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On behalf of the editorial board of International Journal of Engineering Technologies (IJET), I would like to share our happiness to publish the 31st issue of IJET. My special thanks are for members of Editorial Board, Publication Board, Editorial Team, Referees, Authors and other technical staff.

Please find the 31st issue of International Journal of Engineering Technologies at http://ijet.gelisim.edu.tr or https://dergipark.org.tr/en/pub/ijet. We invite you to review the Table of Contents by visiting our web site and review articles and items of interest. IJET will continue to publish high level scientific research papers in the field of Engineering Technologies as an international peer-reviewed scientific and academic journal of Istanbul Gelisim University.

Thanks for your continuing interest in our work,

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Analysis of Relatively Short Variable Rate "Noisy" Well Test Data Using Non-Linear Deconvolution

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Abstract - Short well test data are pressure-rate-time data that are not long enough to be used to infer the reservoir boundary model and are very common in the oil and gas industry. Short rate well test data may occur when companies try to cut costs of well test jobs or mostly due to improper well test design. Nevertheless, one may wish to extract the most amount of information from this limited data because the de-convolve response can allow the reservoir engineer to make the best use of the available data in selecting a suitable interpretation model by narrowing down the possible boundary models and also providing a reliable estimates of model parameters. The aim of this study is to demonstrate the usefulness and significance of pressure-rate deconvolution in analyzing relatively short variable rate data using a hypothetical case study. The simulation was carried out using Sapphire's test design module by assuming the presence of an exploratory well in an oil reservoir above bubble point pressure. Further assumption is that the reservoir is homogenous, therefore the possibility of a changing wellbore model was neglected from the analysis. The computer codes for the simulation were inputted using python programming language. We observed from the study that although pressure and flow rate relationship can be nonlinear, the problem can be formulated as a linear problem and the nonlinearity is expressed in the features of the reservoir. The simulation results were satisfactory using the test case and deviations between model parameters and actual reservoir parameters used in simulation was shown to have an absolute value less than 8% which is within acceptable engineering limits.

Keywords: Pressure-transient, Reservoir boundaries, Semi-infinite, Sapphire, Pressure build-up

1. Introduction

In well test interpretation the selection of a well interpretation model involves the selection of flow regimes for each component of the interpretation model. For example, a reservoir interpretation model may be selected to have skin and wellbore storage effects as the inner boundary effects, a homogeneous reservoir behavior, and a constant pressure outer boundary [5].

Proper diagnostic tools are needed in order to identify the different flow regimes which may occur in each component of the interpretation model. Researchers over the years have proposed several techniques (diagnostic tools) for identification of various flow regimes in a well test; specialized plots, pressure-time (log-log) plot and pressure derivative diagnostic plot [3].

These diagnostic tools have some limitations when applying them to variable rate well test data. For example, the pressure in the pressure derivative diagnostic plot, due to the way it is computed amplifies the errors in recorded data; this may lead to generation of artifacts when applied to noisy data [1]. The straight-line plot and flow regime specific plots have errors in selecting the boundaries of the region of the data that shows straight line trend which corresponds to a specific flow regime [3]. All three mentioned diagnostic plots share the constraint that their radius of investigation (the distance the pressure disturbance has travelled into the reservoir) is limited by the longest time in the flow history [8].

Therefore, a technique is needed which takes measurement of noise into account and allows the reservoir engineer to see deeper into the formation in order to enable him select the most appropriate interpretation model that fits the data. This is where pressure-rate deconvolution becomes useful and convenient. Deconvolution is simply the inverse of convolution. It involves the determination of the unit pressure response or the impulse pressure response from the given rate history and well pressure response [8]. Deconvolution is not a new technique that replaces conventional techniques, rather it was introduced to be used alongside conventional techniques.

Nonlinear deconvolution involves fitting a nonlinear response to the variable rate pressure data. It was introduced due to the short comings of previous deconvolution techniques. Nonlinear deconvolution can be helpful in inferring the boundary model in the case of relatively short well test data.

There have been several attempts in literature at deconvolution but all failed considerably when applied to data with considerable noise in rate measurement. Schroeter, Hollaender and Gringarten [8] were the first to account for the effects of large noise in rate measurement on the deconvolution algorithm for linear problems. They formulated the deconvolution problem as a non-linear total least squares (TLS) problem or what in statistics is referred to as an error in variables problem. Their method makes use of the variable projection algorithm to deconvolve the rate and pressure history. However, as pointed out by Levitan [6], the Von Schroeter [8] formulation can only be applied to data with constant wellbore model (i.e. constant skin and wellbore storage) and will not produce satisfactory results when applied to a varying wellbore model.

Levitan [6] developed a new pressure rate deconvolution algorithm to analyze real test data (data which are characterized by changing skin, changing wellbore storage or both). Their implementation is quite different from that of Schroeter, Hollaender and Gringarten [8] in that they applied the algorithm for unconstrained minimization to minimize their objective function and their formulation also allows the selection of specific flow periods to be included in the model parameters [2]. The author suggested that in the case of different skin and wellbore storage for different flow periods the deconvolution should be performed separately on each buildup assuming a value of initial reservoir pressure for each buildup. The initial reservoir pressure is then changed manually until the several deconvolve build-ups have the same value of initial reservoir pressure. The process of manually changing the initial reservoir pressure can be very tedious and also, since their method is conducted on each build-up separately it may lose information about intermediate behaviors [4].

Von Schroeter, Hollaender and Gringarten [9] modified their earlier proposed model. The modified algorithm is similar to that which was originally published except that penalization of smoothness was based on total curvature instead of average slope. They also provided a rigorous error analysis of the method.

Houze, Tauzin and Allain [4] discussed a new technique of deconvolution similar to that of Von Schroeter, Hollaender and Gringarten [9]. Their technique is capable of carrying out deconvolution on a selected reference build-up and the data after the convergence time of other build-ups. The convergence time is the time beyond which the pressure derivative converges. Unlike the Levitan [6, 7] method their method does not require tedious manual iterations for initial reservoir pressure and can produce reservoir responses intermediate between two build-ups.

2. Methodology

The simulation was carried out using Sapphire's test design module. A synthetic downhole gauge data was simulated for our case study, which is a vertical well with constant skin and wellbore storage producing at varying rate in a semi-infinite reservoir at some distance to a sealing fault. The reservoir is homogenous and is assumed to be producing above the bubble point pressure throughout the test in order for the linearity assumption for Duhamel's equation to be obeyed.

The rate history input to the model is shown in Table 1 and consists of four build-up and eleven drawdown rates with each test period (period of constant rate) selected to be of equal duration for simplicity. Table 2 shows the fluid properties. The fluid properties were arbitrarily chosen to be constant, since the reservoir was assumed to be producing above bubble point. The rock properties and other input parameters for the simulation model were arbitrarily chosen as shown in Table 3. Random noise was inputted to both the flow rate history and the simulated pressures using the Pandas and NumPy packages in the python programming environment. For the rate history a noise of zero mean with a standard deviation of 5bbl/day was added to the signal, while for the simulated pressure a noise of zero mean with a standard deviation of 1 psi was added.

Table 1. Rates history

Duration	**Liquid Rate**
(hr)	(STB/D)
42	140
42	0
42	109
42	196
42	0
42	99
42	152
42	202
42	242
42	0
42	207
42	101
42	204
42	292
42	0

Table 2. PVT parameters

Fluid property	Value	Unit
Formation Volume Factor	1.2	bbl/STB
Viscosity	2.3	cp
Total compressibility	3.00E-06	psi^{-1}

Table 3. Rock properties and other model input parameters.

Parameter	Value	Unit
Skin	3.23	-
Flow capacity (Kh)	396	md.ft
Wellbore storage coefficient	0.00972	bbl/psi
initial reservoir pressure	4996.9	Psi
Well radius	0.25	Ft
Pay zone thickness	30	Ft
Porosity	0.20	%
Distance to fault	409	Ft

Conventional well test interpretation was first carried out on the noisy data, then deconvolution was then applied to all build-ups of the noisy data using Sapphire's deconvolution module assuming all other parameters are known except initial reservoir pressure, skin, wellbore storage, flow capacity and distance to fault.

The deconvolution was performed on all extracted build-ups at once using the algorithm developed by Von Schroeter, Hollaender and Gringarten [9] because the well was said to have a constant skin and wellbore storage coefficient. The Deconvolution was performed with a smoothing coefficient of 0.5, rate relative weight of 1 and pressure relative weight of 10. Several plots of the build-up sections for the simulated data (noisy data) and the deconvolve data were generated and analyzed.

3. Results and Discussions

Figure 1 shows the plot of the simulated pressure response and rate history input. From this figure we can see that there are no negative pressures, this means that the reservoir was capable of producing at the rates indicated in the rate profile.

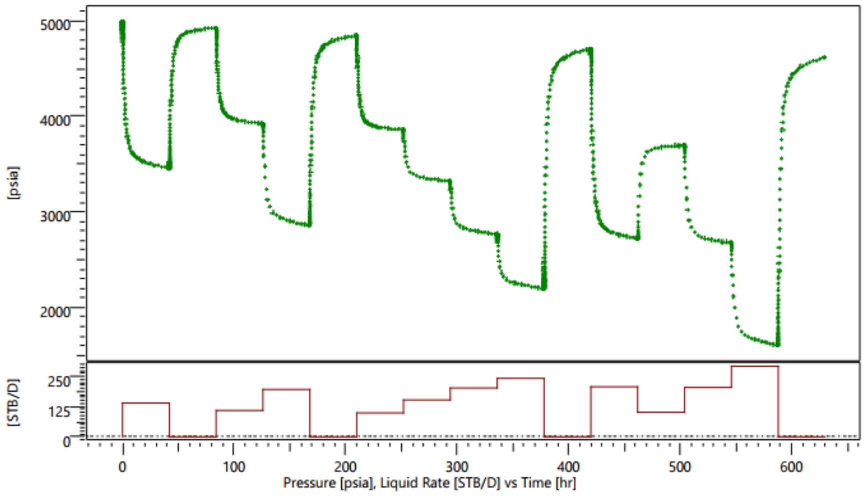

Figure 1. Simulated pressure response and rate history input

Figure 2 shows the log-log plot of pressure change and pressure derivative for the four extracted build-ups. The difference in the plots can be attributed to the different flow rates before each shut-in. The rate normalized plots for the four buildups shown in Fig. 3 confirms this since the plots lay on each other. This plot also shows that the simulated data has a constant wellbore model (i.e. constant skin and wellbore storage).

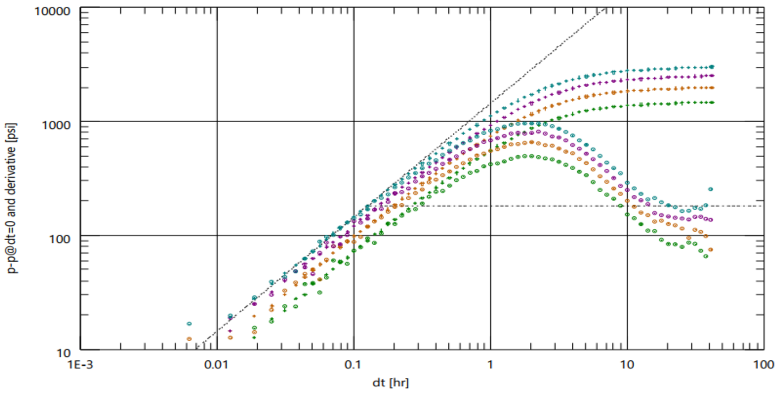

Figure 2. Pressure and Pressure derivative plot

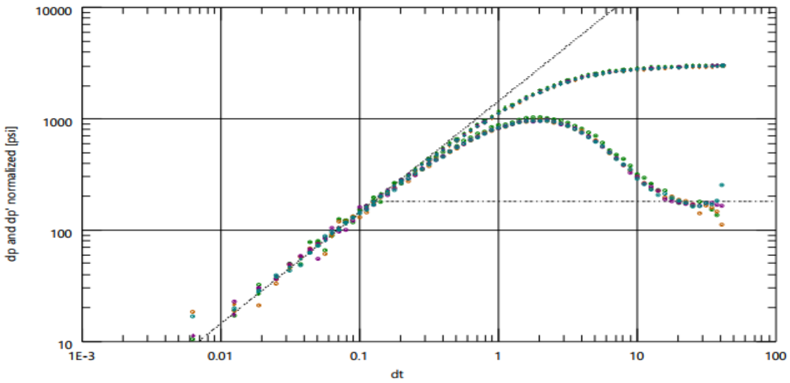

Figure 3. Rate normalized pressure and Pressure derivative plot

Similarly, the same can be seen in Fig.4 and Fig.5 which are non-normalized and rate normalized superposition plots for the four buildups. But unlike the rate normalized log-log plot the rate normalized superposition plot does not overlay one another but instead there is a shift. The shift can be attributed to the difference in pressures at the instant of shut-in for the four build-ups.

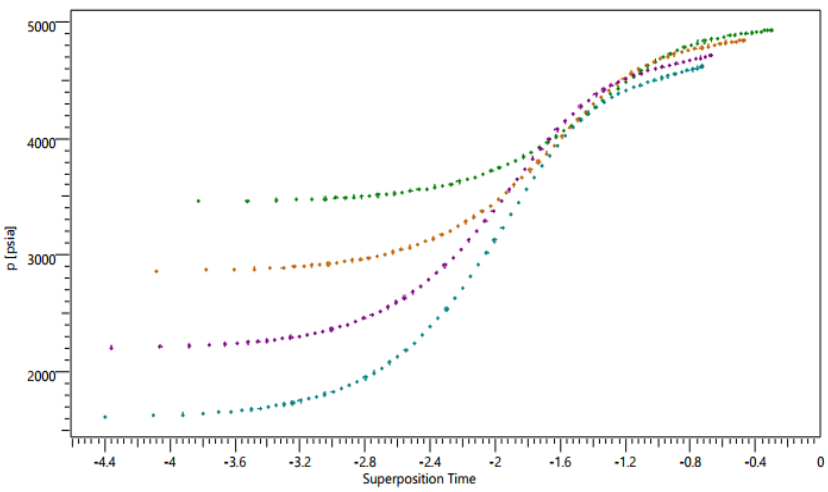

Figure 4. Superposition plot

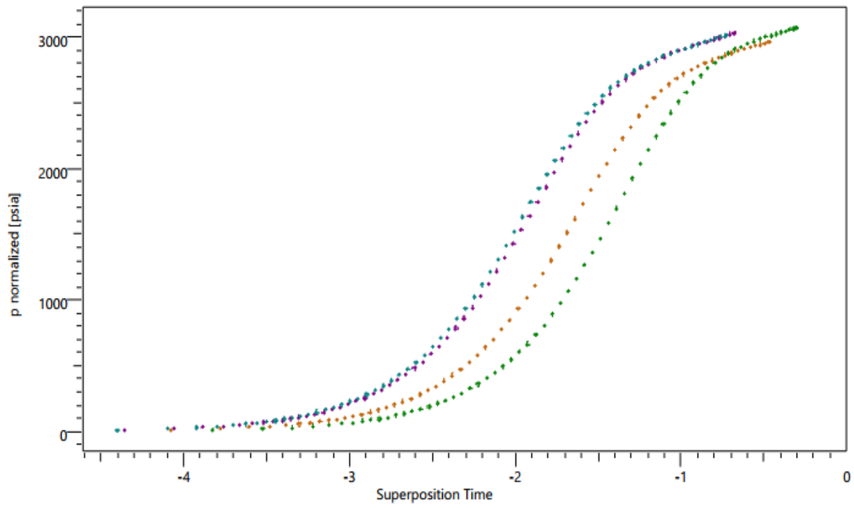

Figure 5. Rate normalized superposition plot

Using conventional well test interpretation techniques, a qualitative view of any build-up in Fig.3 shows only two flow regimes, infinite acting radial flow which is characterized by a horizontal line on the pressure derivative plot and wellbore dominated flow which is characterized by a unit slope on both log-log plots. This might lead us to believe that the reservoir is infinite acting, whereas history matching the data Fig.6, Fig.7 and Fig.8 show otherwise. Fig.6 shows that although the infinite acting model fits the early and middle time data, it does not fit the late time buildup data of the log-log diagnostic plot of the selected buildup.

Figure 7 shows that the model does not match the late time buildup of the history plot. From the superposition plot shown in Fig 8 it is seen that like the diagonostic plot, the model only matches the early and middle time data but does not match the late time data on the superposition plot. In other words, the infinite acting radial model does not match the test data and the data is affected by boundary effects. However, selecting a model with a boundary based on the given test data may result in the reservoir engineer selecting several possible models to see which best matches the data. This is where the use of deconvolution may prove advantageous already as the system was chosen carefully to be a linear system.

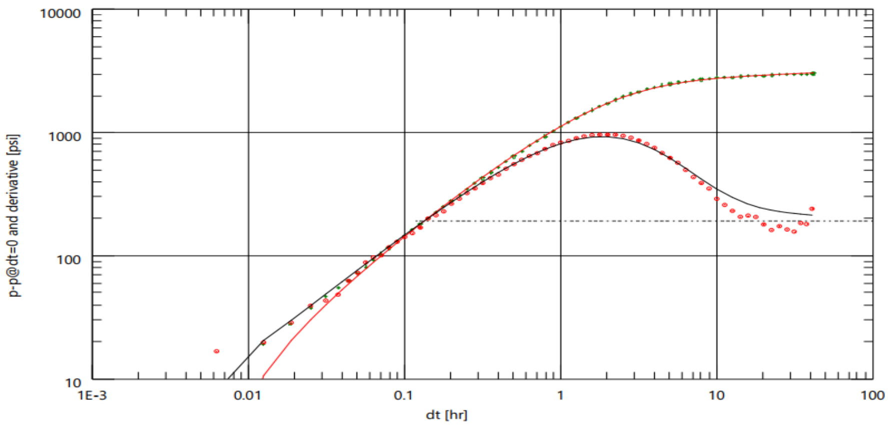

Figure 6. log-log diagonostic plot of noisy data showing model match

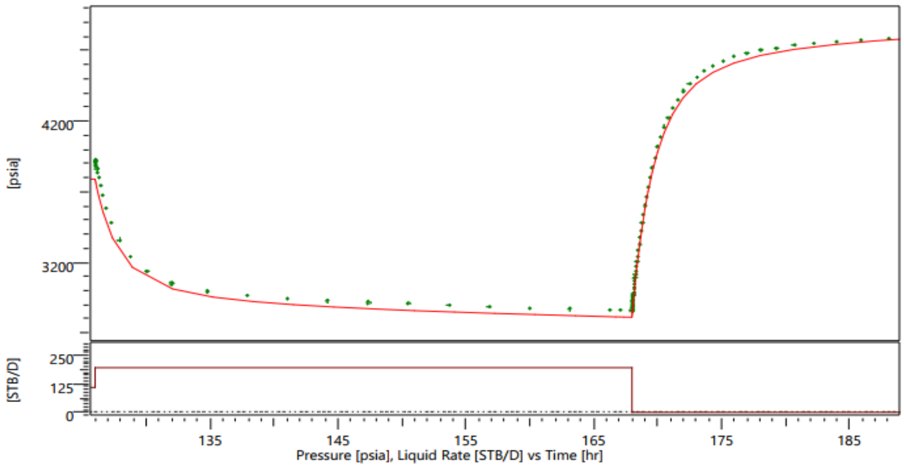

Figure 7. Zoom on History plot showing model match of noisy data

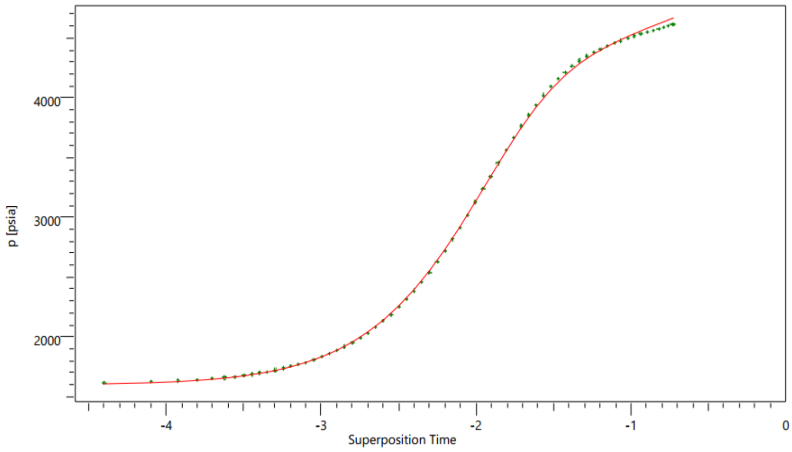

Figure 8. Superposition plot showing model match of noisy data

Figure 9 shows the log-log diagnostic plot of the deconvolve response. From this plot it is seen that for about 50 hours there exist a boundary dominated flow regime which is most likely due to the presence of a sealing fault effectively narrowing down the list of possible boundary models. Hence it can be said that deconvolution increases the amount of information that can be analyzed with pre-existing methods.

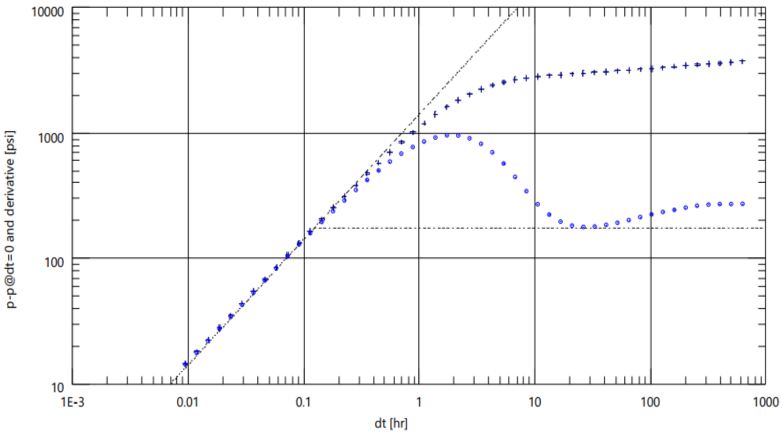

Figure 9. Log-Log diagnostic plot of deconvolve noisy data.

The superposition plot for the deconvolve response shown in Fig 10 does not resemble that of a buildup, instead it resembles that of a drawdown this is because the deconvolution process produces a constant rate pressure response.

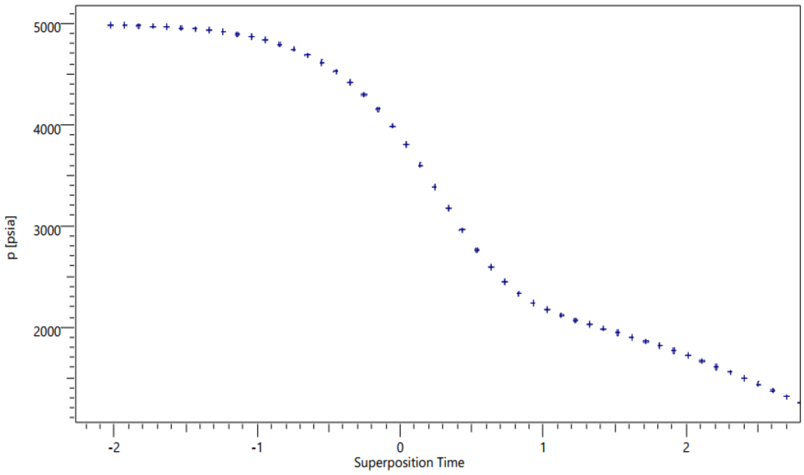

Figure 10. Superposition plot of the deconvolve response

The model match of the deconvolve data on the superposition and log-log diagnostic plots is shown in Fig.11 and Fig.12 respectively while Fig.13 is the history plot showing the deconvolve pressure (black), the deconvolve rate (red) and observed pressure response model match (green). The model match in Fig.11 and Fig.12 are acceptable. While the model in Fig.13 matches all the buildups perfectly but does not produce a perfect match on the drawdown data. This may be attributed to the fact that deconvolution is carried out on the whole rate history using pressure data from only the four buildups.

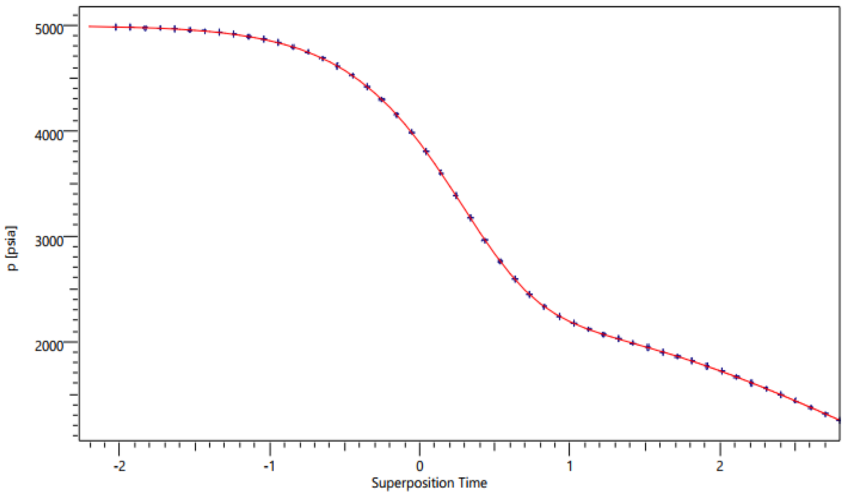

Figure 11. Superposition plot of the deconvolve data showing model match

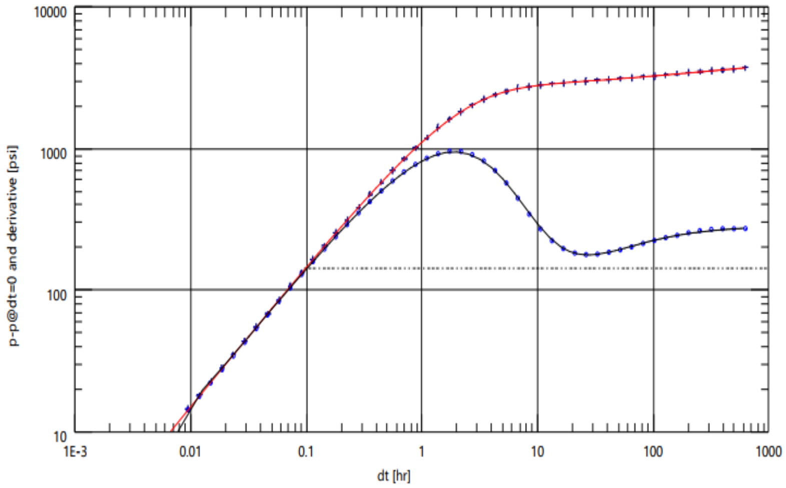

Figure 12. Log-Log diagnostic plot of the deconvolve data showing model match

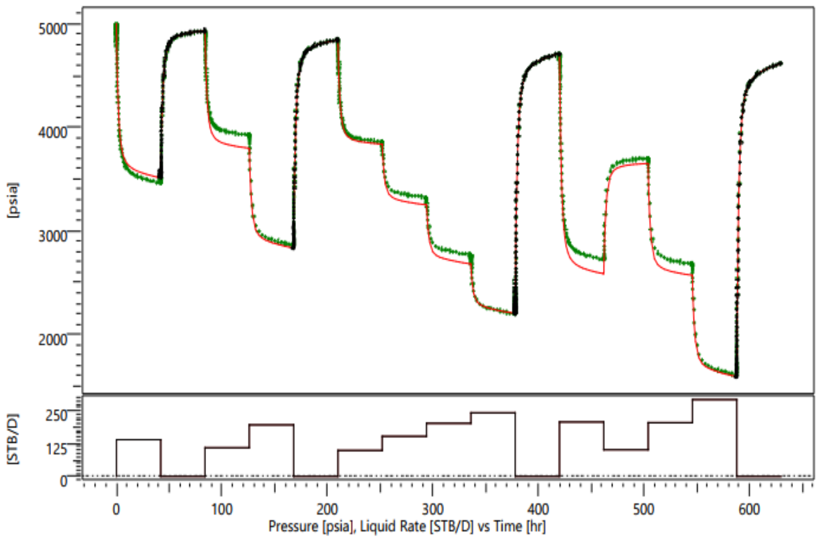

Figure 13. History plot showing the deconvolve pressure (black), the deconvolve rate (red) and the observed pressure response (green)

Table 4 shows the percentage deviation between deconvolve model match values and actual values. From the table it is seen that the deviations are within acceptable engineering limits.

Table 4. Comparison between model match values and actual values.

Parameter	**Model match value**	**Actual value**	**% Deviation**
Skin	3.23	3	7.7
Flow capacity (Kh)	396	400	-1.0
Wellbore storage coefficient	0.00972	0.01	-2.8
Initial reservoir pressure	4996.9	5000	-0.062
Distance to fault	409	400	2.25

4. Conclusion

A demonstration of the use of non-linear deconvolution in analyzing relatively short variable rate well test data has been carried out using sapphire's test design module and python programming language. The results show as indicated by the log-log diagnostic plot that deconvolution avails more data for selecting an interpretation model.

Deconvolution carried out on the simulated data indicated the presence of a sealing fault boundary model unidentifiable with conventional techniques. Similarly, based on the deconvolve data the following parameters were estimated; skin (3.28), wellbore storage coefficient (0.00972 bbl/psi), flow capacity (396 md.ft), initial reservoir pressure (4996.9 psi) and distance to fault boundaries (409 ft). The deviations between these model match parameters and actual reservoir parameters used in simulation was shown to have an absolute value less than 8%.

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Effect of Vertical Elastic Design Spectral Obtained According to Different Soil Classes on Beam Behavior and Comparison of Vertical Component of K.Maras Earthquake with Beam Effect

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Abstract- In practice and theory, many types of reinforced concrete slabs are used, such as beamed, beamless, and ribbed slabs. Beamed floors are connected to the columns by means of beams, and their vertical and horizontal loads are transferred to the columns through these beams. Therefore, beams are accepted as an important structural element by earthquake experts and many formulas and approaches have been developed in terms of horizontal and vertical load effects that occur in order to transfer the load transfer to the elements as desired. In this study, beam shear forces that occur under the influence of vertical earthquakes at the i and j ends of the beams of a fictional building whose floors are modeled according to the rigid diaphragm assumption in the ETABS were investigated. In this study, the shear forces that occur in the beams of a fictionally designed building under the effect of vertical earthquakes, and the floors carried by the beams are examined by designing with the assumption of a rigid diaphragm. The structure is designed with 3 openings in the X and Y directions and each opening is equal and 5 m. The 5-storey building has been designed to have equal floor heights of 3 m. The structure was obtained by using parameters belonging to 5 different soil classes as ZA, ZB, ZC, ZD, ZE, and 5 different vertical elastic design spectrums represented by the abbreviations EZ_ZA, EZ_ZB, EZ_ZC, EZ_ZD were activated in the ETABS. Seismic station coordinates numbered 4631 in K.Maras/Elbistan were used to obtain the parameters to be used in obtaining the vertical elastic design spectral of the structure. These coordinates were selected in order to compare the i and j end shear forces of the beam with the previously obtained beam i and j ends shear forces by influencing the Mw:7.6 Elbistan earthquake recorded by the seismic station to the building. Since the structure is symmetrical in both X and Y directions, the results obtained from beams B2, B3, B5, B19 represent the beam shear forces occurring at the i and j ends of all beams of the structure. As a result, it has been seen that the highest values of beam i and j end shear forces, obtained by affecting both the vertical elastic design spectral and the data of the vertical component of the Elbistan Mw:7.6 earthquake, were obtained on the 5th floor, which is the top floor of the building. The structure showed similar behavior among the different vertical elastic design spectral, and the highest value was obtained for each vertical elastic design spectrum at the 5th floor. Among these vertical elastic design spectral, the EZ_ZC spectrum gave the highest value at the 5th floor of the building. When the EZ_ZC vertical elastic design spectrum beam i and j end shear forces are compared with the beam i and j end shear forces of the vertical component data of the Elbistan Mw:7.6 earthquake, it is seen that the difference is not significant. It has been seen that the beam i and j end shear force value of the spectrum is higher than the shear force value.

Keywords: Shear force, TBER, Elbistan, Earthquake, Vertical Earthquake Component.

1. Introduction

The loads on which the structure will be constructed may vary according to the conditions of the region. These conditions that will affect the building are determined, regulated and published in a way that is closed to interpretation by the management of the region where the building is located. Mnistry of Environment, Urbanization and Climate Change has undertaken this task in Turkey and has published many regulations such as TS500, TS498, and Turkey Building Earthquake Regulation (TBER).
Although there are design, calculation and dimensioning codes of reinforced concrete structures according to the purpose and duration of use of the structure according to the TS500 standard, this standard does not cover the design of all reinforced concrete structures.[1] TS498 clarifies the definition of moving loads such as wind, snow and ice to be used in buildings. [2] TBER, on the other hand, includes methods and guidelines to be used in the design, calculation and dimensioning of structures under earthquake risk [3]. This standard clarifies the methods to be used for building structures intended to be designed in areas with earthquake risk. The first of the methods is to deal with the slab primarily according to the elastic design acceptance and to make the calculations in this way, and in the next step, where the earthquake load will be applied eccentrically in the regulation, the slab will be solved according to the rigid diaphragm acceptance and the data will be evaluated in this context. The second method is to dissolve the slab in a single step according to the rigid diaphragm acceptance. It is expected that the slab, which is expected to behave as a rigid diaphragm in these assumptions to be made in the design phase of the slabs, especially the horizontal loads will be transferred to the columns in proportion to the stiffness of the columns, so slab-column connections gain importance.
In this study, the shear force values occurring at the i and j ends of the beams of a fictional building whose floors are designed according to the rigid diaphragm assumption will be examined. The building to be modeled in the study has equal spans in the X and Y directions, and each span is determined as 5 m. Again, the building was designed as 5 floors and all floor heights were determined as equal and 3 m. In the first stage, 5 different vertical elastic design spectrums, represented by the abbreviations EZ_ZA, EZ_ZB, EZ_ZC, EZ_ZD, were obtained by using parameters belonging to 5 different floor classes as ZA, ZB, ZC, ZD, ZE, and in this article, 5 different vertical elastic design spectral were applied to the building with the Etabs program and for each floor. The shear forces at the beam i and j ends will be obtained. In the later stages of the study, the vertical component data of the 7.6 Mw earthquake in Elbistan will be affected by the seismic station 4631 and shear forces at the beam i and j ends will be obtained. In the conclusion part, the obtained data will be compared and analyzed.
Since the structure is symmetrical in the X and Y directions in the study, B2, B3, B5, B19 type beams represent the entire structure.
In beamed floors, floors are connected to the columns by beams and their horizontal and vertical loads are transferred through these beams. For this reason, beams are accepted as an important structural element by construction experts and methods to be used in design are investigated.

1.1. Literature Survey

It is seen that the studies carried out to understand the importance of the effect of the vertical earthquake component on the behavior of the structure and to emphasize this importance are limited in the literature records. However, even in these limited studies, it has been emphasized that the vertical seismic component is an important dynamic component in the building design. In this context, when we look at the records of the last 10 years, one of the most important studies;
The effect of the vertical earthquake component on the derailment of the railway vehicles was investigated and it was determined that the vertical earthquake component increased the probability of derailment of the railway vehicles [4].
In another study, firstly, the horizontal component of the acceleration records obtained from seven strong ground motions was applied to the 3- and 7-storey buildings, and then the vertical component was added to these forces. While it is assumed that the vertical component of the earthquake effect has a significant effect on the axial force of the column under study, it has been determined that there is no significant effect on the column shear force and nodal points [5].
In another work, the effect of the vertical earthquake effect on high-rise buildings was examined. According to the non-linear analysis results in the time domain, it was determined that vertical earthquake motion did not have a significant effect on the relative story drift, overturning moment and base shear force, and increased by 20% in both tensile and compressive stresses in the near-field regions in column axial forces. When only the increase in compressive stresses was observed, it was determined that the values of this increase were approximately 105%, 57% and 68% of the axial capacity of the column according to the A, B and C soil classes, respectively [6].
In addition, in a different study, when the effect of the vertical earthquake component on the steel-concrete plate composite beam bridge was investigated, it was determined that the axial force of the bridge columns and pillars was significantly higher than the shear force and bending moment. As a result of the studies, it was emphasized that the vertical earthquake component should be taken into account, especially in steel-concrete plate composite beam bridges in near-fault regions [7].
In the study conducted on inclined bridges, it was found that the lateral displacement of the bridge slab was 21% higher in case the ratio of the vertical component to the horizontal component values in earthquake components is 2/3 (V/H=2/3) in bridges with this form, and the impact frequency is found in different bridge piers. It has been found that different values were given [8].
The possible vertical split of the bridge and the structural damage in the split were calculated by superpositioning the calculations under the influence of vertical and horizontal earthquakes in the 2-span continuous bridge modeled by the researchers who theoretically examined the multiple splitting of the bridge under the influence of vertical earthquakes in the near region. In the calculations made using the transition wave

characteristic function and indirect mode superposition methods, it has been observed that the splitting in high-pier bridges widens the deformation and even causes damage to the bridge pier. It has been determined that the seismic wave affects the deformation of the bridge piers in external effects such as the time to reach the structure and the strength of the supports, and in addition to these, the number of divisions will affect the seismic response occurring in the bridge pier [9].
In accordance with the observation of past earthquake effects, the seismic performance of the structure and the possibility of collapse were examined, especially by affecting the vertical earthquake effect on a reinforced concrete structure. For this purpose, the behavior of three high reinforced concrete frame-core wall structures under bidirectional ground motion is discussed. In the study, in which incremental dynamic analysis was applied, slenderness curves covering both horizontal and vertical earthquake effects were obtained. As a result, in the buildings where the vertical and horizontal earthquake effects were applied together, the collapse criteria were met at low density measurements; It has been seen that the risk of collapse increases due to the two-way earthquake effect that the structure is exposed to, and the seismic performance obtained in this way allows a more accurate evaluation [10].

2. Methology

2.1. Soil classes and other parameters according to TBER

Methods specified in TBER should be used to obtain the elastic design spectral of different soil classes. In order to obtain the earthquake design spectral of different soil classes by using the earthquake code, the properties of the ground on which the building will be built should be determined according to Table 2-I. In the next step, local ground effect coefficient Fs will be obtained by using Table 2-II and local ground effect coefficient F1 for 1s period will be obtained using Table 2-III.

Table 2 I. Local Ground Classification [1].

Local Ground Class	**Ground Type**	**Average in the upper 30 m**		
		(Vs)30 [m/s]	**(N60)30 [pulse/30 cm]**	**(Cu)30 [kPa]**
ZA	Solid hard rocks	>1500	-	-
ZB	Slightly segregated medium solid rocks	760-1500	-	-
ZC	Very tight layers of sand, gravel, and hard clay, or segregated, very fractured weak rocks	360-760	>50	>250
ZD	Medium-density sand, gravel or multi-layered clay layers	180-360	15-50	70-250
ZE	Profiles containing loose sand, gravel or soft-solid clay layers or a total of more than 3 meters of soft clay layer (Cu<25 kPa) satisfying PI>20 and W>40% conditions	<180	<15	<70
ZF	Soils requiring site-specific investigation and evaluation; 1)Soils requiring earthquake effect investigation and evaluation (liquefiable soils, highly sensitive clays, collapsible weak cement soils, etc.) 2)Clays with a total thickness of more than 3 meters of peat and/or high organic content, 3)Clays of high plasticity (PI>50) with a total thickness of more than 3 m, 4)Very thick (<35m) soft or medium solid clays ZD ZE ZF			

Table 2 II. Local ground effect coefficient for the short period region [2].

Local Ground Class	**Local ground effect coefficiency for short period region F_S**					
	$S_S \leq 0.25$	**$S_S = 0.25$**	**$S_S = 0.50$**	**$S_S = 0.75$**	**$S_S = 1.00$**	**$S_S = 1.50$**
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 ground behavior analysis will be performed.					

Table 2 III. Local ground effect coefficient for 1 s period [2]

Local Ground Class	**Local ground effect coefficiency for 1 s period F_1**					
	$S_1 \leq 0.10$	**$S_1 = 0.20$**	**$S_1 = 0.30$**	**$S_1 = 0.40$**	**$S_1 = 0.50$**	**$S_1 = 0.60$**
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	1.4
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 ground behavior analysis will be performed.					

The map spectral acceleration coefficient (Ss) for the short period and S1 for the 1 s period can be obtained from the website **(tdth.afad.gov.tr)** made available by AFAD. By using these obtained data, short period design spectrum acceleration coefficient SDS and design spectrum acceleration coefficient SD1 for 1 s period were obtained by using Equation X.x.

SDS=SS x FS 2.I [2]
SD1=S1 x F1 2.II [2]

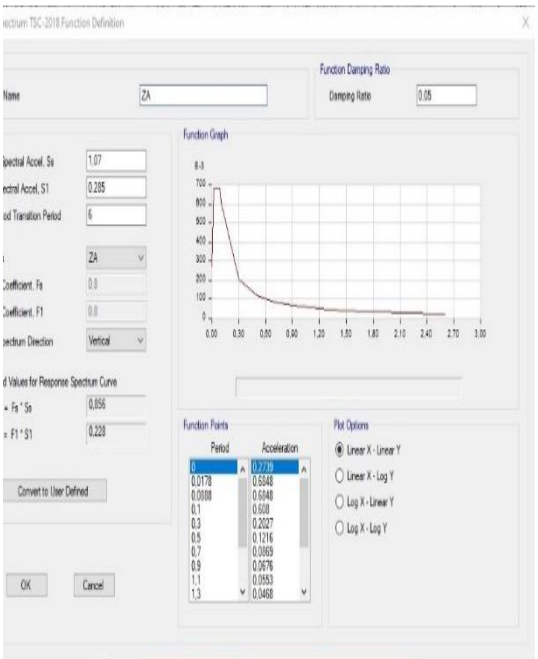
Design spectrum acceleration coefficients of 5 different soil classes, which were attained according to the earthquake code and entered into the ETABS to be used in the analysis, were given in Table 2-IV. In order to obtain these data, 37.38676 latitude and 37.13803 longitude coordinates belonging to the seismic station numbered 4631 were entered into the earthquake hazard map interface on website.

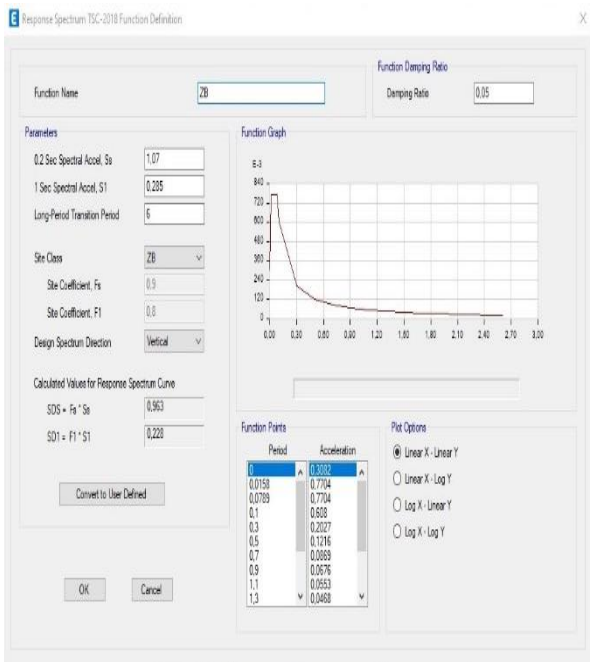
Table 2 IV. Spectrum acceleration coefficients attained according to different soil classes.

Local Ground Class	S1	SS	F1	FS	SD1	SDS	TA	TB	TL	TAD	TBD	TLD
ZA	0.285	1.07	0.8	0.8	0.228	0.856	0.053	0.266	6	0.018	0.089	3
ZB	0.285	1.07	0.8	0.9	0.228	0.963	0.047	0.237	6	0.016	0.079	3
ZC	0.285	1.07	1.5	1.2	0.428	1.284	0.067	0.333	6	0.022	0.111	3
ZD	0.285	1.07	2.03	1.072	0.579	1.147	0.101	0.504	6	0.034	0.168	3
ZE	0.285	1.07	2.875	1.044	0.819	1.117	0.147	0.733	6	0.049	0.244	3

2.2. Defining Response Spectral in ETABS

Design spectrum acceleration coefficient values for five different soil classes were defined in the fields specified in the response spectrum definition interface of Etabs, and vertical elastic response spectral were obtained for five different soil classes.





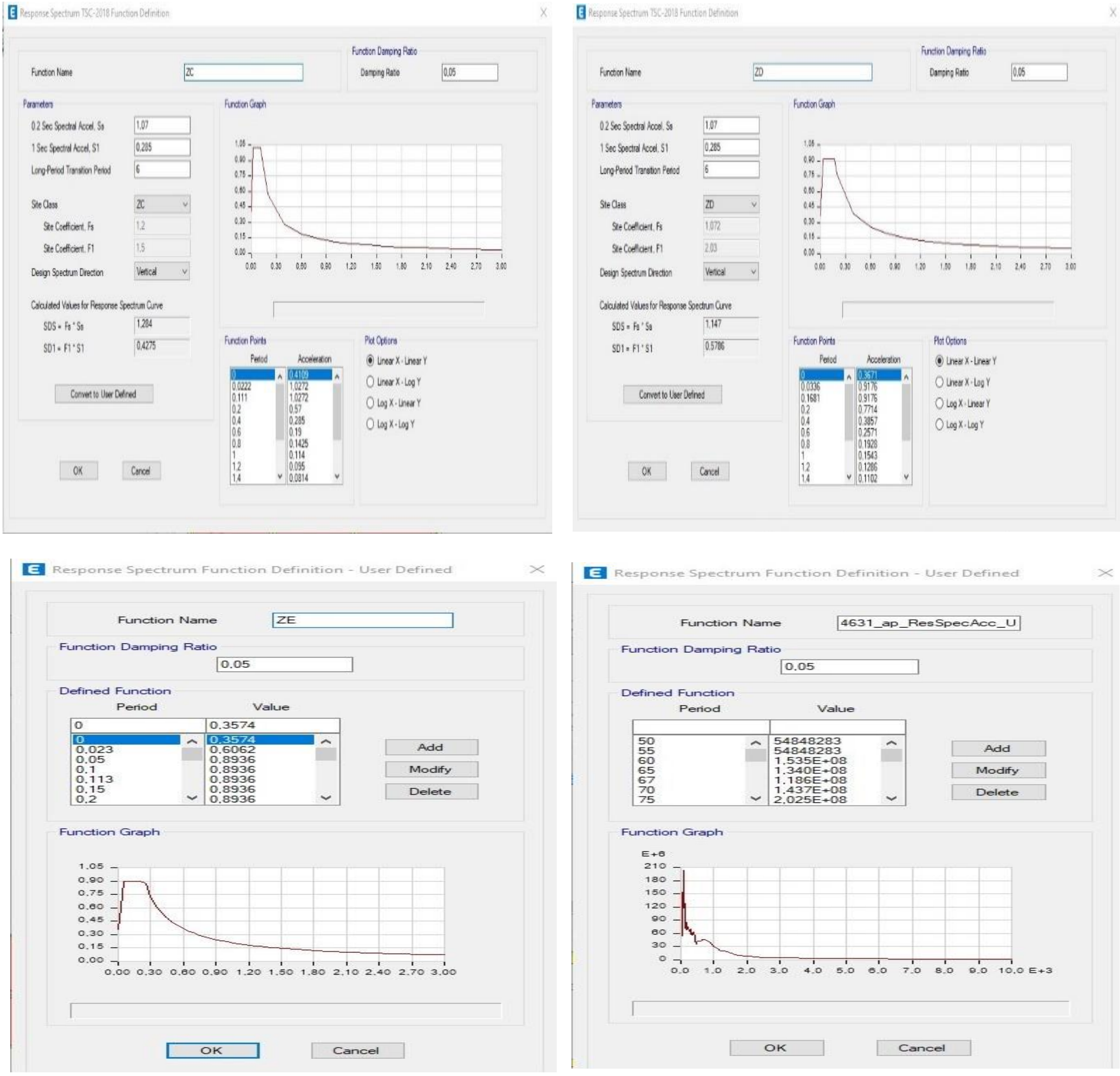


Figure 2 1. Vertical elastic design spectral and spectrum definition for Elbistan earthquake.

3. Modeling of the Building And Assigning Loads To Structural Elements

The columns of the building to be used in the analysis were chosen as 40x40 cm type columns. The beams of the building to be used in the analysis were determined as 25x50 cm type beams. Floor thickness was determined as equal and 12 cm slab for each floor. No foundation design was made for the building, and the columns were fixed to the ground with built-in supports. Earthquake curtains were not used in the building. The loads on the structure have been determined by considering the TS498 standard. Loads on the structure are given in Table 2-V.

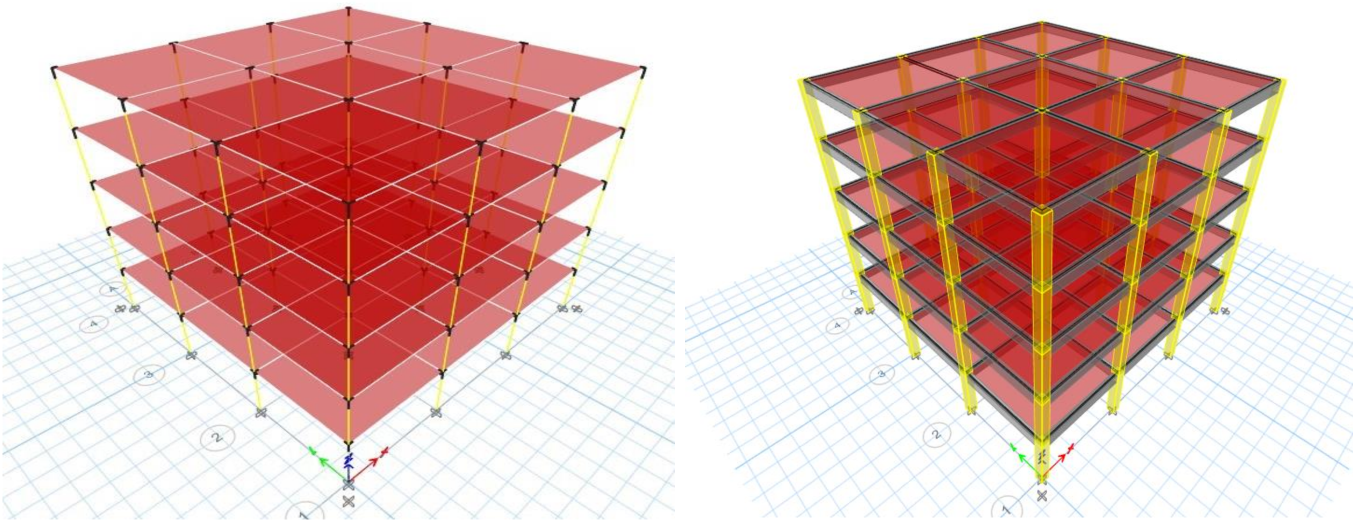


Figure 3 1. Bar model of the building to be used in the analysis and its visualization in 3D in the ETABS.

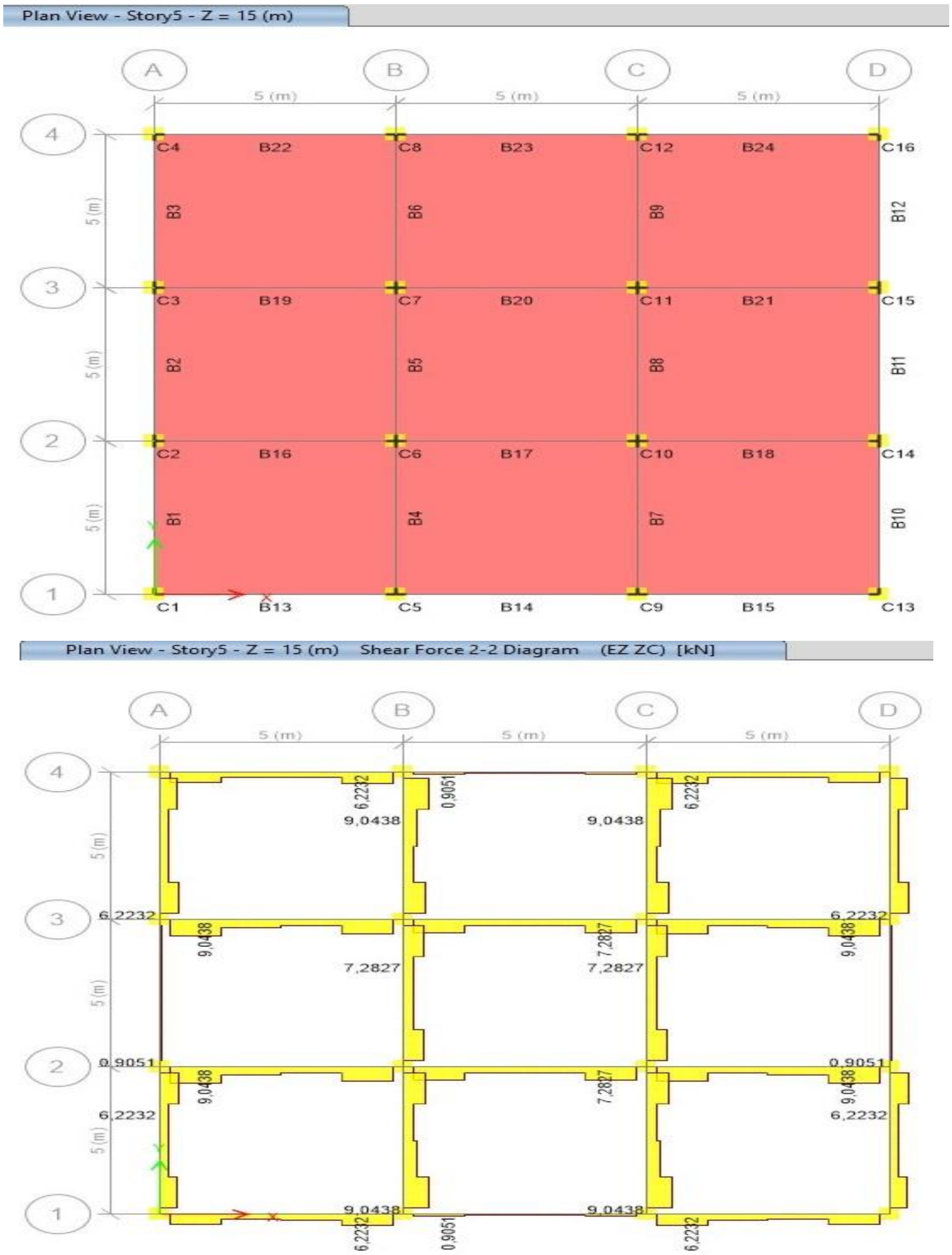
Table 3 V. Loads on the structure and their values.

Load Type	Symbol	Unit	Magnitude
Self–Weight	G	kN	software-defined
Live load (floor)	Q	kN	2
Live load (Roof)	Q	kN	1.5
wind Load	W	kN	software-defined
Snow Load	S	kN	1.48
Super Dead Load	Wall	kN/m	1.5
Super Dead Load	Cover	kN/m^2	0.25

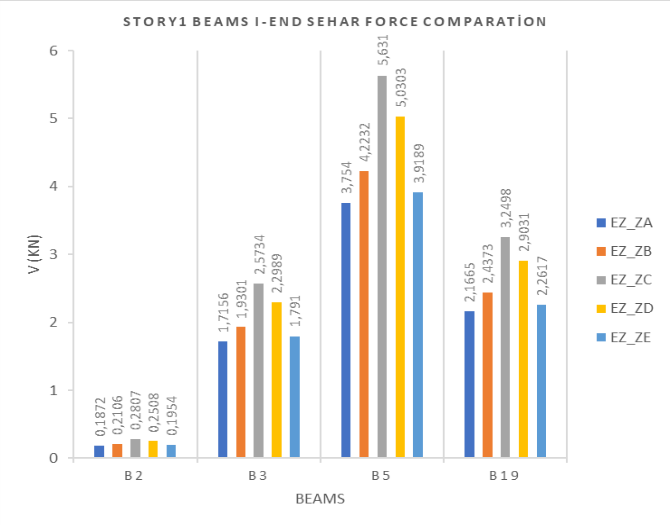
4. Conclusion

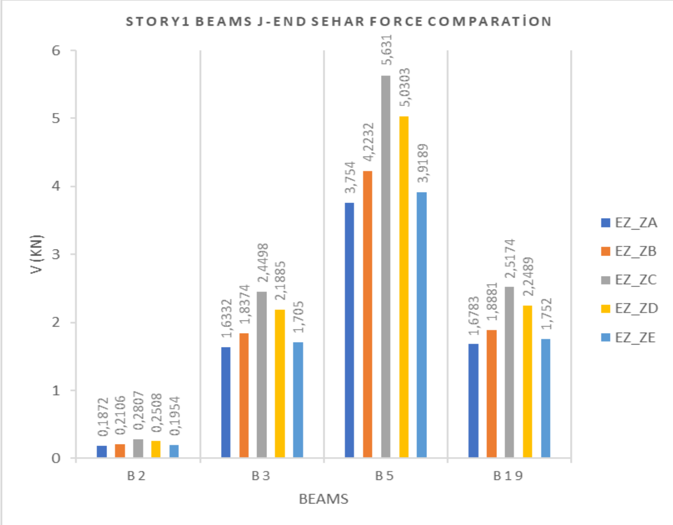
As a result of the analysis, the vertical elastic design spectrum obtained by using the ZC soil class with the highest shear force at the beam i and j ends was obtained in B2, B3, B5, B19 type beams at the 5th floor by the effect of EZ_ZC. Under the influence of the vertical elastic design spectrum, the shear forces at the beam i and j ends are visualized in Graph 3-1. When the values in Chart 3-1 are examined, the highest shear forces at beam i and j ends at the first, second, third and fourth floors under the influence of EZ_ZC vertical elastic design spectrum are 4.61 kN, 5.28 kN, 5.93 in B5 beam, respectively. kN was determined as 5.63 kN. In the fifth floor, under the effect of EZ-ZC spectrum, the highest shear force at beam i and j end was obtained in B19 beam as 7.93 kN. For B3 and B19 beams, the shear forces of beam i and j end were obtained differently at each floor. However, the behavioral responses of the beams under the influence of the vertical elastic design spectral at each floor are the same, and the shear forces of the beam i and j ends can vary according to the quantitative values of the spectrum. In other words, the most stressed beam on any floor is the same for all design spectral, but the most stressed beam on every floor is not the same.

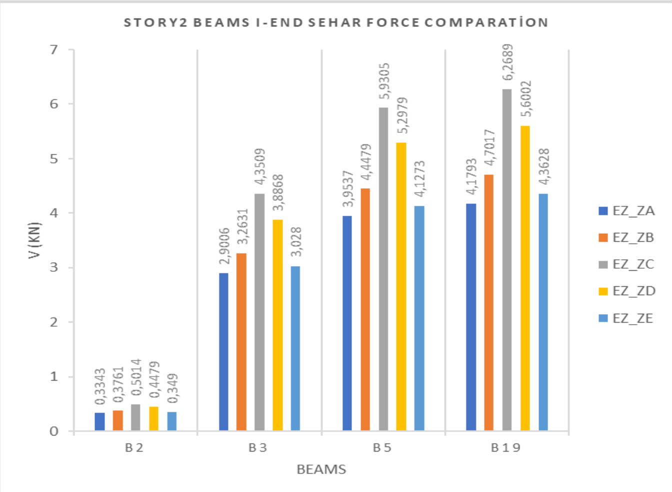
The next stage of the study is the analysis made by influencing the vertical response spectrum obtained using the vertical earthquake component of the Mw:7.6 Elbistan earthquake. By influencing the vertical response spectrum of the Elbistan earthquake, the highest beam i and j end shear forces were again obtained on the 5th floor of the building. From this point of view, when the beam i and j end shear forces obtained by influencing the vertical response spectrum of the 5th floor Elbistan earthquake and the beam i and j end shear forces obtained by effecting the EZ_ZC spectrum are compared, it is seen that the difference is negligible. Table 3-I. However, the highest value of the beam i and j end shear forces obtained with the vertical elastic design spectral and the Elbistan earthquake vertical earthquake spectrum used in the study was obtained by influencing the Elbistan earthquake vertical earthquake spectrum.

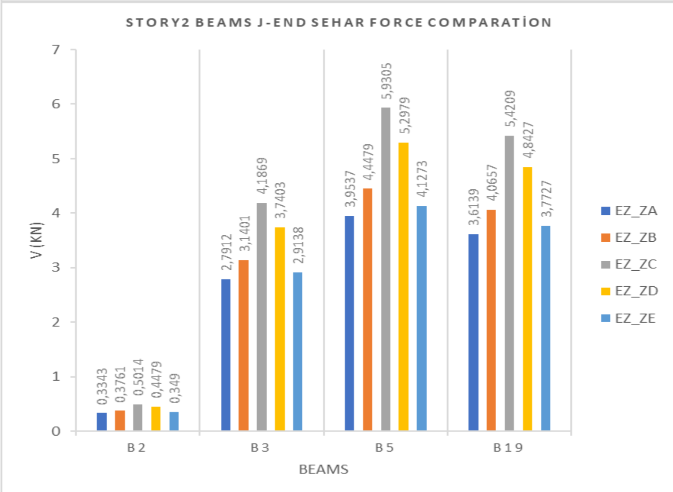


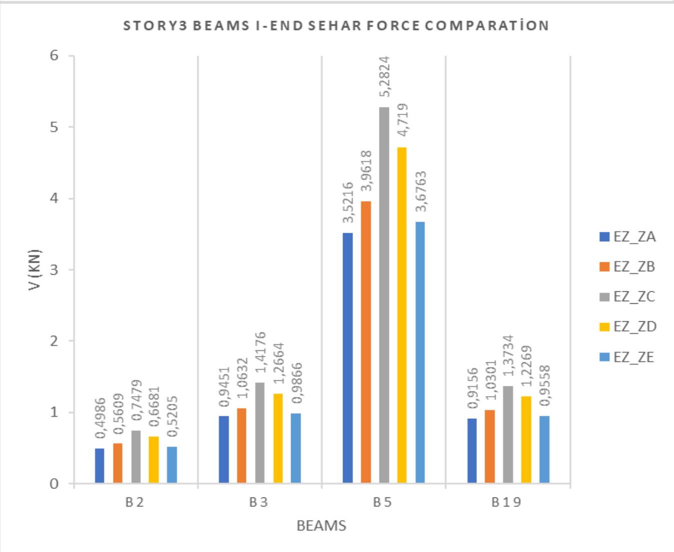
Figüre 4 1. Plan view and shear force values of beam i and j ends (Story 5).

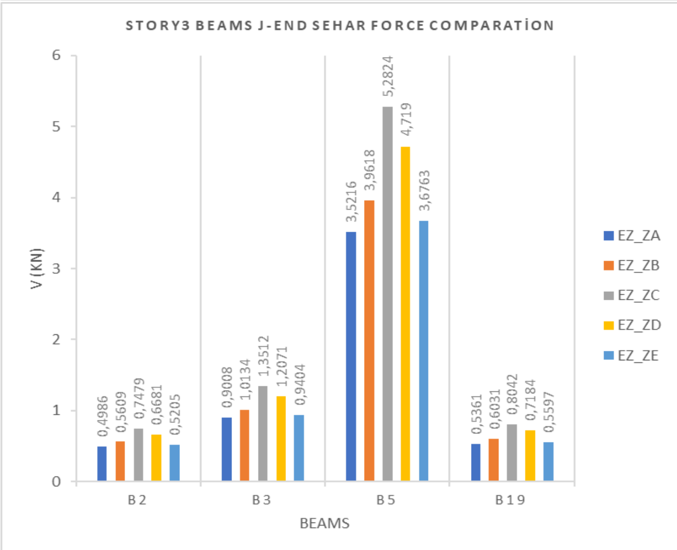

STORY1 BEAMS I-END SEHAR FORCE COMPARATİON
V (KN)
0
1
2
3
4
5
6
0,1872
0,2106
0,2807
0,2508
0,1954
1,7156
1,9301
2,5734
2,2989
1,791
3,754
4,2232
5,631
5,0303
3,9189
2,1665
2,4373
3,2498
2,9031
2,2617
B2
B3
B5
B19
BEAMS
EZ_ZA
EZ_ZB
EZ_ZC
EZ_ZD
EZ_ZE


STORY1 BEAMS J-END SEHAR FORCE COMPARATİON
V (KN)
0
1
2
3
4
5
6
0,1872
0,2106
0,2807
0,2508
0,1954
1,6332
1,8374
2,4498
2,1885
1,705
3,754
4,2232
5,631
5,0303
3,9189
1,6783
1,8881
2,5174
2,2489
1,752
B2
B3
B5
B19
BEAMS
EZ_ZA
EZ_ZB
EZ_ZC
EZ_ZD
EZ_ZE


STORY2 BEAMS I-END SEHAR FORCE COMPARATİON
V (KN)
0
1
2
3
4
5
6
7
0,3343
0,3761
0,5014
0,4479
0,349
2,9006
3,2631
4,3509
3,8868
3,028
3,9537
4,4479
5,9305
5,2979
4,1273
4,1793
4,7017
6,2689
5,6002
4,3628
B2
B3
B5
B19
BEAMS
EZ_ZA
EZ_ZB
EZ_ZC
EZ_ZD
EZ_ZE


STORY2 BEAMS J-END SEHAR FORCE COMPARATİON
V (KN)
0
1
2
3
4
5
6
7
0,3343
0,3761
0,5014
0,4479
0,349
2,7912
3,1401
4,1869
3,7403
2,9138
3,9537
4,4479
5,9305
5,2979
4,1273
3,6139
4,0657
5,4209
4,8427
3,7727
B2
B3
B5
B19
BEAMS
EZ_ZA
EZ_ZB
EZ_ZC
EZ_ZD
EZ_ZE


STORY3 BEAMS I-END SEHAR FORCE COMPARATİON
V (KN)
0
1
2
3
4
5
6
0,4986
0,5609
0,7479
0,6681
0,5205
0,9451
1,0632
1,4176
1,2664
0,9866
3,5216
3,9618
5,2824
4,719
3,6763
0,9156
1,0301
1,3734
1,2269
0,9558
B2
B3
B5
B19
BEAMS
EZ_ZA
EZ_ZB
EZ_ZC
EZ_ZD
EZ_ZE


STORY3 BEAMS J-END SEHAR FORCE COMPARATİON
V (KN)
0
1
2
3
4
5
6
0,4986
0,5609
0,7479
0,6681
0,5205
0,9008
1,0134
1,3512
1,2071
0,9404
3,5216
3,9618
5,2824
4,719
3,6763
0,5361
0,6031
0,8042
0,7184
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B3
B5
B19
BEAMS
EZ_ZA
EZ_ZB
EZ_ZC
EZ_ZD
EZ_ZE

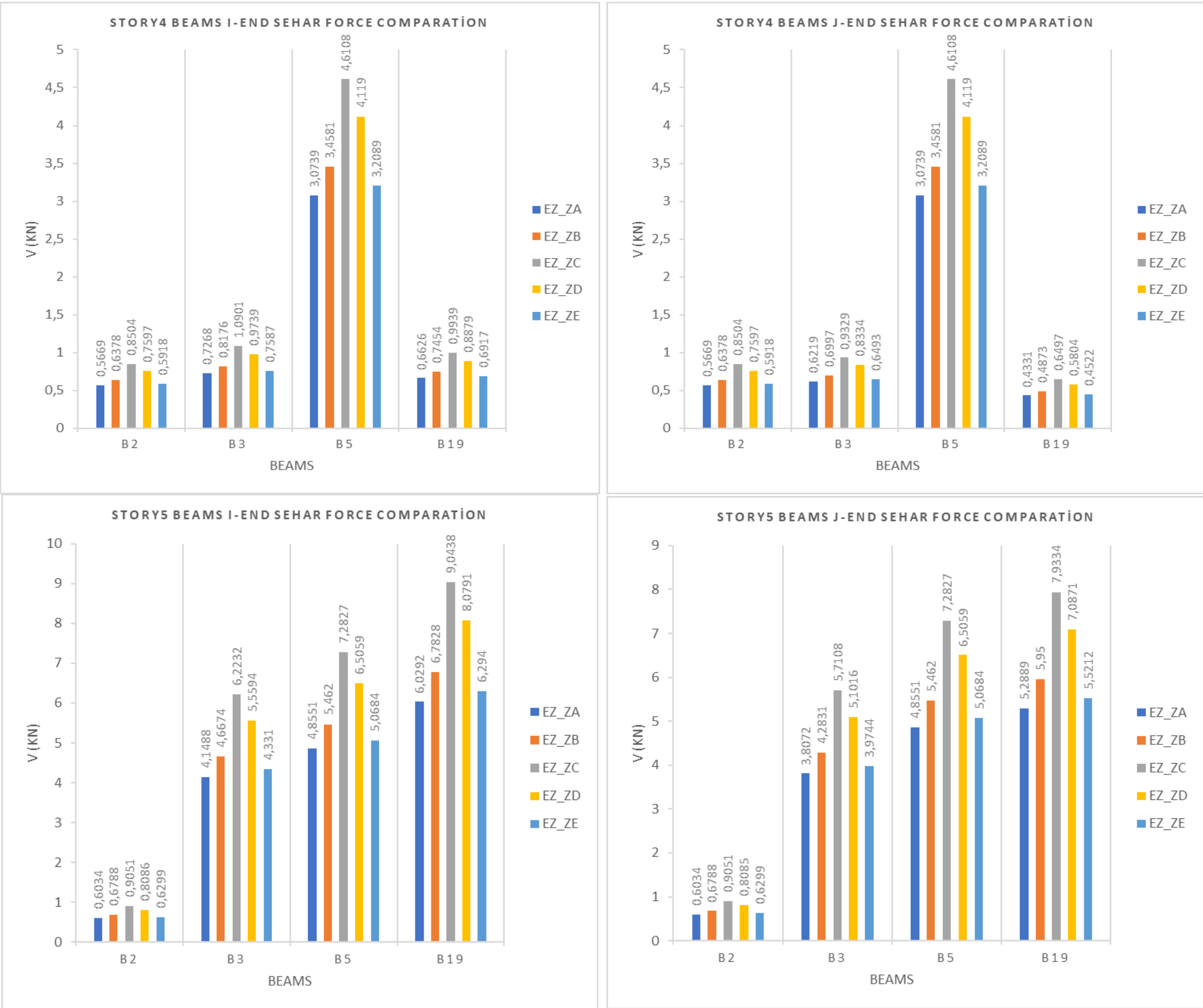

Figure 4 1. Comparison of the i and j ends shear force of B2, B3, B5, B19 type beams for all floors.

Table 4 I. Numerical comparison of the beam i and j end shear force values obtained at the 5th floor using the Elbistan vertical earthquake spectrum and the EZ_ZC spectrum.

	Ground Class = ZC		**Location = K.Maras**		**Ratio**	
Beams	**i**	**j**	**i**	**j**	**c/a**	**d/b**
İndex	**a**	**b**	**c**	**d**		
B1	5.71	6.22	5.91	6.44	1.03	1.03
B2	0.91	0.91	0.94	0.94	1.04	1.04
B3	6.22	5.71	6.44	5.91	1.03	1.03
B4	9.04	7.93	9.36	8.21	1.03	1.04
B5	7.28	7.28	7.51	7.51	1.03	1.03
B6	7.93	9.04	8.21	9.36	1.04	1.03
B7	9.04	7.93	9.36	8.21	1.03	1.04
B8	7.28	7.28	7.51	7.51	1.03	1.03
B9	7.93	9.04	8.21	9.36	1.04	1.03
B10	5.71	6.22	5.91	6.44	1.03	1.03
B11	0.91	0.91	0.94	0.94	1.04	1.04
B12	6.22	5.71	6.44	5.91	1.03	1.03
B13	5.71	6.22	5.91	6.44	1.03	1.03
B14	0.91	0.91	0.94	0.94	1.04	1.04
B15	6.22	5.71	6.44	5.91	1.03	1.03
B16	9.04	7.93	9.36	8.21	1.03	1.04
B17	7.28	7.28	7.51	7.51	1.03	1.03
B18	7.93	9.04	8.21	9.36	1.04	1.03
B19	9.04	7.93	9.36	8.21	1.03	1.04
B20	7.28	7.28	7.51	7.51	1.03	1.03
B21	7.93	9.04	8.21	9.36	1.04	1.03
B22	5.71	6.22	5.91	6.44	1.03	1.03
B23	0.91	0.91	0.94	0.94	1.04	1.04
B24	6.22	5.71	6.44	5.91	1.03	1.03

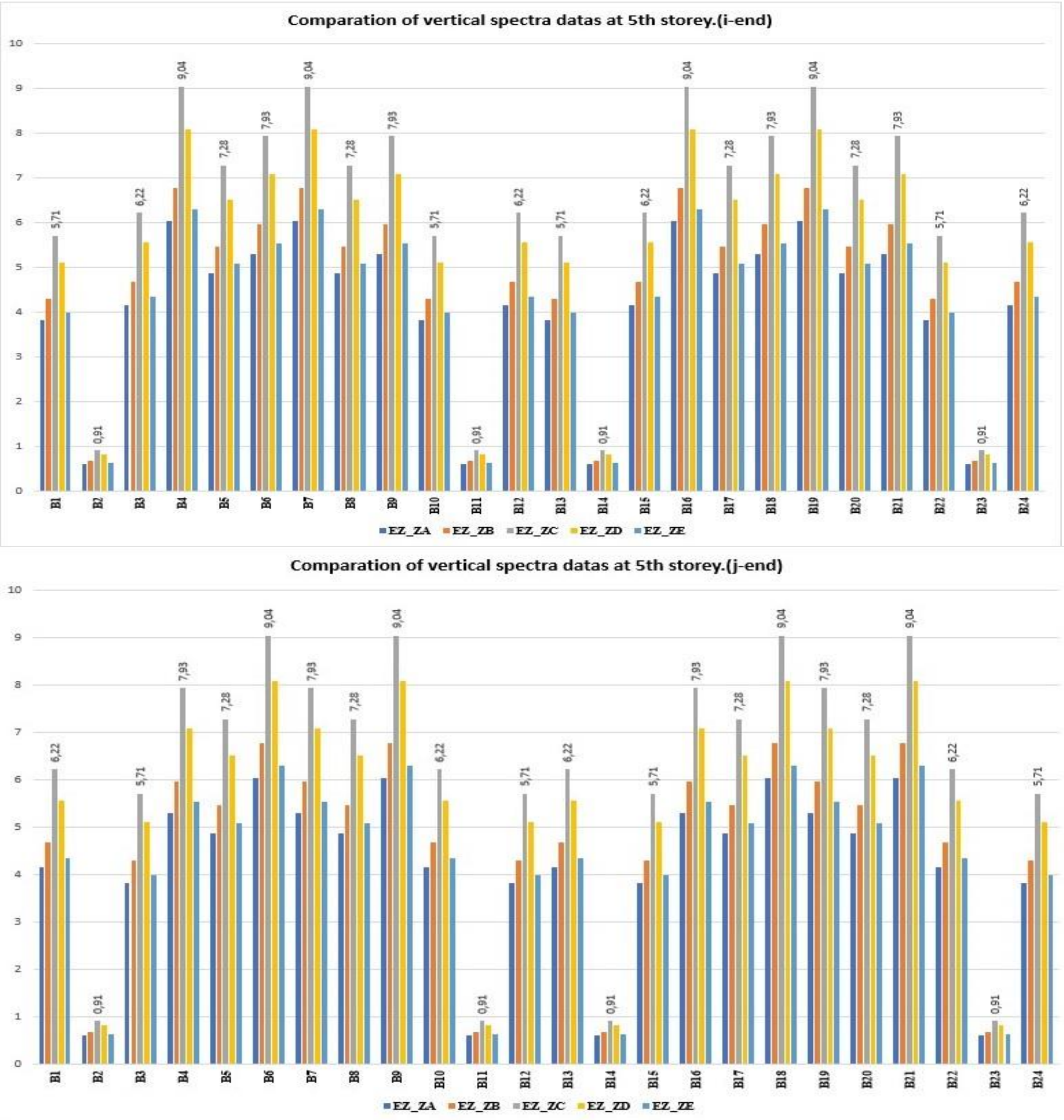

Figure 4 2. Comparation of vertical spectrum effect at i and j ends of beams for 5th floors.

5. Discussion

In the study, the shear forces at the i and j ends of certain beams were examined within the scope of the finite element method by influencing the vertical elastic design spectral attianed by using parameters belonging to different soil classes, and the vertical earthquake data of the Mw:7.6 Elbistan earthquake recorded by the seismic station 4631. It has been seen that the values obtained for each floor are different, and the highest values are obtained on the fifth floor, that is, on the top floor of the building. The occurrence of such a strain on the top floor of a building-type structure due to the vertical earthquake effect may cause the design capacity to be exceeded, and the floor collapses on the top floor of a building floor that has not been designed considering the vertical earthquake impact. This collapse, which will occur on the top floor of the building, will cumulatively affect the lower floors as an undesigned sudden load and may cause sudden wholesale collapses in the building. In further studies, in addition to this study, the shear stresses that occur in the beams of a building-type structure, whose foundation design has been made and whose soil properties have been determined, will be examined under the influence of vertical earthquakes.

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Experiential Learning in Daylighting Course through Performance Measurements

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Abstract- The main objective of this study is to adapt research studies on performance measurements for daylighting design to education. An experimental course has been introduced in Missouri University of Science and Technology, and the curriculum was developed by including active learning beside the traditional learning environment. The parameters used in the schematic design and design development stages are presented, and the curriculum topics and practical experience are explained in the study. Particularly performance measurements are associated with course assignments. Curriculum results are evaluated qualitatively with assignment results and quantitatively with surveys. Current and emerging metrics are included in lab assignments and results of course assessments show that emerging metrics in daylighting technology and practical experience had attraction over participants. As a result of the evaluation of two sample courses, differences emerge regarding the courses that can be given at undergraduate and graduate levels. These differences are grouped into traditional lecture learning environments and experiential learning environments. The learning outcomes of the course curricula are summarized as gaining the knowledge and skills to communicate technically at the level of design practitioner for the student aiming for undergraduate graduation and at the level of the research community for the student aiming for graduate level.

Keywords: Daylighting, Performance measurement, Experiential learning, Course curricula

1. Introduction

A significant impact on the energy performance of a building can be provided by applying daylight-focused design parameters [1]. A well-designed day-lit space does not need excessive artificial lighting and energy consumption loads [2]. A well-daylit space is mainly illuminated with natural light. It combines high occupant satisfaction with the visual and thermal environment with low overall energy use for lighting, heating, and cooling [3]. The lighting quality concept contains several parameters regarding human needs, economics, the environment, and architecture. The proper balance of these (sometimes conflicting) dimensions aids to succeed good lighting quality [1]. Daylighting and view credits are also available in green building rating systems. Plenty of certified buildings have these credits with LEED certificates because daylighting is a core sustainable design consideration [4].

In order to make daylight and sunlight analysis for a building, there are many tools to be used. But, the use of tools is mostly not included in a building design budget and is thought to be the specialists' domain. Moreover, performing these studies as part of a design studio is not commonly promoted among architectural students [5]. As a teaching exercise for students to intuitively understand contemporary daylight performance metrics, daylight designing also has significant educational value [3]. In a 2010 US survey of 220 architectural, engineering, and construction (AEC) firms, the "biggest emerging concerns" experienced by the building industry were climate change and sustainability. The same survey reported by the participation of deans and department heads of 126 academic architecture programs that strengthening their sustainable design course offerings had been the most substantial change in their curricula over the previous five years [4]. The International Energy Agency, Solar Heating and Cooling Programme (IEA and SHC), commenced Task 41: Solar Energy and Architecture in 2012. The released Task 41 aims to clarify barriers that architects face with solar building design at the schematic design phase, maintain documents for handling obstacles, and aid in developing communication within involving sides [6].

The luminance-based techniques are mostly popular within the research community for application, and design practitioners have not given sufficient attention to these metrics. Consensus-based design recommendations for design practitioners are not supported by adequate research till now [7]. Hence, identifying the strengths and limitations of existing and emerging metrics and continuing research on developing luminance-based metrics are very important [1].

Current and emerging daylighting metrics aid design practitioners during early design phase and design development phase. The problem according to hypothesis of this paper is; these metrics are popular among research community not in design practitioners. The hypothesis and problem definition let us to think on the research question; how research results of current and emerging metrics can be adopted into the education. This paper is mainly seeking for curriculum development for daylighting course which will help recent graduates to gain ability on performance measurement on daylighting design.

2. Curriculum Development with Daylighting Performance Measurements

Emerging metrics beside current metrics, make more complicated measurement of daylighting performance of a building which needs expertise in different fields such as; computer simulation, photography, solar path etc. As a research field, integration of these diverse performance measurement tools needs further study which means open to new researchers. The daylight metrics can be categorized in two schematic or early design phases, and the design development phase is derived from the traditional project development process. One more phase can also be named post-occupancy evaluation, which uses similar metrics. Several research studies have been done so far for the first part, but there is not a common consensus and popularity yet in practice for the second part. Hence, assignments focused on current and emerging daylight metrics. Based-on motivations on research background, a daylighting course part of sustainable design and smart living would provide valuable perspective to architectural engineering education. Learning objective of daylighting course is to understand appropriate and verified luminance-based metrics of daylight modeling in building and each performed assignment shows a significant step towards this main objective.

2.1 Course Variables

Curriculum development was initiated for an experimental course with 3 credits at undergraduate/graduate levels in a Midwest Public University Architectural Engineering Program. Active learning is engaged along with traditional lecture learning environment and assignments are generated accordingly. One semester of experiential courses provided students with envisioning these metrics, tools, and possible results. Four undergraduate students enrolled in this experiential course who help a lot to developing curriculum materials. Once it was developed, course documents were used in a typical elective course in another institution with a large number of participants, with 81 students. Hence, two courses are named in this paper as one is an "experiential course" with a low number of participants, and the other is a "typical course" with a large number of participants. Basically, course 1 targeted to develop a new course and course 2 targeted to test the developed curriculum in a large number of participation of a typical course. Course variables belong to mentioned these two courses are introduced in Table 1.

Table 1: Course variables

Daylighting	course type	compulsary or elective	course delivery	total hours	lec-lab hours	number of assignm.	student number
Course 1	experiantial	elective	face-to-face	3	2 - 1	6	4
Course 2	regular	elective	online	2	2 - 0	2	81

Performance measurements are grouped as schematic design and design development which is retrieved from research community and these activities are assigned for students as lab activities. Active learning by real life problems are engaged in these activities. Six assignments were engaged in experiential course by students during lab hours as depicted in Table 2. Students are performed these activities to develop their assignments or case studies.

Table 2: Daylighting metrics during schematic/early design and design development phases

Active Learning by Real Life Problems		#	Assignment	Activities	Development of Assignments / Case Studies
	Schematic Design	1	Solar path analyze	Lat./longt., azimuth/altitude and magnetic decl.	⇨
				Stereographic sun path diagram	
				Orthographic projection	
		2	Massing studies & daylighting metrics	Daylight feasibility test	⇨
				Window to floor area ratio (WFR)	
				Daylight factor (DF) analyze	
		3	Sunlight shading calculation	Obstruction mask	⇨
				Glazing shading mask	
				Obstruction and sun position	
	Design Development	4	Computer simulation	Daylight factor (DF) analyze (computer-based)	⇨
				LEED daylighting analyze report	
				False color rendering for illuminance	
		5	HDR imaging technique	Camera calibration	⇨
				Image capture with regular and fish eye lens	
				Picture merge with software	
		6	Heliodon analyze with physical model	Physical scaled model and sun-dial assembly	⇨
				Heliodon set-up	
				Shadow mask and luminance measure	

3. Methods of Performance Measurements

In building design, some basic information about natural lighting is needed to influence the design. Various performance measurement methods are used to determine the natural light levels in a building. These methods can be used before the construction of the building, during the design phase, and after the construction. These measurement methods are grouped under six headings: solar path analysis, massing studies, sunlight-shading calculation, computer simulation, HDR imaging technique, and Heliodon analysis. The information obtained from the proposed measurement methods will be used in different phases of the design, and the design phase is divided into two for professional practice, schematic design, and design development phases.

3.1 Schematic design phase

In the schematic design, the daylighting-building relationship is analyzed, especially according to the terrain and the location of the building on the land. At this stage, general data on natural lighting that will guide the building mass and its spatial design are tried to be revealed. Facade-space relations are analyzed according to the direction of movement of the sun. It is investigated how which directions affect the natural lighting levels of the spaces to be designed.

- *Solar path analyzes;*

The intensity of solar rays hitting a given building area can be estimated for different periods, and the negative impact can be managed and solved by design [8]. Solar path diagrams can determine or calculate the Sun's position in the sky. Furthermore, solar path diagrams are used in architecture to inform how the sun will affect the building [9]. A sun path diagram is essential in determining the position and altitude of the sun [10]. The most used projection methods are polar (stereographic) and cylindrical (orthographic) projections as graphical display techniques [11]. Solar path diagrams are a suitable way to show the annual changes of the sun's position in the sky on a 2D diagram. The behavior of the sun's lighting and heating characteristics is affected by latitude and longitude [12]. Another development in solar angle calculation is computer-aided programs that can calculate the sun's elevation and azimuth angles, given the necessary data. One of these calculators is the web interface proposed by NOAA, where latitude, longitude, date and time are entered to get the necessary data [8] [10]. Stereographic diagrams represent the sun's changing position in the sky throughout the day and year [12]. The solar path diagram is a two-dimensional graphical representation of the sun's path for a given latitude across the hemispherical vault of the sky. The three-dimensional sky dome in the sun-path diagram is reflected on a 2D circular display of which the sun's path transforms a series of elliptical curves [11]. A two-dimensional plot of the sun's position in Cartesian coordinates, where the x-axis represents the azimuth angle and the y-axis represents the azimuth angle, is called orthographic projection [8].

- *Massing studies and daylighting metrics;*

It should be taken into account when designing lighting of a building that building layout and orientation can reduce the need for artificial lighting and thus increase user satisfaction. It is accepted that a building layout adjusted to the solar path should provide sufficient natural daylight through windows [2]. Use of rules of thumb and daylight factor as a metric are still popular during schematic design in current daylighting design practice [13]. Rule of thumbs get common acceptance during preliminary design phase of massing studies are atrium and top lighting rule of thumbs, sky exposure plane rule of thumb, window-to-wall and window-to-floor area ratios and window head height. Calculation of sky angle is a helpful tool for daylight feasibility test. Building owner, architects and engineers should discuss the overall lighting design and user comfort objectives at the Preliminary design stage. A more general rule of thumb can be derived from the so-called daylight feasibility test. The basic idea is that in order for a sidelit space to be daylit, a minimum amount of daylight flux has to be able to enter the space through a window [4]. The percentage ratio between indoor illuminance and outdoor horizontal illuminance at a work plane under overcast sky conditions is called the daylight factor (%DF). This ratio used to measure and evaluate the presence of daylight in buildings is actually a fairly simple method [14]. Illuminance levels at desk height along the gridline of a space is measured to provide on-site data and this grid also helps illuminance mapping during digital analysis [3]. It can be calculated on a grid, plotted as a counter map, or averaged across a grid and reported as average DF [15]. The simplicity of the DF method let it enter into the building regulations in countries. It can also be used at physical models or post-occupancy of a building with illumination meters [16].

- *Sunlight shading calculation;*

Sunlight shading calculation can be performed by solar site evaluation, obstruction mask and glazing shading mask. Stereographic diagrams can be used by superimposing them on a field photograph taken with a fisheye camera. These two overlaid documents provide information on the times of the day throughout the year when the sun is blocked by buildings or vegetation and the times of shading [8]. A solar path diagram can also be attached digitally on a fisheye image with SunPath software. The time period when the relevant project area receives direct sunlight is determined with this superimposed image. Furthermore, these images are also used to assess how suitable a given area is for installing photovoltaic panels, solar hot water panels, outdoor seating, plants, etc [17]. The shading period of a year is pointed on the sun path lines as an obstruction mask [8]. The profile angle is needed to determine the position and size of the projections on the building mass and façade, to understand the length of the shadow they cast, and to grasp how they affect the space [18]. Today, overheating in office buildings designed with large window areas is a problem that needs to be solved in terms of building energy efficiency, even in cold climate zones. In building design, it should be remembered that solar radiation will result in significant cooling demands during the hot period and reduced heating demands during the cool period [19]. Increasing the size of a window allows for more light in the space, but simultaneously increases thermal loads. How to solve two opposing effects in a balanced way is an important design problem [4]. Solar shading systems are proposed as a solution to reduce the cooling energy demand of the building.

3.2 Design development phase

After determining the general positioning of the building with schematic design, there is a need for more detailed analysis to understand the natural lighting levels of the designed spaces more clearly, and solutions to this need are sought in the design development phase. At this stage, the focus is no longer on the mass of the building, but on whether the natural lighting levels of the spaces are sufficient.

- *Computer simulation;*

The performance of a building in terms of illuminance level in the design of a building should be examined taking into account different sky conditions and times of the day/year. For this, computer simulations are used widely [1]. Developments in computer software and the popularity of BIM have brought a different perspective to the subject. Research in integrating BIM with building performance tools has been a focus of both BIM software developers and users [20]. Features such as sun path, sun settings, shadow intensity are also integrated into Autodesk Revit, a BIM software [6]. On the other hand, independent of BIM, DF analysis and false color rendering visualizations can be performed with software such as the Velux daylight visualizer [21]. In addition to these widely used lighting simulation and analysis tools, some specialized software is also used by lighting analysts in research community [22]. For a building to receive credit for IEQ (Indoor Environmental Quality) 8.1, it must achieve a minimum daylight factor of 2% in 75% of all areas used for "critical visual tasks". The US Green Building Council's LEED green building rating system recognizes a daylight or glazing factor of 2% as a minimum reference level. Version 3.0 of LEED specifies a minimum light level of 25 footcandles (269lux) under CIE clear sky conditions from 9 am to 3 pm at the equinox [3]. The LEED calculations and/or computer simulation model should be developed in more detail during the preparation of the construction documents to verify the appropriateness of the design [23]. Autodesk Revit provides users LEED daylighting analysis report by lighting analysis add-in on cloud service. DF analysis on layout, a report shows passed or failed based on selected threshold, a detailed schedule of each room with lighting analysis are automatically created by running this software. Images that depict a scene using wavelengths in the visible region of the spectrum are called true color images. false color images show colors at one or more "invisible" wavelengths. Many types of radiation are invisible in the electromagnetic spectrum, so it is possible to see reflected energy in false color images [24]. It is often a good idea to present numerical results using a false color scale [25].

- *HDR imaging technique;*

High Dynamic Range (HDR) imaging enables one to record a scene of wide luminance range by merging a series of photographed images at different exposures [26] [27]. HDR imaging technique is also called radiance map or luminance mapping when used for luminance analysis. This technique is frequently used in different fields such as road and pedestrian lighting, spatial visual comfort, illuminance and glare analysis [1]. Scenes with high dynamic range – the difference between the brightest and the darkest areas - are not possible to be recorded without loss of details and texture in dark parts (due to underexposure) and in bright parts (due to overexposure) because the digital sensor's limitation in high dynamic range recording. These images are created by merging multiple images of the same scene, each of which has been taken with different shutter speeds, thus providing a better range of images with different exposures [28]. An HDR image accurately capture a physical scene's lighting data and "match human perception" of a scene [29]. The human eye can see a broader range of light than a digital camera can capture or than a computer screen can display [30] [31] [32] [33]. The human eye can see 24 different stops of light difference. Cameras, however, only make instantaneous exposures, with film and expensive medium format digital cameras being able to capture 12 different stops of light variations, while most other digital cameras can only capture about 5 stops of light variations or even less [28] [34]. Most current digital cameras have 5-20 megapixels, often cited as falling far short of our own visual system. This is because at 20/20 vision, the human eye is able to resolve the equivalent of a 52-megapixel camera (assuming a 60° angle of view) [32]. An HDR image is merged from an appropriate exposure range of photographs using a free software program (e.g., Radiance, Photosphere, HDRgen, HDRscope) [35].

- *Heliodon analysis with a physically scaled model;*

Physical models are the best way to evaluate the designs that are developed since there is virtually no scale factor for lighting in scale models [36]. A heliodon is an architectural design tool that physically simulates sun angles in reference to a surface. Altering a light source's position relative to the surface can simulate any global latitude, date, and time. Heliodons can be used outdoors or indoors [5]. So far, the heliodons for indoor development could be broadly categorized into two categories; the fixed sun-moveable earth model and the fixed earth-moveable sun model [37] [38]. These heliodons are mechanical devices and can be operated by manually or automatically [5]. Mechanical heliodons with fixed and moving tables need expertise and several types are produced and used in research centers and Universities around the world. Sky modeling and sun modelling can be generated for indoor heliodon. Sky modeling with a "mirror box" allows to simulation an overcast CIE (International Commission on Illumination) sky condition and thereby evaluate the daylight factor at any area of the modeled building [6]. Luminance measure can be performed on physical model if model have sufficient size to locate sensor inside [39]. Material type, reflectance values and sealing shall be paid attention during assembly of physical scaled model to get accurate indoor luminance level. Adjustable overhang, roof attachment, south, east or west overhangs, fin attachment, skylight attachment and clerestory attachments can be tested on a base building model [40]. In order to use a heliodon outside, a sundial is necessary to follow the sun path. [41]. "Shadows" computer program helps to produce and print-out easily a sundial relevant any specific latitude on earth [42]. Creating a shadow mask will be practical by using a portable heliodon with sundial for an outside heliodon. In these circumstances, sun is the light source and heliodon is a tilt-up table for physical model as moving earth model. The effect of clear sky over massing study results in shadow and this shadow mask can be measured at a given latitude and any time.

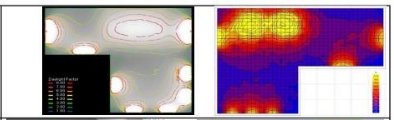
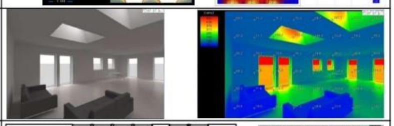
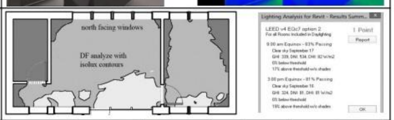
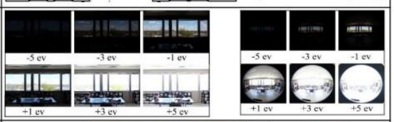
4. Results of Course Activity

An experimental course curriculum over daylighting technology has been developed and included current and emerging daylighting metrics into the assignments as lab activity. The activity carried out is evaluated qualitatively and quantitatively. Qualitative assessment is done by examining the outputs obtained from the assignments, while quantitative assessment is done by surveying the entire course curriculum and getting feedback from the students. It is thought that both evaluations will provide data for possible curriculum development. Likewise, in the light of this data, from experiential course to typical course has been reached. The development of the syllabus was divided into modules, and the survey for student feedback was designed according to these modules. For example, module A focused on the condition of the course materials, module B examined the traditional learning environment and module C evaluated the results of the experimental course environment.

4.1 Assignment results

Especially the assignment outcomes obtained in the experiential course are presented in this section. Experiential learning environment is created by implementation of these assignments and this is grouped under module C. This module covers performance measurements used in both schematic and design development phases. Results of design development phase in experiential course is depicted in Table 3.

Table 3: Assignment results of design development phase in experiential course (Course 1)

A. Computer Simulation	DF analyzes on sample layouts produced in experimental course (37N; overcast sky; March 21; 12pm-noon); Velux daylight visualizer (left); Ecotect (right).	
A. Computer Simulation	Luminance mapping of a sample interior space produced in experimental course (37N; overcast sky; March 21; 12pm-noon); true color visualization (left); false color rendering with luminance mapping (right).	
A. Computer Simulation	DF isolux contours on building layout by Autodesk Revit lighting analysis for 37N/91W (left); sample of result by Autodesk Revit cloud service (right).	
B. HDR Imaging Technique	Multiple exposure at interior of architectural design studio, produced in experimental course (left; 6 exposures with regular lens, right; 6 exposures with fish eye lens)	
B. HDR Imaging Technique	HDR image of 6 exposures with regular lens (between -5 ev and +5 ev) (center); HDR image of 6 exposures with fish eye lens (between -5 ev and +5 ev) (right).	
C. Heliodon Analyze	Sample of shading mask for 37N produced in experimental course (Dec., March, June 21 - 2pm).	

Accordingly, a comparison of assignment workloads according to course type is made. Considering the amount of time students spend on homework in these elective courses, a reasonable amount of homework is targeted. From this point of view, the same amount of time and effort is not possible in the regular course for a smaller number of students in the experiential course. Therefore, there is a difference between experiential and regular courses. In the experiential course all six assignments are completed in one semester, while two in the regular course are completed. However, in the regular course, the general introduction and technical information about the other assignments are presented to the students theoretically. On the other hand, the major difference is in the delivery method of both courses. While the experiential course was face-to-face, the regular course was online including exams and homework submissions.

Table 4: Assignment number / intensity based on course type

Daylighting	Assignment 1 solar path analyze	2 massing studies	3 sunlight shading calc.	4 computer simulation	5 HDR imaging	6 heliodon analyze
Course 1	X	X	X	X	X	X
Course 2		X		X		

As it is directly related to spatial design, performance measurements in the design development phase are included here. When the place of the course in the general curriculum, credit-hour load, purpose, targeted learning outcomes, and homework outcomes, which are the end products, are evaluated together, it is decided in this section which assignments will be included in which type of courses (Table 4).

4.2 Survey results

Implemented teaching methodology along with course materials has been assessed by students. A survey was held at the end of semester including eighteen questions. First two questions were relevant to students' academic level and level of construction experience. Remaining sixteen questions belong to teaching methodology and course material. Questions are grouped under three categories; Module A-course content, Module B-traditional learning and, Module C-active learning. Question topics, grouping (modules) and numeric results of survey results are depicted in Table 5. Students rated the significance of each item by using a scale of 1 through 10 (with 1 meaning unimportant ……. and 10 meaning very important). In addition, average rate of significance of each question is shown in Table 6. The table provides to monitor strength and weakness of learning environments and course materials to enable instructor to do necessary revisions.

Table 5: Question topics, grouping and numeric results of each question for both courses

Module			Measured Course Material	Aver. Rate	Module			Measured Course Material	Aver. Rate
Module A	Course Content	A.1	Daylighting in sustain. build. design	9,00 / **9,05**	Module C	Experiantial Learning Environment	C.1	Solar path analysis	8,75 / **8,03**
		A.2	Deylighting technology	9,50 / **8,49**			C.2	Massing studies & daylight metrics	9,00 / **7,78**
		A.3	Daylighting design parameters	8,75 / **8,38**			C.3	Sun shading calculation	8,25 / **8,05**
		A.4	Case studies presented in the lecture notes	9,25 / **8,16**			C.4	Computer simulation	8,75 / **8,30**
Module B	Tradition. Learn. Envir.	B.1	Face-to-face lecture / Online lecture	8,75 / **6,89**			C.5	HDR image technique	8,75 / **7,84**
		B.2	Reading (lecture notes)	7,50 / **8,51**			C.6	Heliodon analysis on physical model	8,75 / **7,68**
		B.3	Face-to-face lab exer. / Online exercises	8,75 / **8,19**			C.7	Final presentation by students	8,00 / **7,57**
		B.4	Paper based exam / Online exam	7,75 / **6,95**			C.8	Team work effectiveness	10,00 / **7,43**

☐ Results of Course 1 ▨ Results of Course 2

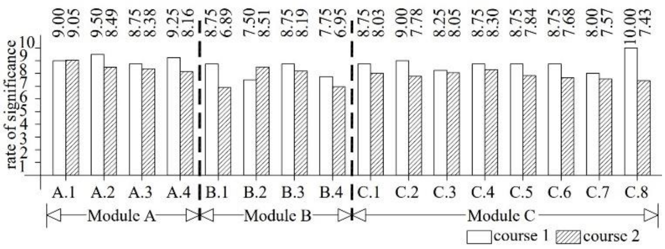
General attention and interest of students over course topics is observed in Module A-course content. The rate of significance of all topics in this section is measured always above 8 out of 10 in both classes. When we compare the results of both courses, the only increase in rates occurred in Module B-reading (lecture notes). This would have happened due to lectures notes were ready in regular course whereas it was under preparation in experiential course. On the other hand, the major decrease is observed in Module B section B1 and section B2 which are related with course delivery method as lecture and exam respectively. Moreover, another major decrease is obvious in teamwork effectiveness, but this one is negligible, because of having limited number and well-organized group of students in course 1.

Daylighting technology aroused students' interest and enthusiasm for practical experience. Therefore, an advanced case study may improve course material.

- **The survey results of course one** can be summarized as follows; Team-work effectiveness has the highest rate and reading (lecture notes) has the lowest rate per survey results. Daylight technology attracted students receiving 9.5 points out of 10. Presented case studies belong to previous research findings having 9.25 out of 10 shows that students' interest in practical experience. The final presentation was received less popularity as having 8 out of 10 as well, when compared with other items.

- **The survey results of course two** can be summarized as follows; Daylighting in sustainable building design has highest rate and online lecture has the lowest rate as per survey results. Reading (lecture notes) attracted students with receiving 8.51 points out of 10. Computer simulation having 8.3 out of 10 shows that interest of students over practical experience. Teamwork effectiveness was received less popularity as having 7.43 out of 10 in practical experience, when compared with other items.

Table 6: Average rate of significance of each question for both courses



5. Conclusion

Due to inclining trend over daylighting technology, a course curriculum is developed and active learning is engaged for assignments in lab. Boundaries of these activities shall be different based on course type. In the light of the data obtained from both course curricula, survey results and observations, it was determined that there should be a difference between undergraduate and graduate level courses. The level of differentiation in course types depends on the objectives and learning outcomes of the course. Likewise, the difference in the learning outcomes stated in the course syllabus is reflected in the assignments and course content. It is also related to the calculation of the weekly credit load of the assignments in the course for which the student is responsible. In addition, the objectives and learning outcomes of the regular course in the undergraduate program must be compatible with the program outcome. Therefore, not all course material developed in the experiential course can be applied to the regular course. Hence, suggestions are made in this section regarding course content and assignments.

- *Suggestions for assignments;*

In the evaluation of the outcomes of the assignments, the condition of the students when they graduate is considered. If they work as design practitioners, the question of which assignments are necessary for them should be decided. From this point of view, it is recommended that massing studies and computer simulation assignments should be included in the undergraduate curriculum where they can be widely used. On the other hand, at the graduate level, the main goal is to have a minimum level of technical communication within the research community at the end of the course. Therefore, it is recommended to include all six assignments in the graduate level syllabus (Figure 1).

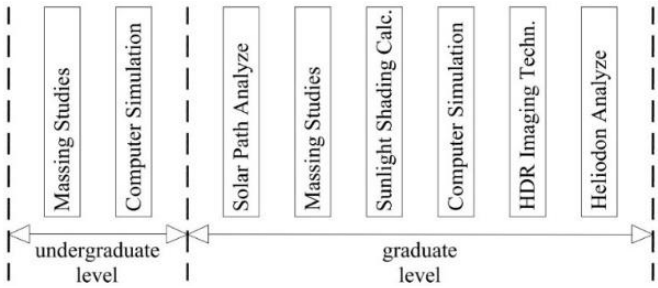


Figure 1: Suggestions for assignment content

- *Suggestions for course content;*

Similarly, the common differences in content between the research community and design practitioners should be reflected in courses at different levels. Two topics that are not common among design practitioners should be removed from the undergraduate course content. These proposed topics are photometry / HDR and heliodon / sundial. Instead, topic of static shading shall be expanded in weekly schedule.

Measures to indicate the effectiveness of learning activities and course material by survey show that daylighting technology and practical experience attracted participant students. Hence, curriculum development and result of survey shaped the necessity of advanced study over daylighting technology.

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Conflict of Interest

The authors declare that they have no conflicts of interest.

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INTERNATIONAL JOURNAL OF ENGINEERING TECHNOLOGIES-IJET

Guide for Authors

The **International Journal of Engineering Technologies (IJET)** seeks to promote and disseminate knowledge of the various topics of engineering technologies. The journal aims to present to the international community important results of work in the fields of engineering such as imagining, researching, planning, creating, testing, improving, implementing, using and asking. The journal also aims to help researchers, scientists, manufacturers, institutions, world agencies, societies, etc. to keep up with new developments in theory and applications and to provide alternative engineering solutions to current.

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The coverage of IJET includes the following engineering areas, but not limited to:

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Enter an abstract of up to 250 words for all articles. This is a concise summary of the whole paper, not just the conclusions, and is understandable without reference to the rest of the paper. It should contain no citation to other published work. Include up to six keywords that describe your paper for indexing purposes.

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Use single column layout, double spacing and wide (3 cm) margins on white paper at the peer review stage. Ensure that each new paragraph is clearly indicated. Present tables and figure legends in the text where they are related and cited. Number all pages consecutively; use 12 pt font size and standard fonts; Times New Roman, Helvetica, or Courier is preferred.

Research Papers should not exceed 12 printed pages in two-column publishing format, including figures and tables.

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Number equations consecutively with equation numbers in parentheses flush with the right margin, as in (1). To make equations more compact, you may use the solidus (/), the exp function, or appropriate exponents. Italicize Roman symbols for quantities and variables, but not Greek symbols. Use an dash (–) rather than a hyphen for a minus sign. Use parentheses to avoid ambiguities in denominators. Punctuate equations with commas or periods when they are part of a sentence, as in

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Please ensure that every reference cited in the text is also present in the reference list (and viceversa). Any references cited in the abstract must be given in full. Unpublished results and personal communications are not recommended in the reference list, but may be mentioned in the text. Citation of a reference as "in press" implies that the item has been accepted for publication. Number citations consecutively in square brackets [1]. Punctuation follows the bracket [2]. Refer simply to the reference number, as in [3]. Use "Ref. [3]" or Reference [3]" at the beginning of a sentence: "Reference [3] was …". Give all authors' names; use "et al." if there are six authors or more. For papers published in translated journals, first give the English citation, then the original foreign-language citation.

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Journals

[2] Y. Yorozu, M. Hirano, K. Oka, and Y. Tagawa, "Electron spectroscopy studies on magneto-optical media and plastic substrate interface", *IEEE Transl. J. Magn. Japan*, vol. 2, pp. 740-741, August 1987.

Conferences

[3] Çolak I., Kabalci E., Bayindir R., and Sagiroglu S, "The design and analysis of a 5-level cascaded voltage source inverter with low THD", *2nd PowerEng Conference*, Lisbon, pp. 575-580, 18-20 March 2009.

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10	Authors' affiliations, Section titles, references, tables, table names, first letters in table captions,figure captions, footnotes, text subscripts, and superscripts	**Abstract**	
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Authors should any word processing software that is capable to make corrections on misspelled words and grammar structure according to American or Native English. Authors may get help by from word processor by making appeared the paragraph marks and other hidden formatting symbols. This sample article is prepared to assist authors preparing their articles to IJET.

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3. Figures and Tables

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Acknowledgements

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References

[1] J. Clerk Maxwell, *A Treatise on Electricity and Magnetism*, 3rd ed., vol. 2. Oxford:Clarendon Press, 1892, pp.68-73. (Book)

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[3] Y. Yorozu, M. Hirano, K. Oka, and Y. Tagawa, "Electron spectroscopy studies on magneto-optical media and plastic substrate interface", *IEEE Transl. J. Magn. Japan*, vol. 2, pp. 740-741, August 1987. (Article)

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- Improves the quality of the research

8. Conclusion

The conclusion section should emphasize the main contribution of the article to literature. Authors may also explain why the work is important, what are the novelties or possible applications and extensions. Do not replicate the abstract or sentences given in main text as the conclusion.

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