen to belong to the public (Cagatay, 2005; Sezer et al., 2003).

Six percent of the Gross National Product of Turkey is spent on public building investments (Kanit, 2005).

Because of the costly construction investments, problems are experienced in transferring sources to the other investment sectors. Turkey is both making new building investments and strengthening buildings such as schools, hospitals, etc., which are of intensive use to make them resistant against the earthquakes by the source they have reserved for the building sector.

The needs of new school buildings and classrooms have increased together with increase of compulsory education in Turkey from 5 - 8 years. In order to meet this increasing demand, new school buildings are being constructed on one hand while the existing school buildings are also being strengthened against the earthquake on other hand.

In this context; the limited sources of the country in renewing and strengthening of school buildings are required to be used efficiently. The fair use of the sources

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also starts with accurate estimation of the source needed at planning stage.

In this study, the estimation of the strengthening costs for school buildings with reinforced concrete framed structures is intended.

### **School buildings in Turkey**

The typical-project which was developed by the Ministry of Public works and Settlement was put into practice for the school buildings at different grades in Turkey until 1970. These type-projects have been used by the Directorates of the Province National Education since 1980 by amending them according to the needs of the provinces. These typical-projects of similar architectural features showing no major differences from province to province are still being applied. The overall features of these typical-projects are shown below (Kol, 2003):

- (i) The structural system is a reinforced concrete frame.
- (ii) These projects were made according to the 1997 earthquake regulations, the former ones according to the earthquake 1975 regulations.
- (iii) Insufficient reinforced concrete shear walls which provide rigidity are available.
- (iv) Frame intervals are not frequent.
- (v) The frame spaces are enclosed with the brick walls which do not carry loads.

### **Seismic performances of the school buildings**

The projects of all the reinforced concrete buildings in Turkey are prepared according to Reinforced Concrete Requirements (TS500) and the Earthquake Regulations - 2007 (TDC, 2007) consequently. There is no distinction for the intensively used school buildings. Major damages took place in school buildings at the earthquakes that occurred in the recent years causing serious worries related with the performance of these buildings in the future earthquakes. The reasons for these damages are listed as in the following (Dogangün, 2004; Gur et al., 2004):

- (i) Compressive concrete strength is too low (7-14 MPa).
- (ii) Reinforcing bars are plain, not sufficient and detailing ineffective (such as the hook angles to be 90°).
- (iii) No stirrups exist in the column and beam connection regions.
- (iv) The structural frames are planned as strong beams and weak columns.
- (v) The column and beam cross-sections are inadequate.

### **Construction financing of the school buildings**

The construction of the 2nd grade schools (at High School level) in Turkey are made with the appropriations

reserved for the investments that take place in the income budget of the state. The majority of the financing for primary schools come from the appropriations reserved from the state budget and the rest of financing from the appropriations reserved from the budget of Private Province Administration consisted of that province (city) incomes. The strengthening of these schools is also realized by the same funds reserved from the same budgets.

The fiscal year is the calendar year in Turkey. For this reason, estimated appropriations are put into the budgets for the school building constructions and strengthening within the fiscal year.

It is very important to estimate the closest construction and strengthening costs of these buildings to the costs to be actually realized for the suitable and proper use of the public sources.

### **Strengthening of school building**

#### ***Selection of the buildings***

11 school buildings that are located in the Akşehir, Ilgin, Doğanhisar and Beyşehir of Konya province to, which were given lightly damaged reports by the Konya Directorate of Public works and Settlement after Afyon – Bolvadin centered earthquake occurred in 2002, were selected for this study. The settlement places described are the 1st degree earthquake zone in accordance with the Map of earthquake Zones in Turkey.

### **Strengthening method**

Reinforced concrete shear wall addition and column jacketing methods have been selected in strengthening the determined school buildings. This method is commonly used with the local workmanship, material and technology available in the area.


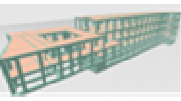


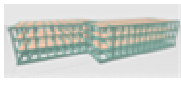

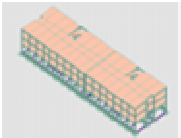

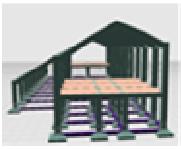
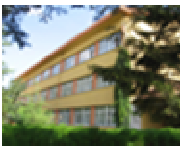
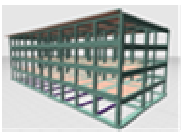
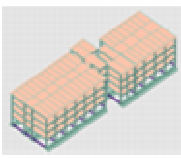
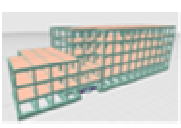
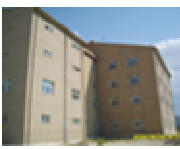
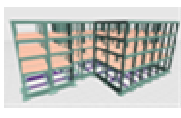

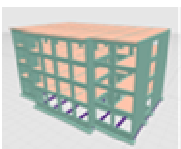
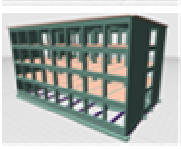
### **Strengthening analysis**

The existing situation data belonging to 11 schools, which were selected for strengthening, are given in Table 1. The methodology application determined in this study is explained through M. P. H. (Ilgin – Argithani Multi Programmed High school) and other findings obtained for the other buildings are also given. In this context, the architectural plan of M. P. H. building is given in Figure 1.

### **Recent studies**

Numerous activities were carried out intended for the strengthening of the reinforced concrete buildings and on the estimation of the construction costs. Not many

**Table 1.** The examined schools and existing condition information.

	Name of school	Plot area (m <sup>2</sup> )	Number of floor	Type of building	Construction year
	Akşehir High School	13869	B+G+2		1965
	Akşehir Anatolian High School	14200	B+G+2		1991-1995
	Akşehir Selçuklu High School	26897	G+2		1965
	Akşehir İsmet İnönü Technical High School. Electric-Electronic Department	52594	G+2		1964
	Akşehir İsmet İnönü Technical school. Metal Department	52594	G		1946
	Akşehir Vocational School Girls' High	5133	B+G+2		1972
	Akşehir Anatolian İmam Hatip High Scholl	7470	B+G+2		1966 -1972
	Akşehir Anatolian Commerce High School	8970	B+G+3		1986
	Beyşehir Ali Akkanat Primary School	6045	G+3		1995
	Doğanhisar Technical High School	3106	G+3		1992 -1993
	Ilgin Argithani M. P. H.	20114	G+3		2000

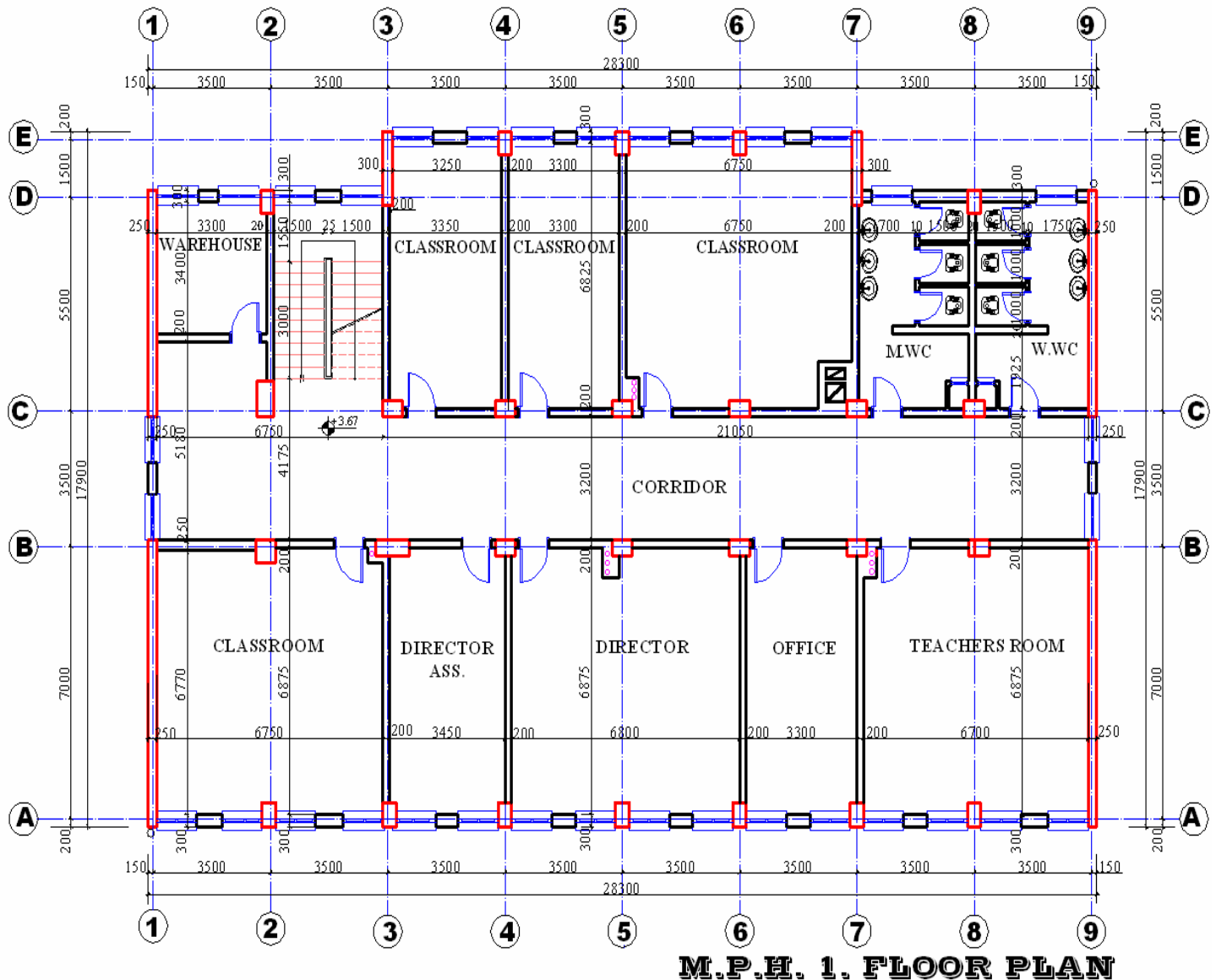
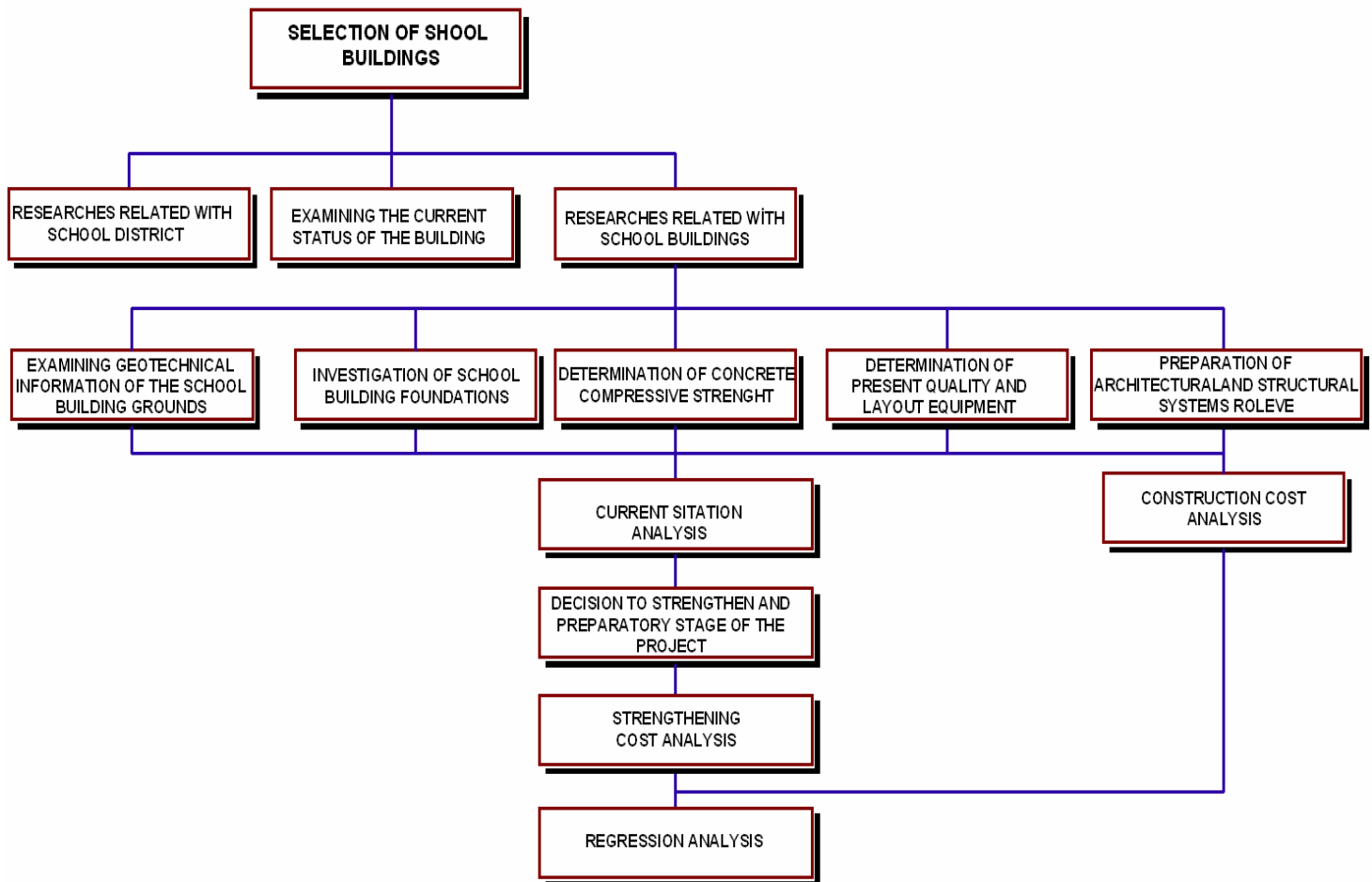


Figure 1. M. P. H. existing 1st floor plan.

practices are seen on the strengthening costs, especially, the activities carried out on the cost estimation of the multi sample building strengthening. Nevertheless, some practices are explained below in terms of their concerns.

Considerable life and property losses have occurred because of the devastation due to the earthquakes happened in Turkey during the last 10 years. Especially, the damages that occurred on the public buildings were more serious and irrevocable when compared with the damages that took place on private buildings. In Turkey, primary school buildings constitute a large portion of the public buildings. Unfortunately, these buildings faced with heavy damages during the last earthquakes. (Kaltakci, 2008). In Turkey, more than 90% of building stock consists of reinforced concrete buildings.

The majority of Turkey's urban population lives in multi-story apartment blocks constructed with reinforced concrete. In addition to reinforced concrete structure damages caused from especially last decade's earthquakes, there were built structures, most of which are unable to carry their own-weight and are not appropriate to engineering and design criteria because of lack of interest, ignorance, lack of inspection and supervision in Turkey (Kaltakci et al., 2007). Özdöner examined the earthquake security of the Konya Numune Hospital, A Block, and Emergency Service building and carried out the controls of the sizes, bending and sliding of the reinforced concrete elements (Özdöner, 2003). Polat carried out the analysis of Konya Selçuklu Şükriye Onsun Primary School building whether it is secured



**Figure 2.** Flowchart of the analysis.

against the earthquake or not according to the stipulations of the current earthquake regulations (Polat, 2007). Stonehouse has examined the seismic impact resistance of the reinforced concrete shear walls on the reinforced concrete shear walled buildings which are exposed to horizontal forces (Stonehouse and Arthur, 1999). Kanit examined the cost of the office buildings in Turkey in statistical methods according to the reinforced concrete steel and concrete class (Kanit et al., 2007). He examined the cost of the office buildings in Turkey, the earthquake zones and the change according to the ground classes with the statistical methods (Kanit et al., 2007).

In this study, the strengthening analyzes of the 11 school buildings which are decided by the authorities to be strengthened within Konya province of Turkey were made, the cost for the strengthening was designated and it is pointed out that the necessary fund for the strengthening of a school building can be estimated without making strengthening calculations setting the relations between the constructions costs and the costs of strengthening forth.

## METHODOLOGY OF RESEARCH

The method followed up in this study has been explained below (Figure 2), respectively:

(a) The architectural and structural system of the 11 school buildings which were selected for the study has been extracted.  
 (b) The seismic analysis of these school buildings have been carried out via commercial software (IdeCAD/2007). Many different software can be used with the building analyze calculations nowadays. Besides calculating these program calculations with a high performance, they are also preferred due to the reasons listed below:

- (i) To be able carry out the nonlinear performance analyze of the buildings using the increasing pushing analyze,
- (ii) To be able to determine the building performance using linear elastic calculation,
- (iii) Full conformation to the 2007 Turkish Earthquake Code (TEC),
- (iv) Calculation options for Federal Emergency Management Agency (FEMA)- 356 (2000) and TEC (1998),
- (v) Making the horizontal load increasing templates in which is the equivalent triangular, modal constant, modal variable, uniform and user defined available within its contents, IdeCAD/2007 program has recently become widely used in the articles published in international journals.

**Table 2.** Ground study result values.

Name of school	Earthquake zone	Ground safety tension (MPa)	Ground class	Ground group	Liquefaction state	Bed co-efficient (kN/m <sup>3</sup> )	Building importance co-efficient (I)
Akşehir High School	I	0.166	G3	B	Existent	16500	1.4
Akşehir Anatolian High School	I	0.150	G3	C	Absent	30000	1.4
Akşehir Selçuklu High School	I	0.113	G3	B	Existent	12000	1.4
Akşehir İsmet İnönü Technical High School. Electric-Electronic Department	I	0.125	G3	B	Existent	18000	1.4
Akşehir İsmet İnönü Technical High school. Metal Department	I	0.053	G4	B	Absent	5000	1.4
Akşehir Girls' Vocational High School	I	0.170	G3	B	Existent	17000	1.4
Akşehir Anatolian İmam Hatip High Scholl	I	0.170	G2	B	Absent	15000	1.4
Akşehir Anatolian Commerce High School	I	0.073	G4	B	Absent	10000	1.4
Beyşehir Ali Akkanat Primary School	I	0.150	G2	C	Absent	50000	1.4
Doğanhisar Technical High School	I	0.135	G3	B	Absent	15000	1.4
İlgin Argithani M. P. H.	I	0.110	G3	B	Absent	13500	1.4

Computer support for conceptual structural design is still ineffective. This is due, in part, to the fact that current computer applications do not recognize that structural design and architectural design are highly interdependent processes, particularly at the early stages. (Mora et al., 2008). In North Cyprus, many construction companies have been constructed the projects without the acceptance of the project control department. In these structures the column-beam joints are the most critical regions to failure during earthquakes because of inadequate attention to joints during structural designing. This study aimed to assess the post yield structural response of a four story existing reinforced concrete building before and after strengthening using nonlinear static procedure defined in FEMA356 and incremental dynamic analysis (IDA) (Hedayat, 2009). (c) In order to perform the seismic analysis and provide the necessary data:

(1) For the purpose of determining the ground parameters required for the static analyses of school buildings, the well bores were opened between 10 - 15 m according to the numbers of the buildings, the standard penetration experiments were done at the levels found to be necessary, at least 2 units of undamaged sample (UD) and 3 - 4 units of damaged samples were taken from each well bores. The laboratory experiments were done and the ground parameters were determined by evaluating the land observations together with the experiment results. In this context, the ground security tension that was obtained for school buildings, ground class, ground group, liquefaction state, bed co-efficient and building importance values are given in the Table 2.

(2) The research data related to the foundations of the buildings were obtained during the ground study works. The excavations were made on the appropriate corners of the buildings, the existing foundation states and measurements were determined in their places. The photographs related to the foundation researches of the M.P.H. were given in Figure 3 as examples.

(3) For the purpose of determining the ultimate strengthening of the reinforced concrete elements, drill samples conforming to the TS

10465 (1992) in terms of shape and number were taken, their heads were prepared under the laboratory ambient and subjected to pressure experiment under the load of 2 kgf/cm<sup>2</sup>/second. The mean compression strength of concrete with the carrier components of the M. P. H. is found to be 9.823 MPa from experimental evaluation. Tension strengths of concrete belonging to other school buildings are given in Table 3.

(4) The type, number and diameter of the reinforcement of the structural elements of the buildings were determined in situ. For this, Hilti Ferrosan RG10 equipment determination device was used. The equipment testing views belonging to M. P. H. obtained from analysis are seen the equipment test results in Table 4.

(d) According to the result of the seismic analysis carried out for the school buildings, the structural elements which were insufficient are determined and according to the seismic strengthening method; the performances of the buildings were increased by the addition of reinforced concrete shear wall, jacketing of weak columns and strengthening the foundations.

(e) The efficiency analysis of the school buildings were carried out via commercial software. The following processes explained through M.P.H. were realized at analysis.

(1) The axes, columns, beams, floors and foundations were input to the software in the direction of the data obtained from the field studies.

(2) The loads of the building and elements were selected in accordance with the TS 498 (1997).

(3) The information necessary for the analysis was input in accordance with the TEC 2007.

(4) The vertical and horizontal test data which were obtained as the result of field tests was also input to the program.

(5) At the end of analysis made, a total of 226 elements were seen to be insufficient.

(6) In the context of the selected reinforced concrete shear wall addition and column jacketing method; shear wall addition of 21.00 m on the X direction and 7.20 m on the Y direction and the increase of the thicknesses of the 4 existing shear walls available at the 1 - 1



Figure 3. M. P. H. Foundation exploration views.

Table 3. Results of the concrete strength tests.

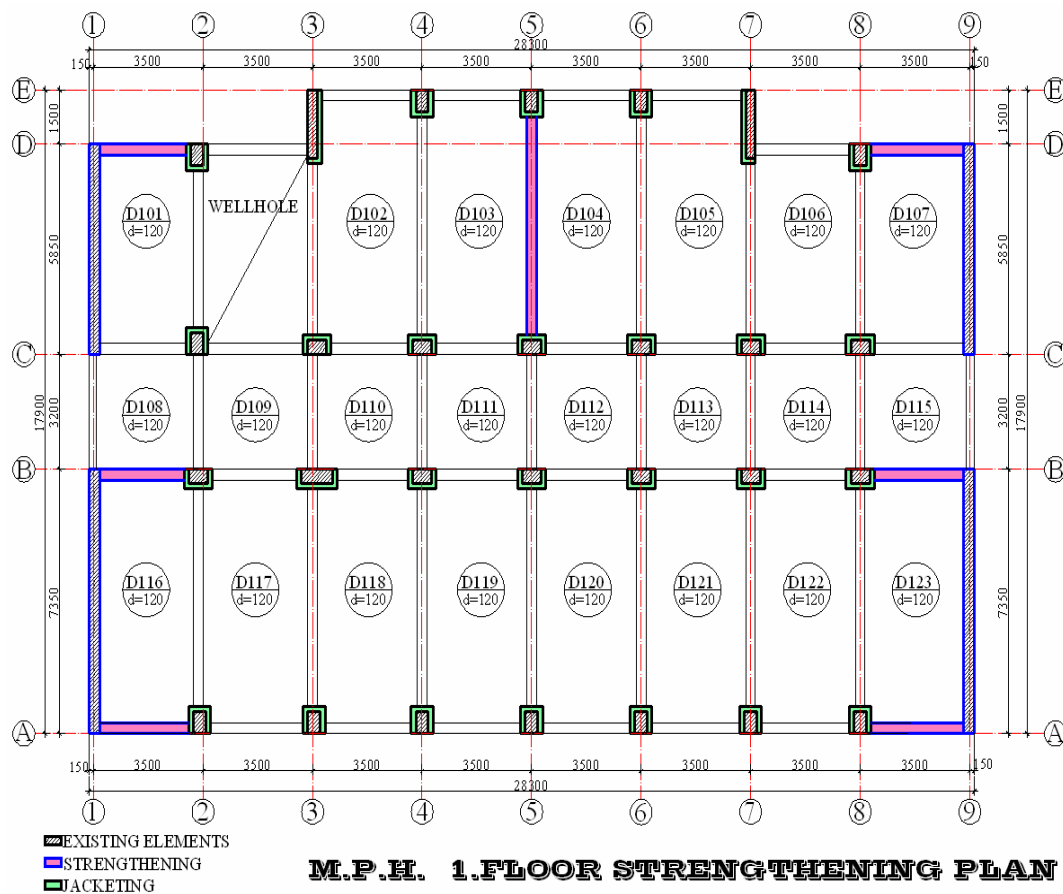
Name of school	Sizes of sample		Number of sample (unit)	Equivalent 28-day 15 / 30 cylindrical sample resistance $f_k = f_{y,ort} / y_k$ (MPa)
	Diameter (mm)	Length (mm)		
Akşehir High School	100	100	12	12
Akşehir Anatolian High School	100	100	12	13
Akşehir Selçuklu High School	100	100	9	9
Akşehir İsmet İnönü Technical High School. Electric-Electronic Department	100	100	9	7
Akşehir İsmet İnönü Technical High school. Metal Department	100	100	5	7
Akşehir Girls' Vocational High School	100	100	12	8
Akşehir Anatolian İmam Hatip High Scholl	100	100	12	8
Akşehir Anatolian Commerce High School	100	100	15	9
Beyşehir Ali Akkanat Primary School	100	100	12	8
Doğanhisar Technical High School	100	100	9	10
İlgin Argithani M. P. H.	100	100	9	10

Table 4. M. P. H. equipment testing report.

Floor no.	Identification of column	Dimension of column (mm)	Vertical testing value in the existing building	Horizontal testing value in the existing building
Ground	S15	500/600	10Φ14	Φ8/20
Ground	P2	250/5850	Φ12/20	Φ12/20
Ground	P1	250/7350	Φ12/20	Φ12/20
Ground	P3	250/7350	Φ12/20	Φ12/20
Ground	P4	250/5850	Φ12/20	Φ12/20
Ground	S23	400/600	8Φ14	Φ8/21
1. Floor	S16	400/600	10Φ14	Φ8/22
1. Floor	S10	400/600	10Φ14	Φ8/20
1. Floor	P1	250/7350	Φ12/16	Φ12/22
1. Floor	S12	400/600	10Φ14	Φ8/20
1. Floor	P3	250/5850	Φ10/21	Φ10/30
1. Floor	S13	400/600	8Φ14	Φ8/22
1. Floor	S6	400/600	10Φ14	Φ8/22
2. Floor	S8	400/60	8Φ14	Φ8/20
2. Floor	P4	250/7350	Φ10/15	Φ10/20
2. Floor	S12	400/600	8Φ14	Φ8/21

**Table 4.** Contd.

2. Floor	S1	300/1900	20 $\Phi$ 14	$\Phi$ 8/21
2. Floor	S2	300/1900	20 $\Phi$ 14	$\Phi$ 8/20
3. Floor	S25	400/600	8 $\Phi$ 14	$\Phi$ 8/22
3. Floor	S22	400/600	8 $\Phi$ 14	$\Phi$ 8/25
3. Floor	S8	400/600	8 $\Phi$ 14	$\Phi$ 8/27
3. Floor	S13	400/600	8 $\Phi$ 14	$\Phi$ 8/23
3. Floor	S21	400/600	8 $\Phi$ 14	$\Phi$ 8/23
3. Floor	S13	400/600	8 $\Phi$ 14	$\Phi$ 8/20

**Figure 4.** M. P. H. Strengthening shown on the floor formwork plan.

and 9 – 9 axes were preferred taking into consideration the architectural functions of the building.

(7) All the columns were examined one by one for jacketing decision due to the fact that the quality of the concrete was very low. Analyses were continued as far as ultimate strengths of the elements were reached, after which coating of columns were preferred.

(9) The analyses are continued keeping in mind the basic methods of strengthening and the quantitative results of strengthening are obtained.

At the result of the analyses carried out, the type floor strengthening plan of the M.P.H. was given in the Figure 4.

(f) The determination of the performance levels of the buildings in strengthened conditions was carried out through a pushover

analysis.

(g) The construction costs of the school buildings were accomplished in accordance with the unit production method. The amounts of the unit productions were determined using the building relief prepared and the data and measurements in the locality lists and multiplied by the production prices of the year 2009 and the estimated construction costs for 2009 were found out taking their totals. As the heating and lighting construction costs, the mean installation costs in the school buildings were taken and added to the construction costs at the ratio of 8% of the cost. According to the M.P.H. application, the construction cost of this building is TL1.090.584,00 (\$727.056) as per the prices of the year 2009. The estimated costs of the other buildings are given in Table 5.

(h) The unit production costs method is applied in the estimation of



**Table 5.** Total construction costs of the school buildings.

Item no.	Name of school	Number of floor	Basement floor area (m <sup>2</sup> )	Ground floor area (m <sup>2</sup> )	Normal floor areas (m <sup>2</sup> )	Total area (m <sup>2</sup> )	Total const. cost. (TL/m <sup>2</sup> )	Total cost (TL)	Total cost (\$)
1	Akşehir High School	B+G+2 N	695	1.180	1.805	3.680	561	2.064.480	1.376.320
2	Akşehir Anatolian High School	B+G+3 N	306	917	2.751	3.974	561	2.229.414	1.486.276
3	Akşehir Selçuklu High School	G+2 N		1.103	2.206	3.309	561	1.856.349	1.237.566
4	Akşehir İsmet İnönü Technical High School. Electric- Electronic Department	G+2 N		840	1.680	2.520	561	1.413.720	942.480
5	Akşehir İsmet İnönü Technical High school. Metal Department	G		615	600	1.215	561	681.615	454.410
6	Akşehir Girls' Vocational High School	B+G+2 N	722	722	1.444	2.888	561	1.620.168	1.080.112
7	Akşehir Anatolian İmam Hatip High Scholl	G+3 N		785	2.355	3.140	561	1.761.540	1.174.360
8	Akşehir Anatolian Commerce High School	B+G+3 N	1.100	1.128	2.828	5.056	561	2.836.416	1.890.944
9	Beyşehir Ali Akkanat Primary School	G+3 N		1.023	2.751	3.774	561	2.117.214	1.411.476
10	Doğanhisar Technical High School	G+3 N		486	1.458	1.944	561	1.090.584	727.056
11	İlgin Argithani M.P.H.	G+3 N		486	1.458	1.944	561	1.090.584	727.056

Note: 1\$=1.50 TL.

the strengthening costs of the buildings. Average of 19 different unit productions are required to be realized in each building for strengthening. The strengthening unit production amounts were calculated based on the relief, locality information and the information and measurements of the building, in-situ the measure-ments and information of strengthening and the newly added elements. The estimated strengthening costs were calculated multiplying the obtained production amounts by the prices of the year 2009 and summed up. Heating and lighting costs at %8 ratio was added to this obtained value. According to the M.P.H. application, strengthening types, unit productions, quantities, unit production prices, unit production totals and estimated strengthening cost are shown in Table 6.

(i) Simple linear regression analysis was carried out for the estimation of the strengthening costs of the buildings by means of commercial software. Estimated construction cost values of 10 out of these and estimated strengthening cost values of the same buildings were used. Estimated construction and strengthened values belonging to the M. P. H. buildings were used for the test.

Estimated construction and strengthening cost values belonging to the school buildings used for the Regression analysis and test is given in Table 7. At the end of the a simple linear regression analysis carried out;  $Y = -196344,088 + 0.611 * X_{YM}$  equation was obtained. In Equation (1), Y: Expresses strengthening cost,  $X_{YM}$ : Construction cost. At the end of the analysis carried out, the determination coefficient was seen to be  $R^2 = 0.852$  and  $F = 46.018$ ;  $p < 0.001$  in the variance analysis (Table 7).

Estimated construction cost of Akşehir Girls' Vocational High School that is selected for the test is  $X_{YM}$ : TL 1.620.168,00. (\$1.080.112). This value is placed in Equation (1) and the strengthening cost solving the equality was found to be  $Y = TL 793.578.56$  (\$529.052.37). In accordance with the unit production method of the Akşehir Girls' Vocational High School building, estimated strengthening cost was calculated to be TL 793.419.00 (\$528.946), thus:

(1)The strengthening cost was estimated with -0.0201 tolerance by using the equation.

## CONCLUSION AND SUGGESTIONS

As presented in this study, the determination of strengthening estimation costs of school buildings require a long and costly process which consist of field and office work. Approximately, 56500 school buildings exist in Turkey spreading all over the country (<http://munster.meb.gov.tr/mesistemi.htm>). Almost 80% of these school buildings, which were built before 1996, require to be strengthened. Necessary to know the estimated strengthening cost for each school while deciding the strengthening strategy of school buildings. This is necessary both for the right use of the limited sources and for the source demand and management. In this study:  $Y = -196344.088 + 0.611 * X_{YM}$  equation found for the estimation of the strengthening costs based on construction costs

**Table 6.** The strengthening cost of M. P. H.

No.	Pos. no.	Description	Unit	Quantity	Unit price (TL)	Total price (TL)	Total price (\$)
1	21.011	Smooth surfaced concrete and reinforced concrete formwork	m <sup>2</sup>	1.610	16.08	25.888,80	17.259,20
2	16.044/4MK	Ready-concrete (BS20)	m <sup>3</sup>	246.5	131.15	32.328,48	21.552,32
3	23.001/1	Thin iron-bar	t	26	1515.31	39.398,06	26.265,37
4	23.001/2	Thick iron-bar	t	21.619	1359.38	29.388,44	19592,29
5	27.506/MK	Plain mortaring using the mortar of 350 kg cement dosage for the lower layer; the upper layer with 500 kg cement dosage	m <sup>2</sup>	295	12.43	3.666,85	2.444,57
6	27.507	Single layer plain mortaring using the mortar of 500 kg cement dosage	m <sup>2</sup>	762	9.05	6.896,10	4.597,40
7	25.048/1A	Plastic painting whitewash	m <sup>2</sup>	762	8.20	6.248,40	4.165,60
8	YBF.007	Rod hole opening and epoxy application – Shear wall	number	640	46.43	29.715,20	19.810,13
9	YBF.007	Rod hole opening and epoxy application - Column	number	3.836	46.43	178.105,48	118.736,99
10	YBF.007	Rod hole opening and epoxy application - Foundation	number	500	46.43	23.215,00	15.476,66
11	21.054	Formwork scaffold	m <sup>3</sup>	560	2.76	1.545,60	1.030,40
12	21.065	Scaffold	m <sup>2</sup>	1.196	3.51	4.197,96	2.798,64
13	18.189	Parquet removing	m <sup>2</sup>	20.75	4.13	85,70	57.13
14	27.565	Floor coating	m <sup>2</sup>	28	20.05	561,40	374,26
15	27.560/7	External siding painting	m <sup>2</sup>	72.8	11.44	832,83	555,22
16	18.185/1	Breaking down the concrete construction with iron and without iron with the machine.	m <sup>3</sup>	73.99	35.44	2.622,21	1.748,14
17	18.183	Breaking down the masonry and horasan construction with the cement mortar without using explosive	m <sup>3</sup>	270.97	30.94	8.383,81	5.589,21
19	YBF.008	Plastic window modification	m <sup>2</sup>	203.68	17.5	3.564,40	2.376,27
		Total				396.644,71	264.429,81
		8% Heating and lighting installation construction cost				31.731,58	21.154,38
		Total reinforcement cost				428.376,28	285.584.19

**Table 7.** School total costs and strengthening costs.

Item no.	Name of school	School area (m <sup>2</sup> )	Construction Cost (TL)	Construction Cost (\$)	Reinforcement Cost (TL)	Reinforcement Cost (\$)	Ratio
1	Akşehir High School	3.680	2.064.480	1.376.320	989.395	659.597	0,4792466
2	Akşehir Anatolian High School	3.974	1.856.349	1.486.276	849.726	566.484	0,4577404
3	Akşehir Selçuklu High School	3.309	2.229.414	1.237.566	1.089.215	726.143	0,4885656
4	Akşehir İsmet İnönü Technical High School. Electric-Electronic Department	2.520	1.413.720	942.480	491.061	327.374	0,3473538

of school buildings is limited to the data which was composed belonging to the selected schools and the selected strengthening method. The estimation made in accordance with this equation is seen to be realized at tolerance of -0.0201%.

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