

2023'e
Doğru
TÜBİTAK ile
Geleceğe
Bakış



Türkiye Cumhuriyeti
SANAYİ VE TEKNOLOJİ BAKANLIĞI



TÜBİTAK

Betonarme Çerçeve Sistemler İçin Enerji Esaslı Sismik Tasarım ve Değerlendirme Yönteminin Geliştirilmesi (121M713)

29.12.2021

- Üstveri
- Amaç & hedefler
- Yöntem
- Tamamlanan çalışmalar
- Gelecek 6 ayın planlaması
- Yaygınlaşma çalışması

- **Süresi : 24 ay**
- **Çalışma türü : Deneysel verilere dayalı analitik hesaplama**
- **Araştırmacılar:**
Ahmet Anıl Dindar (GTÜ), Ahmet Güllü (Gedik Ü.), Ali Bozer (Nuh Naci Yazgan Ü.), Hasan Özkaynak (Beykent Ü.), Ziya Müderrisoğlu (Beykent Ü.),
- **Genç araştırmacılar:**
Bilal Güngör (GTÜ), *Emre Gönülcü (İTÜ)*, Fırat Bezir (GTÜ), Furkan Çalım (İTÜ), Gülnihan Doluyurt (GTÜ), İlhan Emre İnam (GTÜ), Serkan Hasanoğlu (Boğaziçi Ü.)

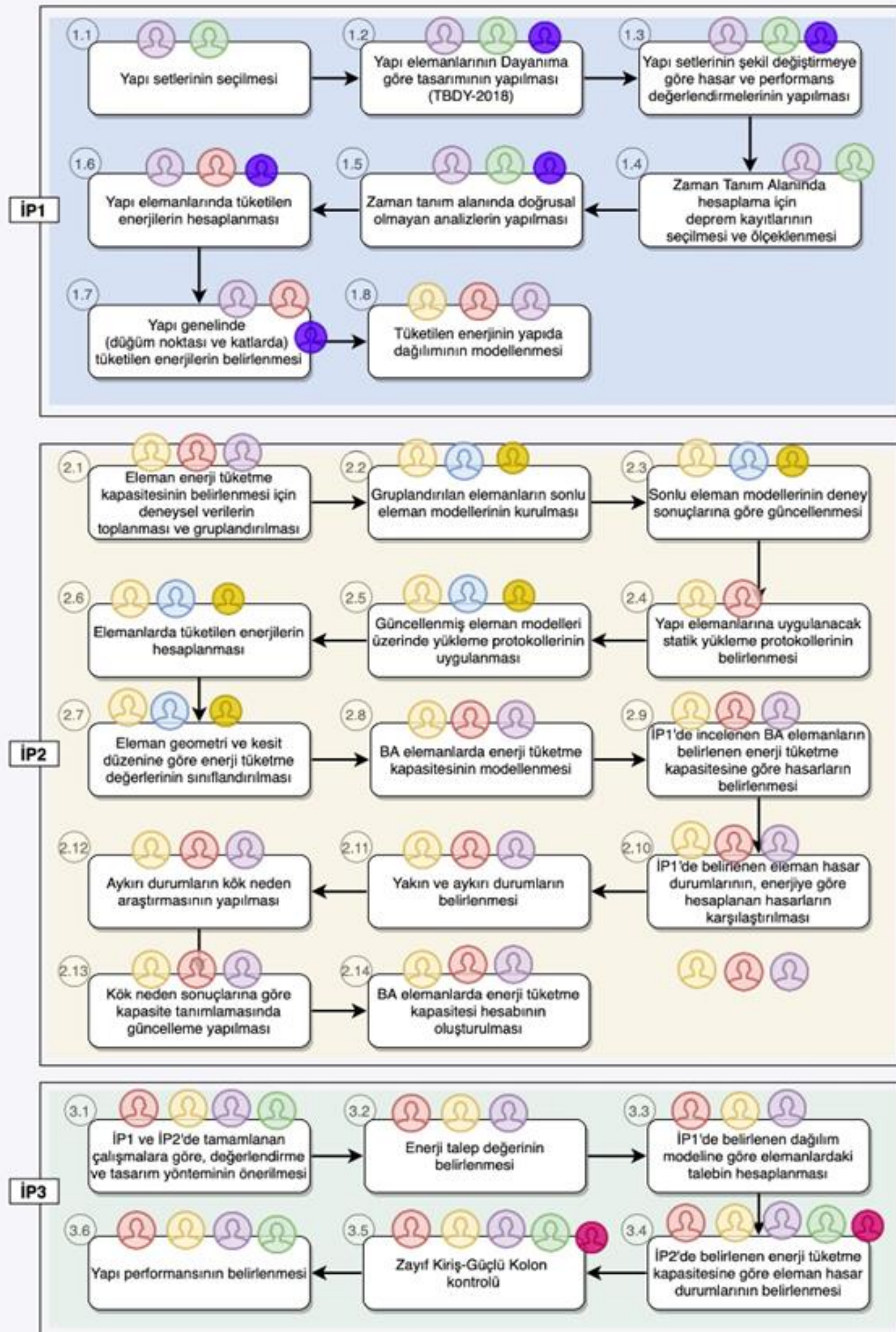
İsimler alfabetik sıralanmıştır.

- Dayanım ve şekil değiştirme tasarım yöntemleri kullanarak **betonarme yapı sistem setleri** oluşturmak.
- Yapı setlerinde zaman serisi analizleri ile **enerji talep/tüketim dağılımını** belirlemek.
- **Deney** veri tabanlarından alınan sonuçlara **dayalı** olarak farklı hasar seviyelerine karşılık gelecek **enerji tüketme kapasitesini** tanımlamak.
- **Çok katlı betonarme yapılarda** enerji dağılım ve enerji tüketme kapasitesini esas alan bir **tasarım yöntemi geliştirmek**.

- Deprem dayanıklı yapı tasarımında dolaylı olarak dolaylı ele alınan **enerji kavramının doğrudan yer aldığı hesap yöntemleri** geliştirmek.
- Gelecek nesil yapım yönetmeliklerinde yer alması vermek beklenen üzere enerji **esaslı sismik değerlendirme ve tasarım yöntemlerine öncülük etmek.**
- Gelecek yıllarda açılması muhtemel olan H2020 benzeri projelerinde yer almak üzere **ulusal araştırma ekosistemi ve platformu** yaratmak.

2021_0401-Energy Based Seismic Assessment and Design of RC Frame Systems

- AG
- HO
- AAD
- AB
- ZM
- B1-GD
- B2-FÇ
- B3-??



İP1

TBDY-2018 UYGUN YAPI SİSTEMLERİ
TASARLANMASI

İP2

DENEY VERİLERİNE DAYALI FEM
ANALİZLERİ VE ENERJİ ESASLI HASAR
VE TÜKETME KAPASİTESİ BELİRLEME

İP3

YAPI SİSTEMİ TASARIM YÖNTEMİNİN
GELİŞTİRİLMESİ

Takvim			
1	1.1	2.1	
2	1.2		
3			
4	1.3		
5			
6	1.4	2.2	
7		2.3	
8	1.5	2.4	
9		2.5	
10	1.6	2.6	
11		2.7	
12	1.7	2.8	
13		2.9	
14	1.8	2.10	
15		2.11	
16		2.12	
17		2.13	
18		2.14	3.1
19			3.2
20			3.3
21			3.4
22			3.5
23			
24			3.6

[121M713] BETONARME ÇERÇEVE SİSTEMLER İÇİN
ENERJİ ESASLI SİSMİK TASARIM VE DEĞERLENDİRME YÖNTEMİNİN GELİŞTİRİLMESİ

Opensees 101

Opensees yapı analizi hesaplamalarında kullanılan güçlü bir araçtır. Gücü, açık kaynaklı olması ve dolaşım- kullanıcı katkısına imkan tanınmasıdır. Buna bir örnek olması amacıyla basit kiriş sistemi üzerinde kendi belirleye parametrik bir hesabı planlayıp, çözümlemeniz istenmektedir. Buna göre sistem bilgileri (geometri, malzeme şartları, kesit bilgileri vb.) ve incelenen problem kapsamını belirlemeniz beklenmektedir.

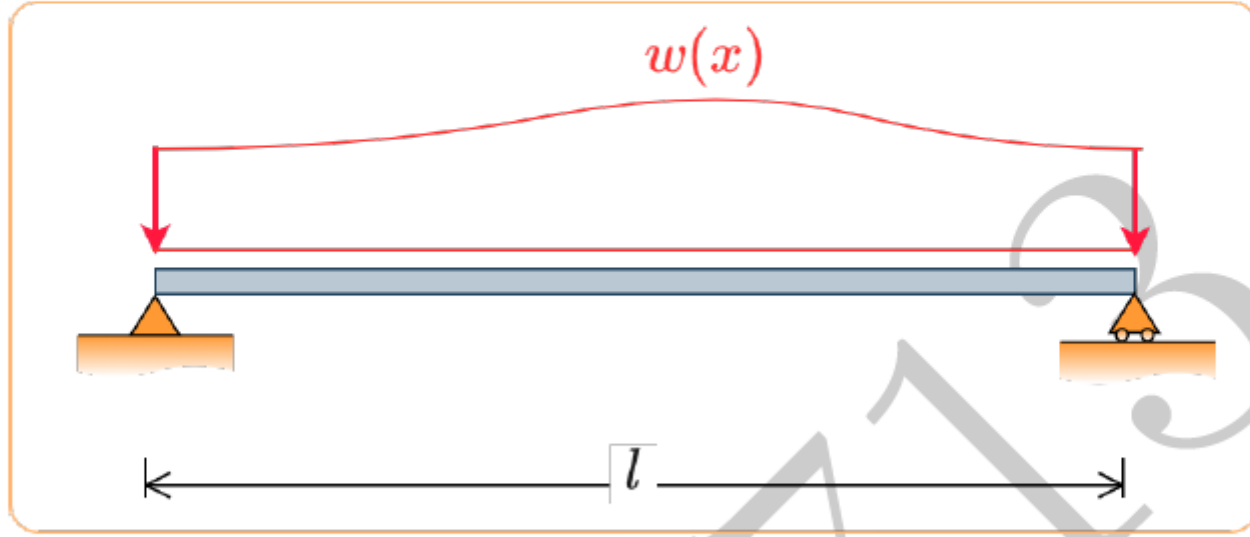


Figure 1: Structural system

Öneriler:

1. Bu problemin en sade ve en karmaşık kapsamı ne olabilir?
2. Problemi tcl ve py ile modelleyebilir misiniz?

[121M713] BETONARME ÇERÇEVE SİSTEMLER İÇİN
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OpenSees 101 - İTME ANALİZİ

Tanımlama:

Şekil 1'de görünen betonarme kolon sisteminin, yanal rijitlik, ötelenme hareketi karakteristiklerinin belirlenmesi için *OpenSees* programında modellenmesi istenmektedir. Geometri, malzeme, yük, sınır şartları bilgileri aşağıda verilmiştir.

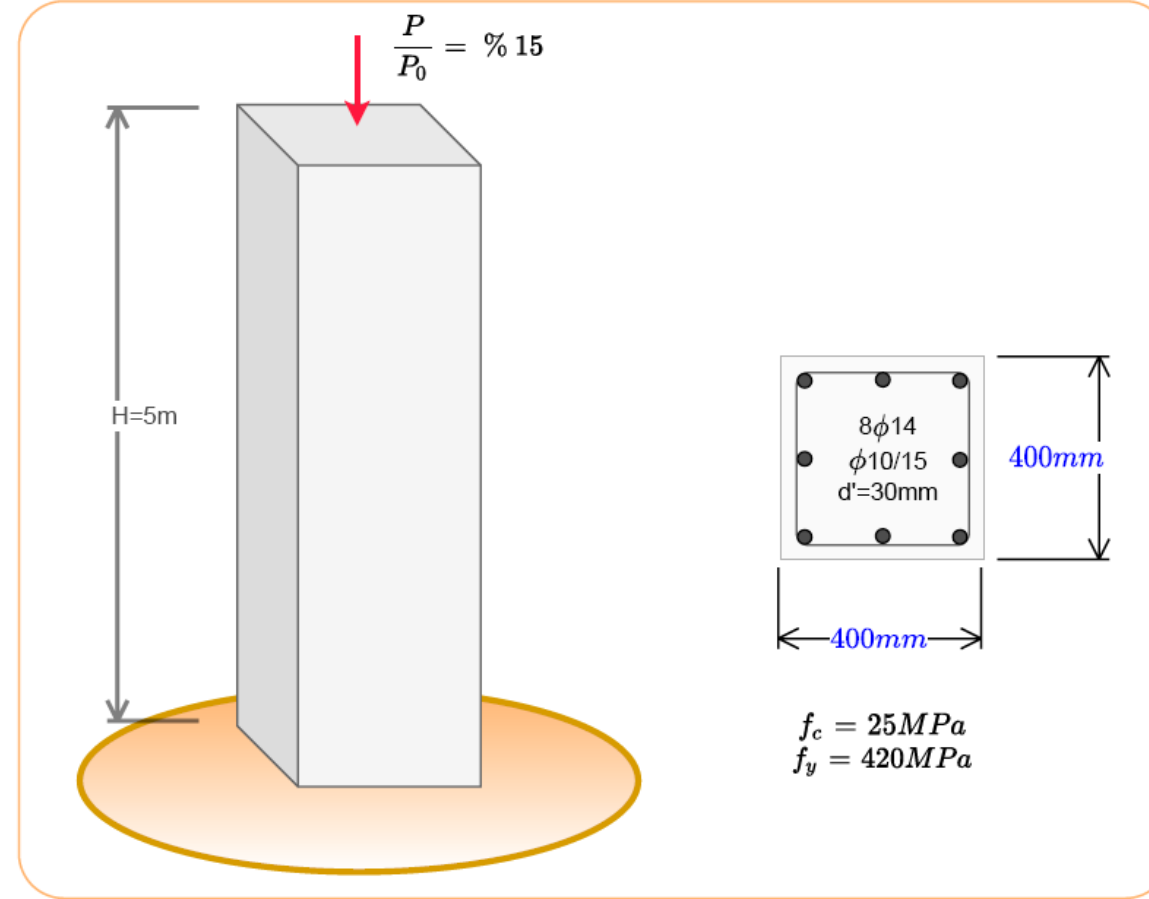


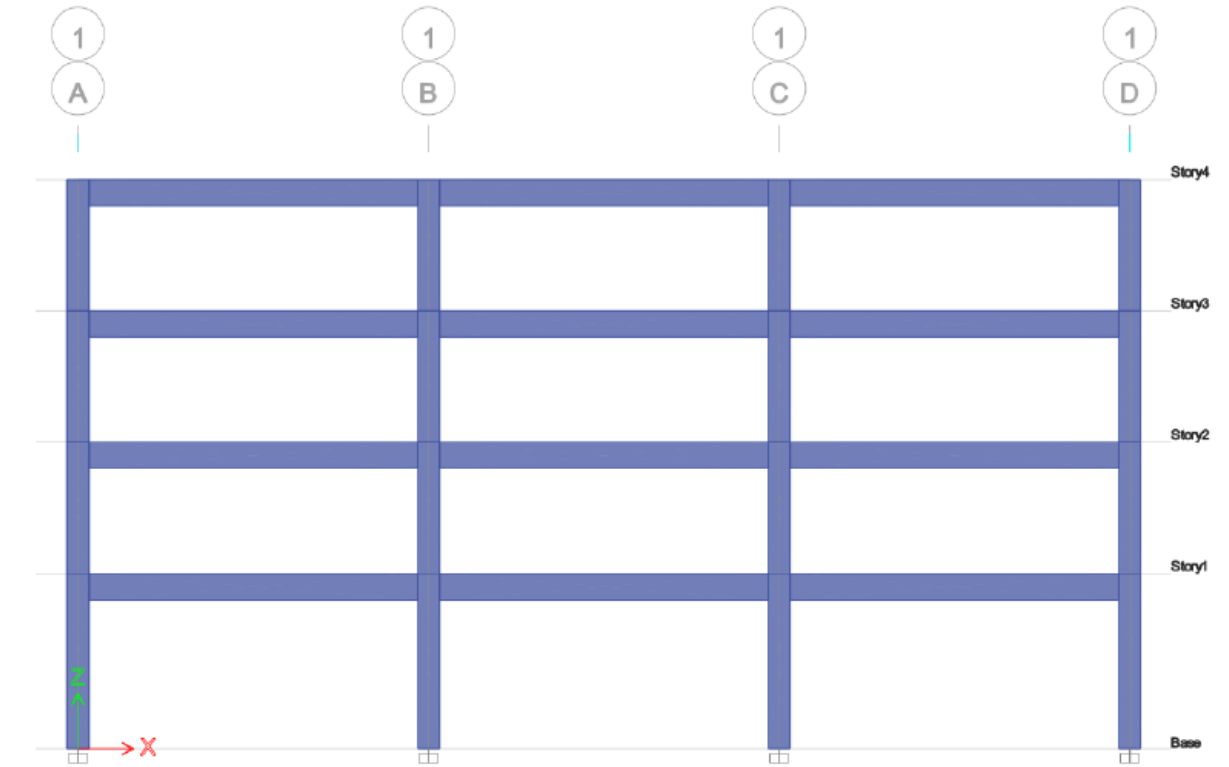
Figure 1: Sistem görünüm

[121M713] BETONARME ÇERÇEVE SİSTEMLER İÇİN
ENERJİ ESASLI SİSMİK TASARIM VE DEĞERLENDİRME YÖNTEMİNİN GELİŞTİRİLMESİ

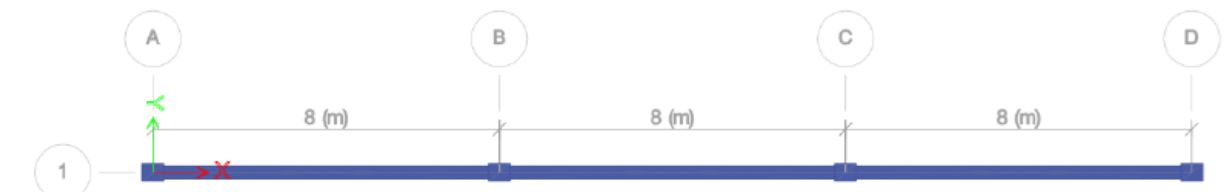
OpenSees 101 - 2D BETONARME ÇERÇEVE

Tanımlama:

Şekil 1'de görünen iki boyutlu betonarme sistem ETABS programında modellenmiştir. Sistemin *OpenSees* programında modellenmesi istenmektedir. Geometri, malzeme, yük, sınır şartları bilgileri aşağıda verilmiştir.



(a) Görünüm



(b) Plan

Figure 1: Sistem görünüm

Tamamlanan çalışmalar- Eğitim – Etabs Analiz & Tasarım

AutoSave OFF 2021_1102-121M713-YapiModel_Isimlendirme.xlsx - Protected View

File Home Insert Page Layout Formulas Data Review View Help

PROTECTED VIEW Be careful—files from the Internet can contain viruses. Unless you need to edit, it's safer to stay in Protected View. Enable Editing

K33 =CONCATENATE(B33,"_K",F33,"_DTS",E33,"_Z",I33)

	C	D	E	F	G	H	I	J	K	L	M
15			Tasarımcı	1	2	3	4	Grand Total			
16			Emre Gönülcü	5		5		10			
17			Fırat Bezir		5	5		10			
18			Furkan Çalım	5		5		10			
19			Gülrihan Doluyurt	5	5			10			
20			İlhan Emre İnam	5	5			10			
21			Serkan Hasanoğlu		5	5		10			
22			Z-Opsiyonel								
23			Grand Total	20	20	20					

121M713- YAPI MODELLERİNİN ISIMLARI

Aks Düzeni	Aks açıklıkları	DTS	Kat adedi	Malzeme	BKS	Zemin Sını
1	1	1	5	C25-S420	3	A
1	1	1	5	C25-S420	3	B
1	1	1	5	C25-S420	3	C
1	1	1	5	C25-S420	3	D
1	1	1	5	C25-S420	3	E
1	1	2	8	C25-S420	3	A
1	1	2	8	C25-S420	3	B
1	1	2	8	C25-S420	3	C
1	1	2	8	C25-S420	3	D
1	1	2	8	C25-S420	3	E

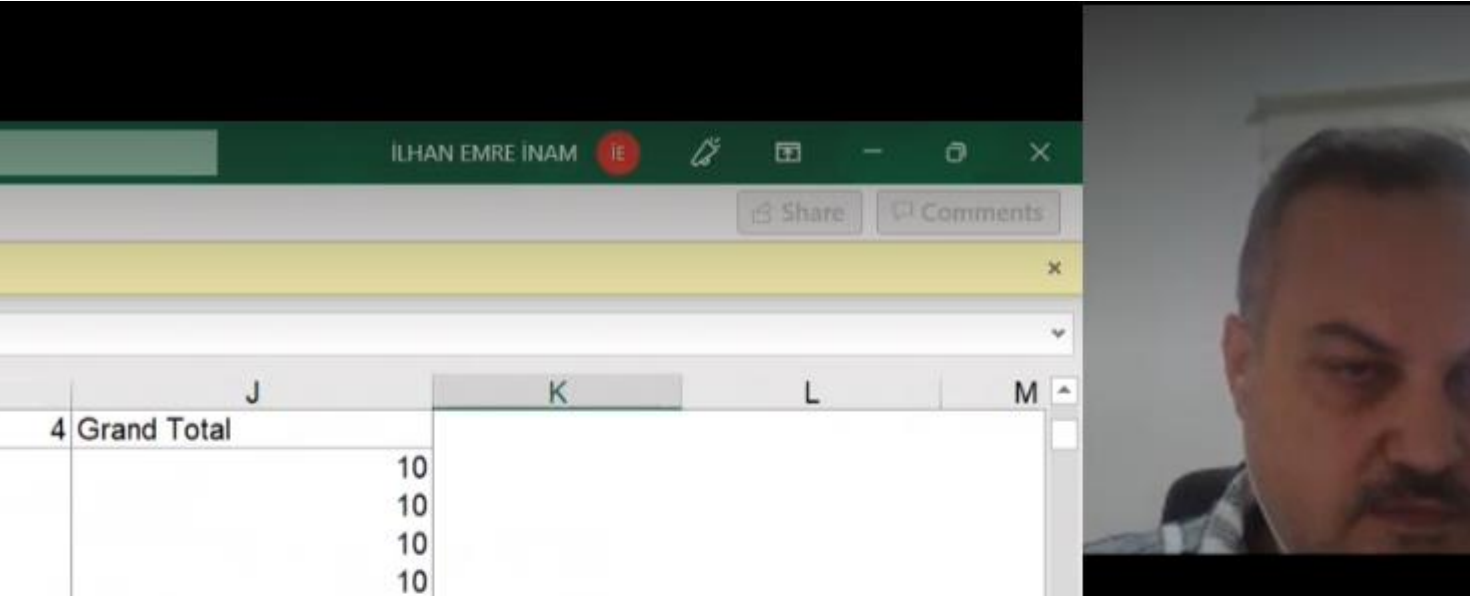
7_K5_DTS1_ZB

2021_1103

Ready

0:48:52

0:48:52 / 2:28:40



Free license (non-commercial use only)

ETABS Ultimate 18.1.1 - 41_K3_DTS1_ZA

File Edit View Define Draw Select Assign Analyze Display Design Options Tools Help

Model Explorer

- Model
- Project
- Structure Layout
- Properties
- Structural Objects
- Groups
- Loads
- Named Output Items
- Named Plots

3-D View: Column P-M-M Interaction Ratios (TS 500-2000/2018)

0.00 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0 6.5 7.0 7.5 8.0 8.5 9.0 9.5 10.0

13°C Yağmur 17:21 23.11.2021

ENG 5:21 PM 23-Nov-21

Play (K)

1:19:40 / 2:28:40

1x

HÖ EG
Hasan ÖZKAYNAK emre gonulcu

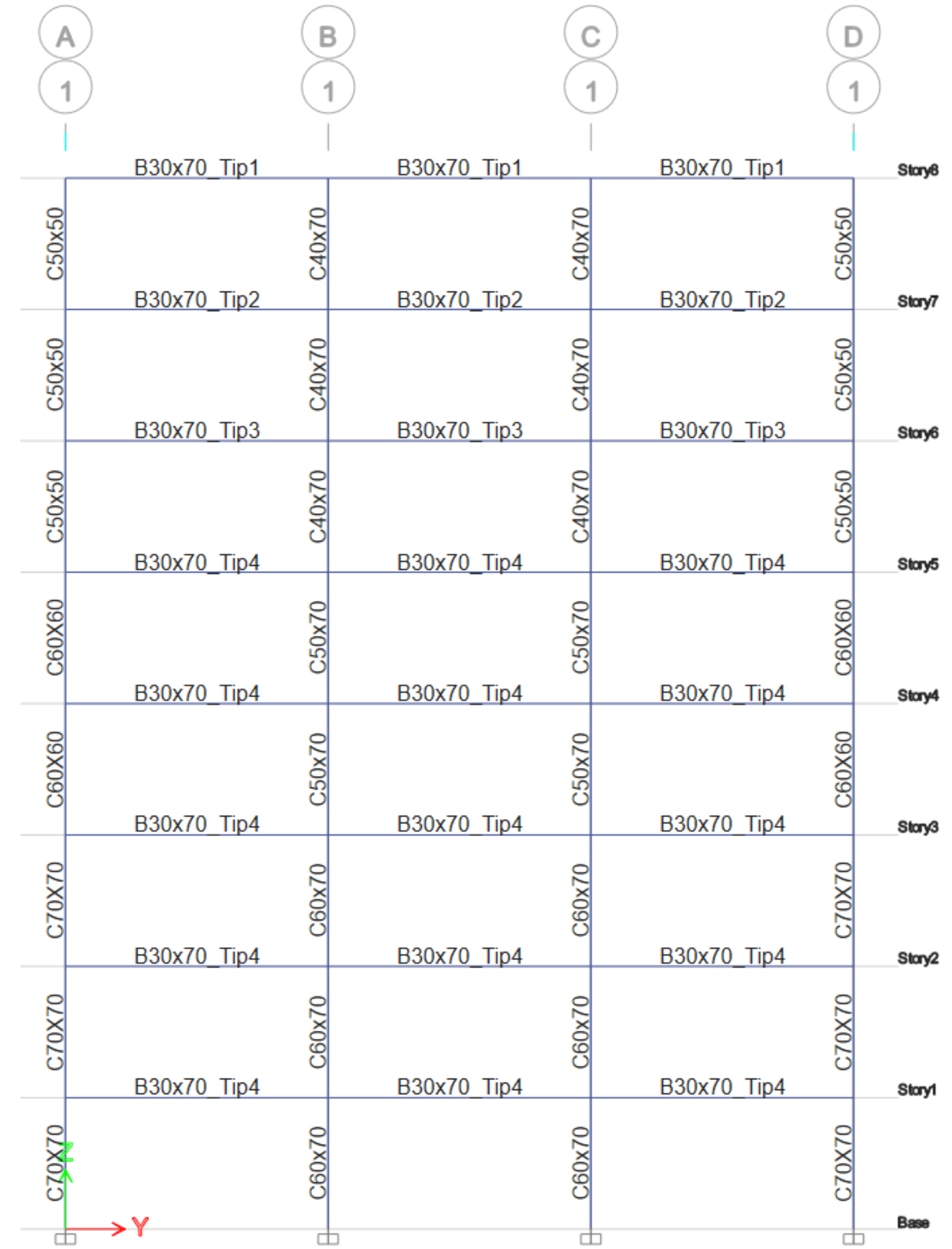
İİ SH
İLHAN EMRE İNAM Serkan Hasanoğlu...

Ahmet Aral DİND... Gülrihan GÖKDAĞ

C
calimfurkan95

- **Kat adedi** : Bina yükseklik sınıfı $BYS = 4$ ve büyük olacak şekilde kat adedi 3, 5, 8 , 10 olacaktır.
- **Bina kullanım sınıfları** : Konut, işyeri vb. yapılar ($BKS = 3$) incelenecektir.
- Çalışmada sismik tehlike açısından **iki farklı sismik bölge sınıfı** dikkate alınacaktır: $DTS = 1$, $DTS = 2$
- Buna göre her bir sınıflandırma dikkate alındığında 5 zemin sınıfında, iki farklı deprem tehlikesinde her biri 4'er adet bina içeren 10 ayrı yapı seti, toplamda **40 adet yapı modeli** oluşturulacaktır.

T.C. Cumhurbaşkanlığı
SANAYİ VE TEKNOLOJİ BAKANLIĞI
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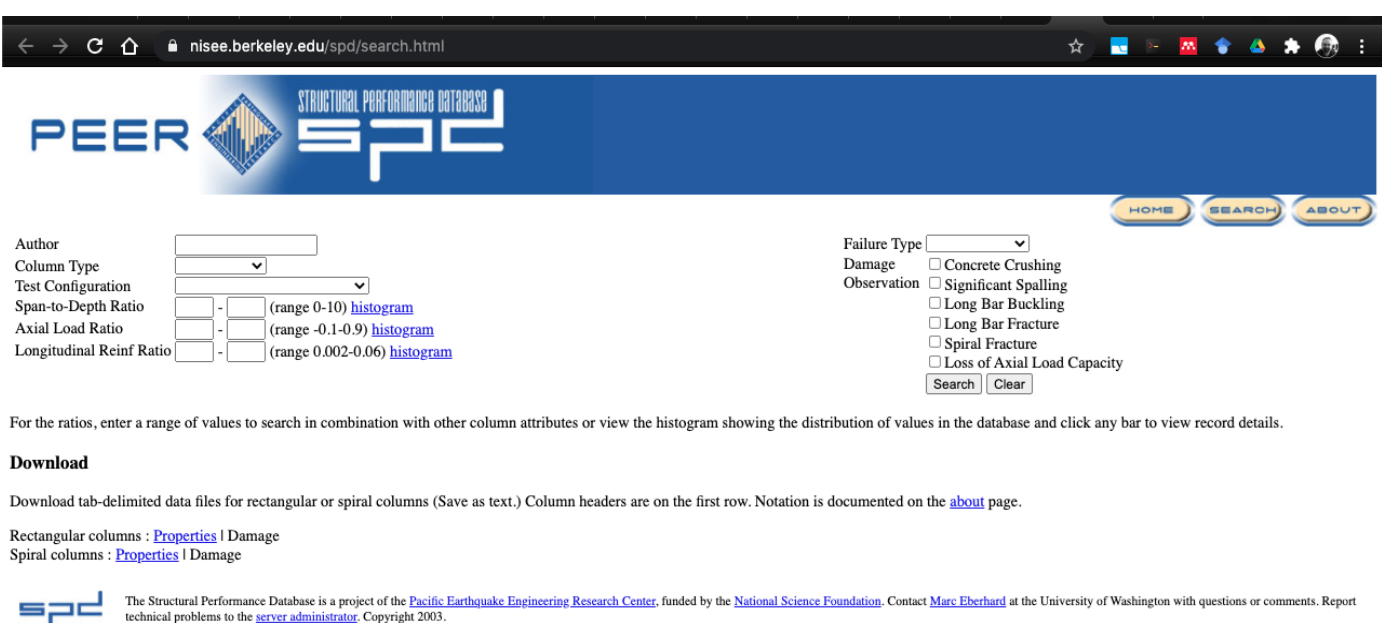
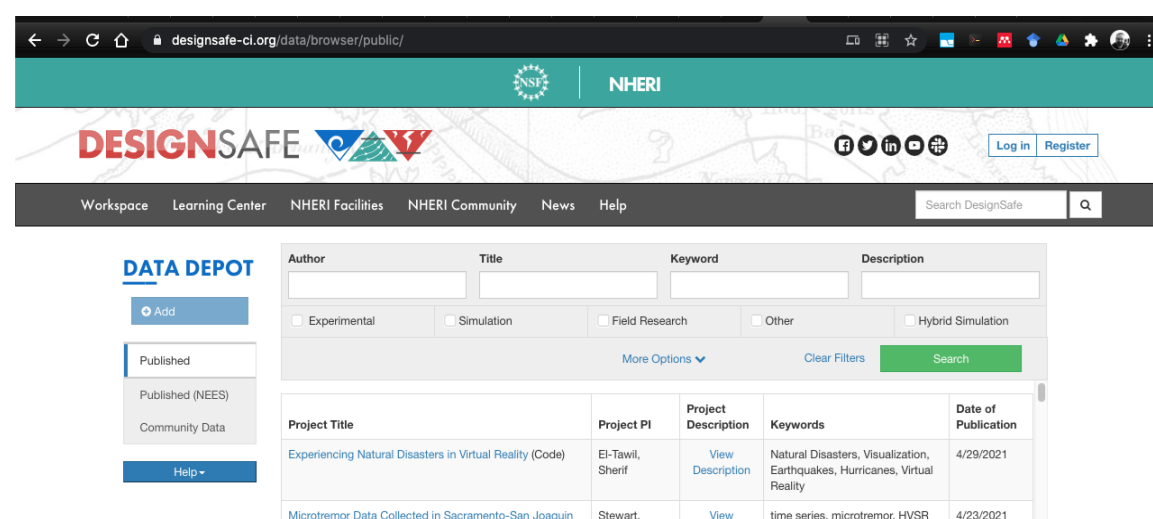
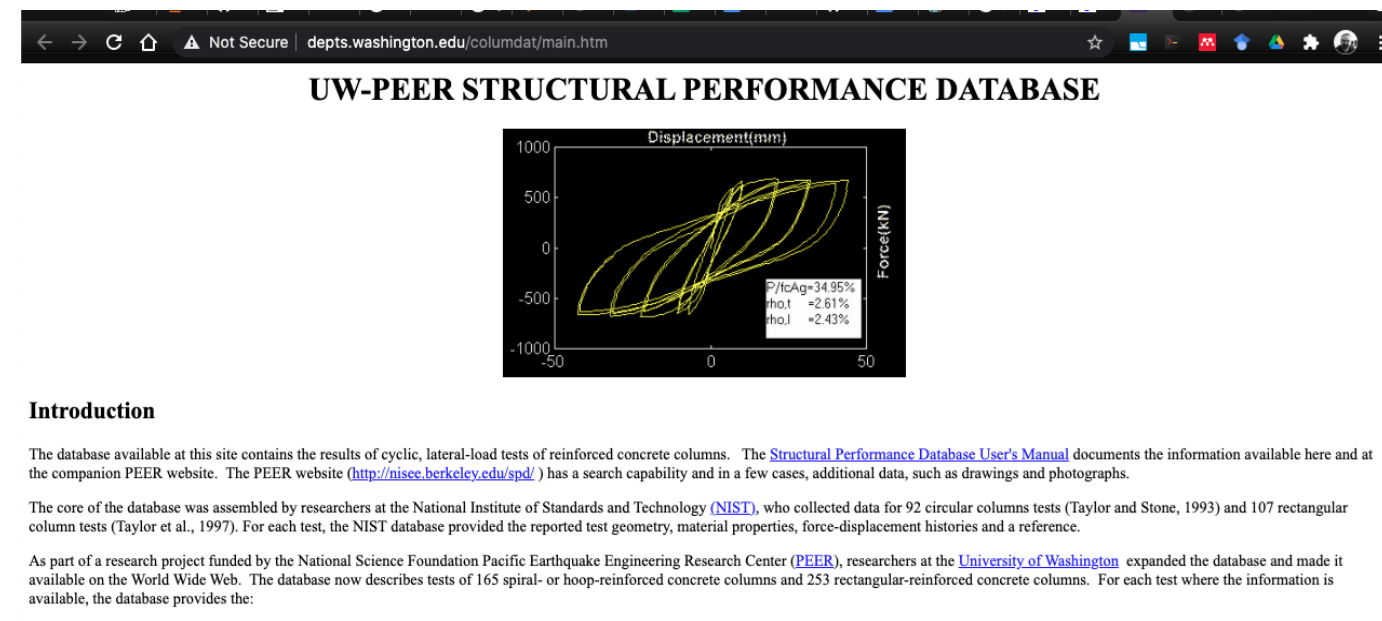
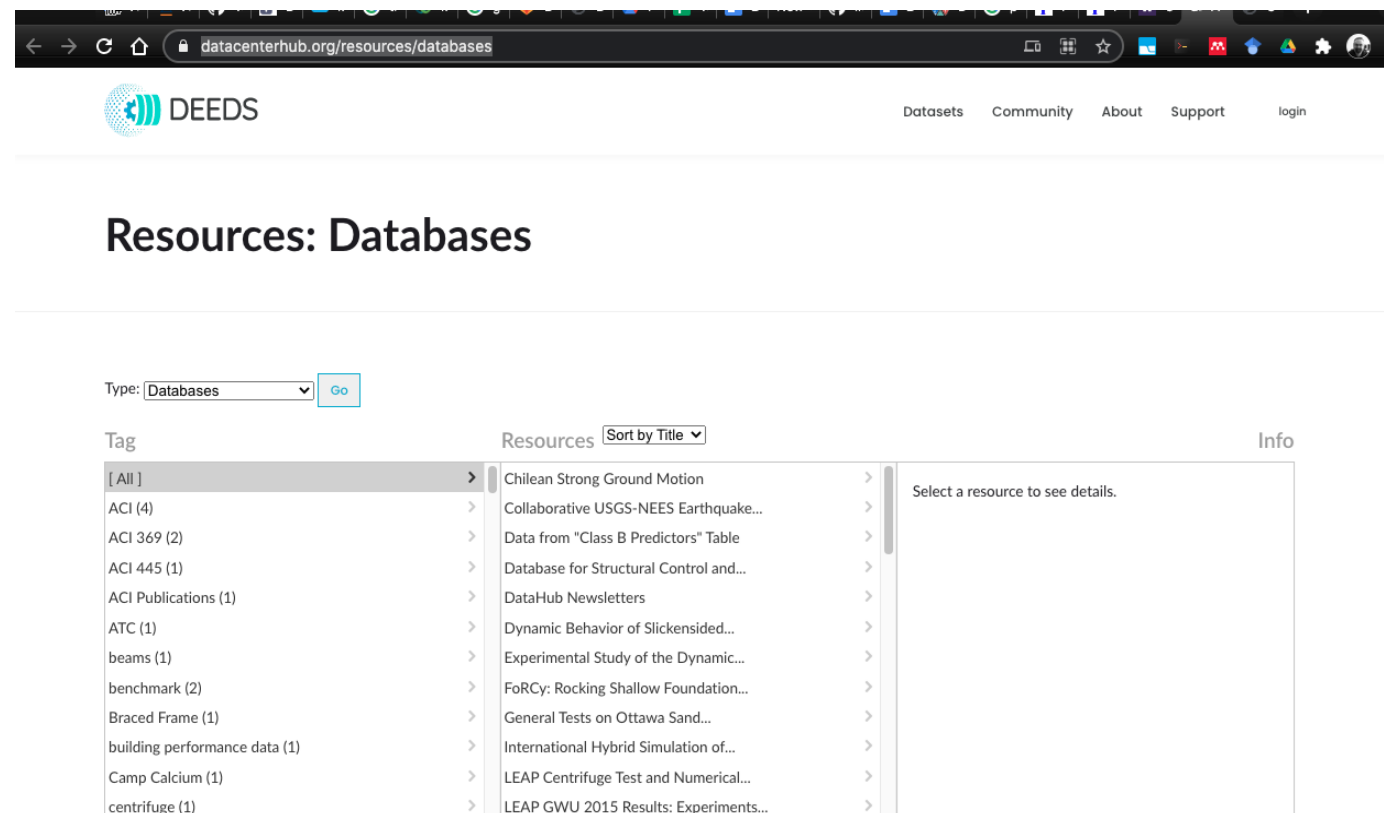
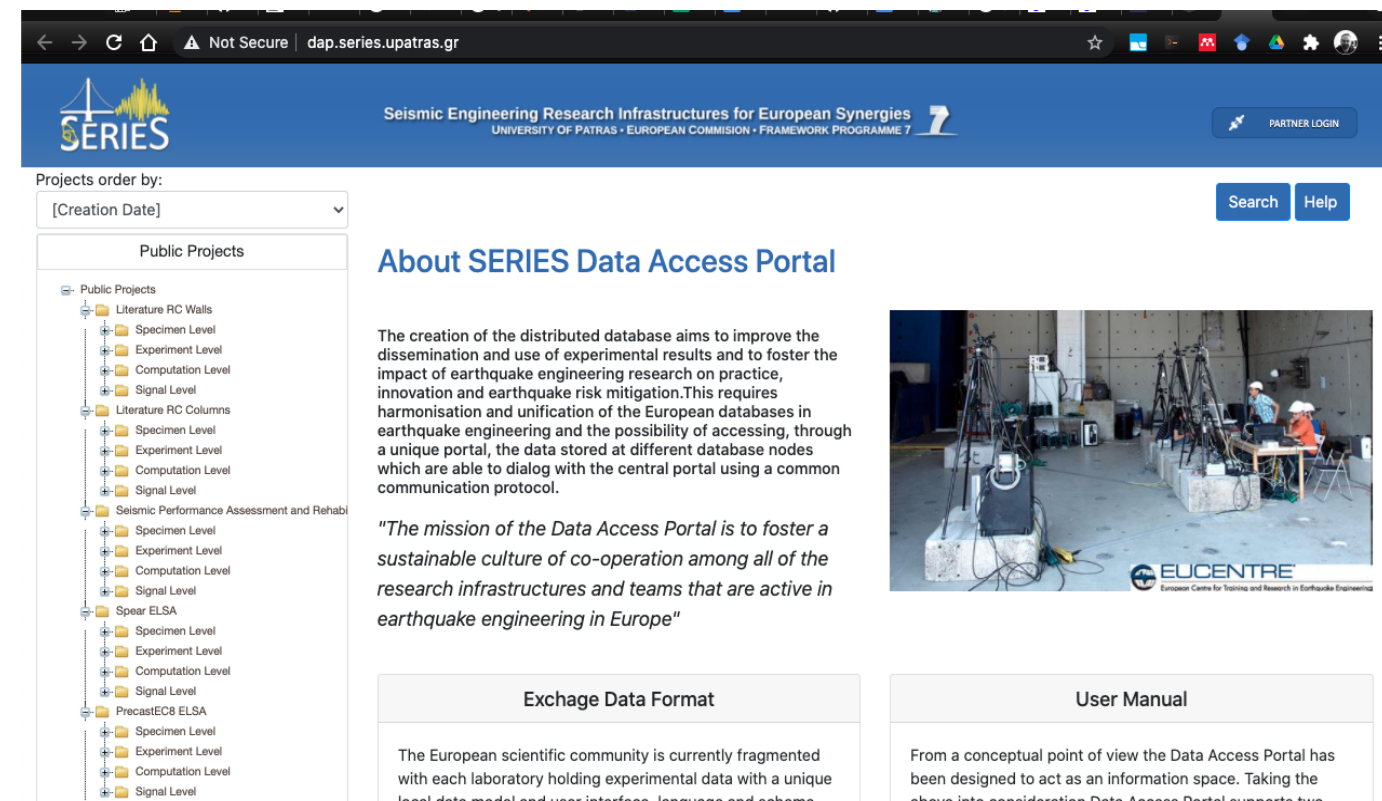
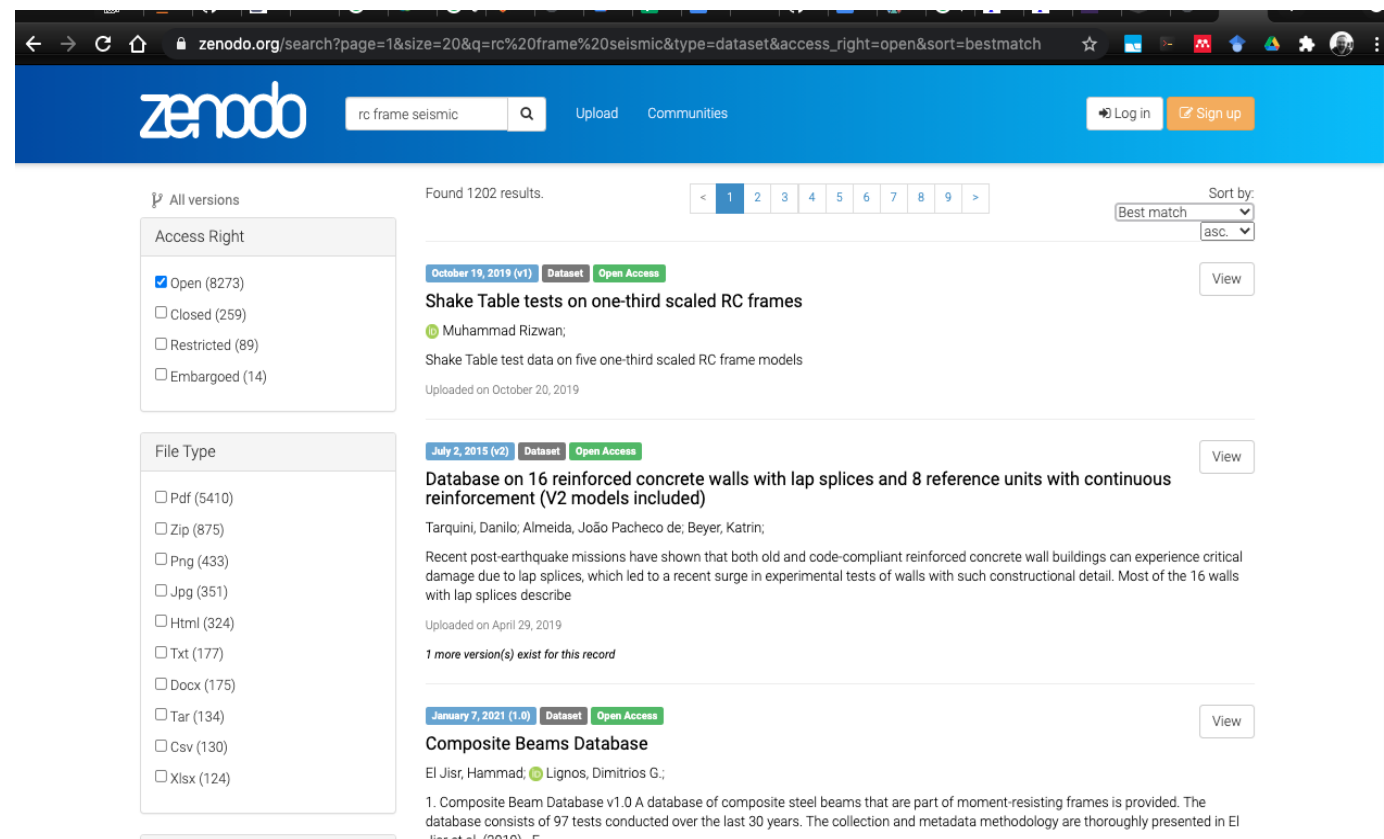


Tamamlanan çalışmalar- 1.2: Yapı setlerinin tasarımı

The image displays a software development environment with three main windows:

- Left Window (Code Editor):** Shows Python code for structural analysis. The code includes functions for setting loads, eccentricity, and analyzing drift. Key lines include:
 - `ret = SapModel.LoadCases.ResponseSpectrum.SetLoads("ExS", 2, LoadNames, FunctionNames, ScaleFactors, ReferenceSystem, AngleList)`
 - `ret = SapModel.LoadCases.ResponseSpectrum.SetEccentricity("ExS", 0.05)`
 - `FunctionNames = [ RS_Design_Name , RS_Design_Name ]`
 - `LoadNames = ["U2", "U1"]`
 - `ScaleFactors = [9.81 , 9.81*0.3]`
 - `ReferenceSystem = ["Global", "Global"]`
 - `AngleList = [0,0]`
 - `ret = SapModel.LoadCases.ResponseSpectrum.SetCase("EyS")`
 - `ret = SapModel.LoadCases.ResponseSpectrum.SetEccentricity("EyS", 0.05)`
 - `# GÖRELİ KAT ÖTELEMESİ TANINLAMALARI`
 - `# Lambda hesabi`
 - `RS_Elastic_D02_df = pd.read_csv( os.path.join( RS_Model_filePath , RS_Elastic_D02_Model_fileName ) , skiprows= 15, names=["T", "Sae"] , delim_whitespace= True , encoding="ANSI")`
 - `RS_Elastic_D03_df = pd.read_csv( os.path.join( RS_Model_filePath , RS_Elastic_D03_Model_fileName ) , skiprows= 15, names=["T", "Sae"] , delim_whitespace= True , encoding="ANSI")`
 - `lambda x = (round( np.interp( T1_x , RS_Elastic_D03_df["T"].values , RS_Elastic_D03_df["Sae"].values ) , 5) ) / (round( np.interp( T1_x , RS_Elastic_D02_df["T"].values , RS_Elastic_D02_df["Sae"].values ) , 5) )`
 - `lambda y = (round( np.interp( T1_y , RS_Elastic_D03_df["T"].values , RS_Elastic_D03_df["Sae"].values ) , 5) ) / (round( np.interp( T1_y , RS_Elastic_D02_df["T"].values , RS_Elastic_D02_df["Sae"].values ) , 5) )`
 - `metinInfo("Drift için analiz başlıyor")`
 - `ret = SapModel.SetModelIsLocked(False)`
 - `ret = SapModel.Analyze.RunAnalysis()`
 - `metinInfo("Drift için analiz bitti")`
 - `metinInfo(f"{Model_fileName} Drift okuma başlıyor")`
 - `ret = SapModel.Results.Setup.DeselectAllCasesAndCombosForOutput()`
 - `ret = SapModel.Results.Setup.SetCaseSelectedForOutput("ExS")`
 - `ret = SapModel.Results.Setup.SetCaseSelectedForOutput("EyS")`
 - `GroupElm, NumberResults, pointlist, Elm, LoadCase, StepType, StepNum, U1, U2, U3, R1, R2, R3 = 2, 0, [], [], [], [], [], [], [], [], []`
 - `[NumberResults, pointlist, Elm, LoadCase, StepType, StepNum, U1, U2, U3, R1, R2, R3 , ret_drift ] = SapModel.Results.JointDispl("All", GroupElm, NumberResults, pointlist, Elm, LoadCase, StepType, StepNum, U1, U2, U3, R1, R2, R3)`
 - `[NumberResults, pointlist, Elm, LoadCase, StepType, StepNum, U1, U2, U3, R1, R2, R3 , ret ] = SapModel.Results.JointDispl("All", GroupElm, NumberResults, pointlist, Elm, LoadCase, StepType, StepNum, U1, U2, U3, R1, R2, R3)`
 - `result_disp_df = pd.DataFrame( columns= ["JointName", "LoadCase", "U1", "U2"] )`
- Middle Window (Interactive Console):** Shows the output of the code execution, including a warning summary and a design summary for column 63.
 - `WarningSummary = []`
 - `[Name, NumberItem, FrameName, Location, TopCombo, TopArea, BotCombo, BotArea, VMajorCombo, VMajorArea, TCombo, TLArea, TTCombo, TTArea, ErrorSummary, WarningSummary] = SapModel.DesignConcrete.GetSummaryResultsBeam(Name, NumberItem, FrameName, Location, TopCombo, TopArea, BotCombo, BotArea, VMajorCombo, VMajorArea, TCombo, TLArea, TTCombo, TTArea, ErrorSummary, WarningSummary)`
 - `#def kolon_design_summary( Name = "63")`
 - `Name = "63"`
 - `NumberItem = 0`
 - `FrameName = []`
 - `MyOption = 1`
 - `Location = []`
 - `PWMCombo = []`
 - `PWMArea = []`
 - `PWMRatio = []`
 - `VMajorCombo = []`
 - `AVMajor = []`
 - `VMinorCombo = []`
 - `AVMinor = []`
 - `ErrorSummary = []`
 - `WarningSummary = []`
 - `[ NumberItem, FrameName, MyOption, Location, PWMCombo, PWMArea, PMWRatio , VMajorCombo , AVMajor , VMinorCombo , AVMinor , ErrorSummary , WarningSummary , ret ] = SapModel.DesignConcrete.GetSummaryResultsColumn( Name )`
 - `#return( PWMArea , PMWRatio , AVMajor , AVMinor )`
 - `#def joint_summary( Name = "63" ) :`
 - `"""`
 - `BURADA 63 KOLON İÇİN HESAP YAPILMIŞTIR.`
 - `"""`
 - `Name = "63"`
 - `NumberItems = 0`
 - `FrameName = []`
 - `LCJSRatioMajor = []`
 - `JSRatioMajor = []`
 - `LCJSRatioMinor = []`
 - `JSRatioMinor = []`
 - `LCBCCRatioMajor = []`
 - `BCCRatioMajor = []`
 - `LCBCCRatioMinor = []`
 - `BCCRatioMinor = []`
 - `ErrorSummary = []`
 - `WarningSummary = []`
 - `ItemType = 0`
 - `[ NumberItems, FrameName, LCJSRatioMajor , JSRatioMajor , LCJSRatioMinor , JSRatioMinor , LCBCCRatioMajor , BCCRatioMajor , LCBCCRatioMinor , BCCRatioMinor , ErrorSummary , WarningSummary , ret ] = SapModel.DesignConcrete.GetSummaryResultsJoint(Name )`
 - `#return( f"Beam-Column {BCCRatioMajor} and {BCCRatioMinor}" )`
 - `#print( joint_summary( Name = "63" ) )`
 - `Run Cell | Run Above | Debug Cell`
 - `# %%`
- Right Window (3D View):** Shows a 3D model of a building frame structure. The model is a longitudinal section of a reinforced concrete frame, showing columns and beams. The structure is labeled with various identifiers like (3218), (3219), (3220), (3221), (3222), (3223), (3224), (3225), (3226), (3227), (3228), (3229), (3230), (3231), (3232), (3233), (3234), (3235), (3236), (3237), (3238), (3239), (3240), (3241), (3242), (3243), (3244), (3245), (3246), (3247), (3248), (3249), (3250), (3251), (3252), (3253), (3254), (3255), (3256), (3257), (3258), (3259), (3260), (3261), (3262), (3263), (3264), (3265), (3266), (3267), (3268), (3269), (3270), (3271), (3272), (3273), (3274), (3275), (3276), (3277), (3278), (3279), (3280), (3281), (3282), (3283), (3284), (3285), (3286), (3287), (3288), (3289), (3290), (3291), (3292), (3293), (3294), (3295), (3296), (3297), (3298), (3299), (3300), (3301), (3302), (3303), (3304), (3305), (3306), (3307), (3308), (3309), (3310), (3311), (3312), (3313), (3314), (3315), (3316), (3317), (3318), (3319), (3320), (3321), (3322), (3323), (3324), (3325), (3326), (3327), (3328), (3329), (3330), (3331), (3332), (3333), (3334), (3335), 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Tamamlanan çalışmalar- 2.1: Deneysel verilerinin toplanıp gruplandırılması



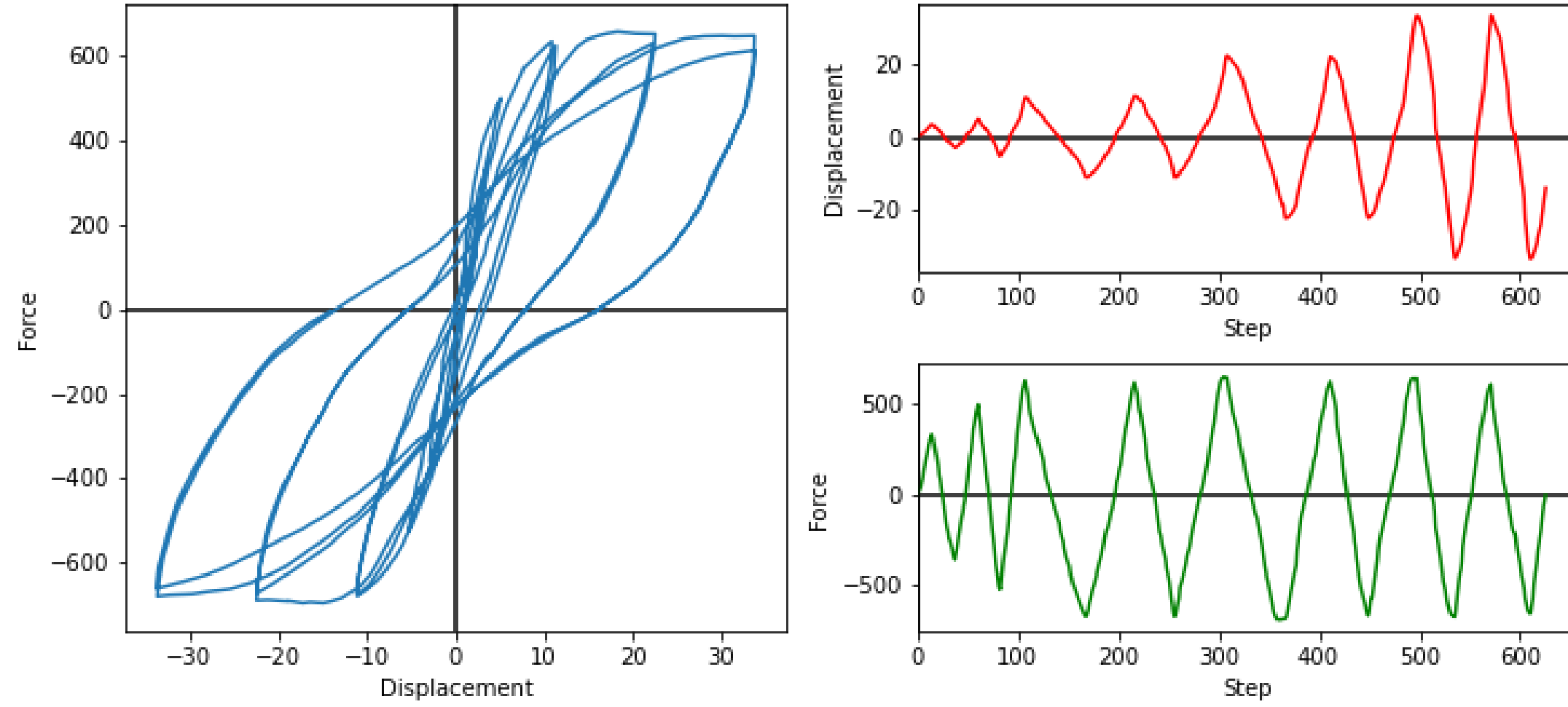
- # DATABASE
1 DesignSafe
<https://www.designsafe-ci.org/data/browser/public/>
- 2 NISEE
<https://nisee.berkeley.edu/spd/>
- 3 UW-PEER
<http://depts.washington.edu/columdat/main.htm>
- 4 Datacenterhub
<https://datacenterhub.org/resources/databases>
- 5 SERIES
<http://www.dap.series.upatras.gr/>
- 6 ZENODO
https://zenodo.org/search?page=1&size=20&q=rc%20frame&type=dataset&access_right=open

T.C. Cumhurbaşkanlığı
SANAYİ VE TEKNOLOJİ BAKANLIĞI
TÜBİTAK

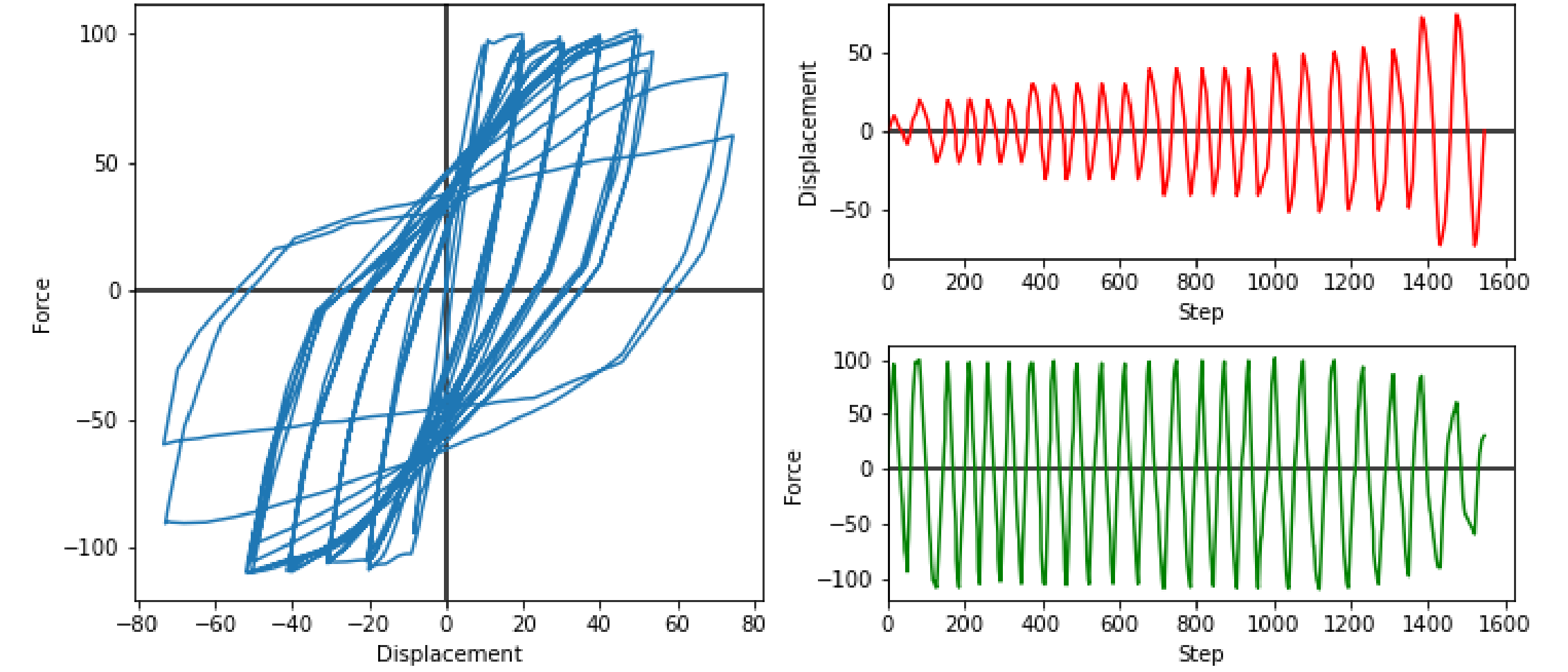


Tamamlanan çalışmalar- 2.1: Deneysel verilerinin toplanıp gruplandırılması

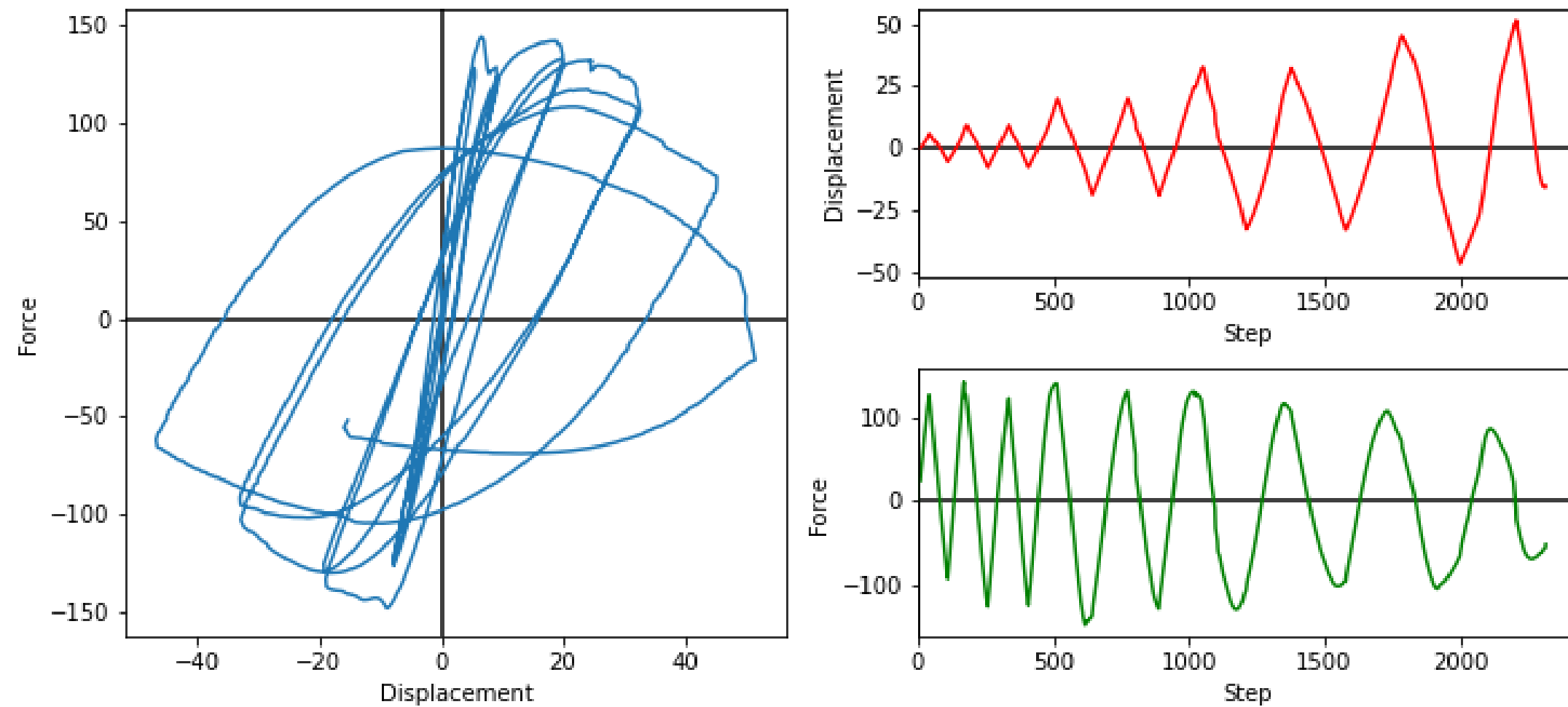
1 / gill79s1 / Gill et al. 1979, No. 1



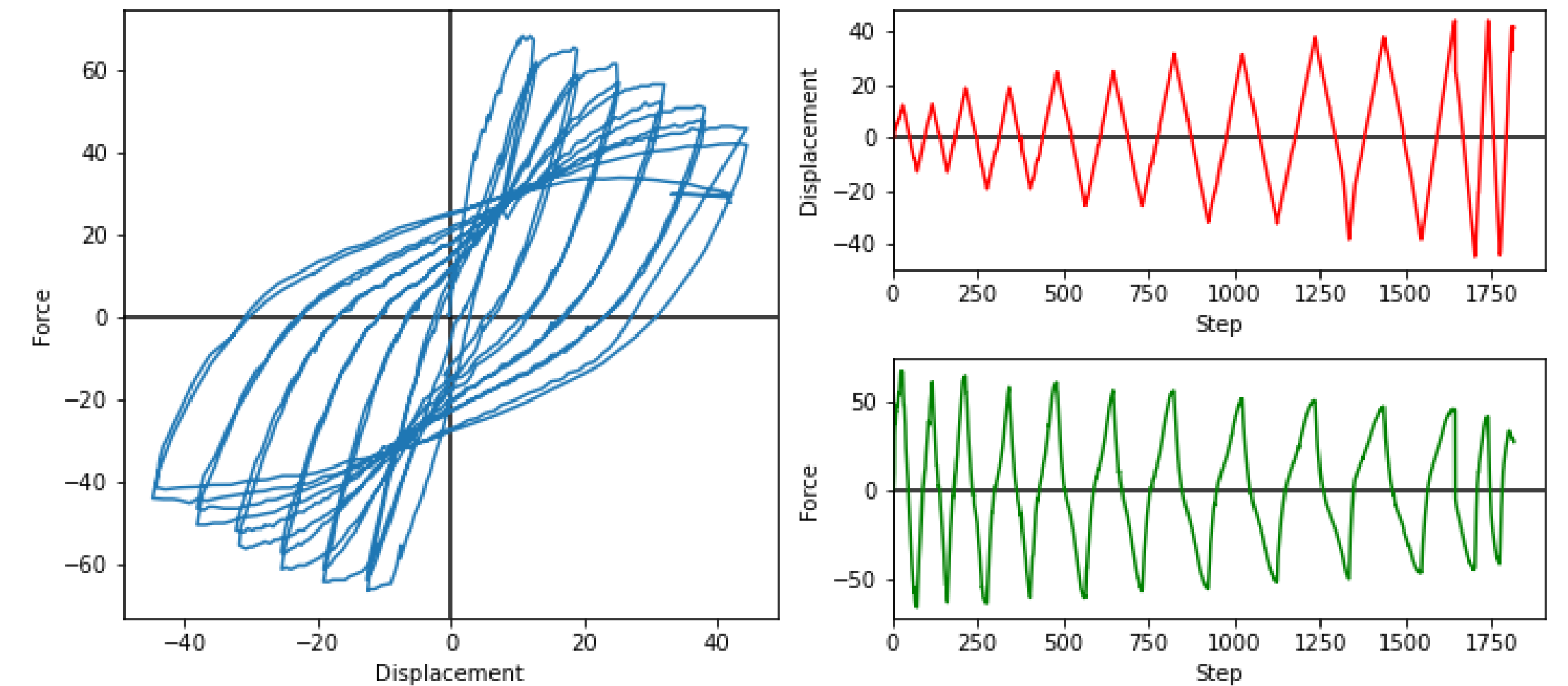
32 / ohno84l3 / Ohno and Nishioka 1984, L3



159 / shkas3ht / Bayrak and Sheikh 1996, AS-3HT



176 / mat1005s / Matamoros et al. 1999,C10-05S



Gelecek 6 ayın planlaması

121M713		AYLAR																							
İŞ PAKETLERİ	LEAD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
		10.2021	11.2021	12.2021	1.2022	2.2022	3.2022	4.2022	5.2022	6.2022	7.2022	8.2022	9.2022	10.2022	11.2022	12.2022	1.2023	2.2023	3.2023	4.2023	5.2023	6.2023	7.2023	8.2023	9.2023
RAPOR	AAD												P						P						P
1.1: Yapı setlerinin seçimi	AB	T																							
1.2: Yapı setlerinin tasarımı	AB		T	T																					
1.3: Yapı setlerinin performans değerlendirmesi	AAD				P	P																			
1.4: Deprem kayıtlarını seçimi ve ölçeklemesi	AAD						P																		
1.5: Zaman serisi analizleri	AAD							P	P																
1.6: Enerji talebinin hesaplanması	AG									P	P														
1.7: Tüketilen enerjinin yapıda konumlandırılması	AG										P	P													
1.8: Enerji dağılım modelinin çıkarılması	AG												P	P	P										
2.1: Deneysel verilerinin toplanıp gruplandırılması	ZM	T	T	T	P	P																			
2.2: Sonlu eleman modellerinin kurulması	ZM			N	N	N	P																		
2.3: Deney kalibrasyonu	ZM							P																	

İP2	2.5: Yükleme protokollerini uygulanması	ZM								P															
	2.6: Tüketilen enerjinin hesaplanması	AG																							
İP3	2.7: Tüketilen enerji sınıflandırılması	AB																							
	2.8: Enerji tüketme kapasite modelleri	HÖ																							
İP3	2.9: Gelişigüzel kesitlerin enerji esaslı hasar belirlenmesi	HÖ																							
	2.10: Hasar durumlarının karşılaştırması	AG																							
İP3	2.11: Yakın ve aykırı durumların belirlenmesi	AB																							
	2.12: Aykırı durumların kök neden analizi	AB																							
İP3	2.13: Kapasite modeli revizyonu	AB																							
	2.14: Hesap algoritmasının oluşturulması	HÖ																							
İP3	3.1: Tasarım hesap adımlarının belirlenmesi	*AB*																							
	3.2: Enerji isteminin belirlenmesi	AAD																							
İP3	3.3: Talep modelinin uyarlanması	AG																							
	3.4: Enerji kapasite tahmin esaslı performans belirlenmesi	AAD																							
İP3	3.5: Zayıf Kiriş-Güçlü kolon prensibinin geçerlilik kontrolü	ALL																							
	3.6: Yapı performansının belirlenmesi	ALL																							

A	B	C	D	E	F	G	H	I	J	K	L
121M713											
İŞ PAKETLERİ		LEAD	1	2	3	4	5	6	7	8	9
			10.2021	11.2021	12.2021	1.2022	2.2022	3.2022	4.2022	5.2022	6.2022
İP1	RAPOR	AAD									
	1.1: Yapı setlerinin seçimi	AB	T								
	1.2: Yapı setlerinin tasarımı	AB		T	T						
	1.3: Yapı setlerinin performans değerlendirmesi	AAD				P	P				
	1.4: Deprem kayıtlarını seçimi ve ölçeklemesi	AAD						P			
	1.5: Zaman serisi analizleri	AAD							P	P	
	1.6: Enerji talebinin hesaplanması	AG									P
	1.7: Tüketilen enerjinin yapıda konumlandırılması	AG									
	2.1: Deneysel verilerinin toplanıp gruplandırılması	ZM	T	T	T	P	P				
	2.2: Sonlu eleman modellerinin kurulması	ZM			N	N	N	P			
	2.3: Deney kalibrasyonu	ZM							P		
	2.4: Yükleme protokollerinin belirlenmesi	AG								P	
	2.5: Yükleme protokollerini uygulanması	ZM									P

1.1: Yapı setlerinin seçimi

1.2: Yapı setlerinin tasarımı

1.3: Yapı setlerinin performans değerlendirmesi



Büyük resim nedir?

121M713			AYLAR																							
İŞ PAKETLERİ		LEAD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
			10.2021	11.2021	12.2021	1.2022	2.2022	3.2022	4.2022	5.2022	6.2022	7.2022	8.2022	9.2022	10.2022	11.2022	12.2022	1.2023	2.2023	3.2023	4.2023	5.2023	6.2023	7.2023	8.2023	9.2023
	RAPOR	AAD	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	P ▼	▼	▼	▼	▼	▼	P ▼	▼	▼	▼	▼	▼	P ▼
İP1	1.1: Yapı setlerinin seçimi	AB	T ▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼
	1.2: Yapı setlerinin tasarımı	AB	▼	T ▼	T ▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼
	1.3: Yapı setlerinin performans değerlendirmesi	AAD	▼	▼	▼	P ▼	P ▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼
	1.4: Deprem kayıtlarını seçimi ve ölçeklemesi	AAD	▼	▼	▼	▼	▼	P ▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼
	1.5: Zaman serisi analizleri	AAD	▼	▼	▼	▼	▼	▼	P ▼	P ▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼
	1.6: Enerji talebinin hesaplanması	AG	▼	▼	▼	▼	▼	▼	▼	▼	P ▼	P ▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼
	1.7: Tüketilen enerjinin yapıda konumlandırılması	AG	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	P ▼	P ▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼
	1.8: Enerji dağılım modelinin çıkarılması	AG	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	P ▼	P ▼	P ▼	▼	▼	▼	▼	▼	▼	▼	▼	▼
İP2	2.1: Deneysel verilerinin toplanıp gruplandırılması	ZM	T ▼	T ▼	T ▼	P ▼	P ▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼
	2.2: Sonlu eleman modellerinin kurulması	ZM	▼	▼	N ▼	N ▼	N ▼	P ▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼
	2.3: Deney kalibrasyonu	ZM	▼	▼	▼	▼	▼	▼	P ▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼
	2.4: Yükleme protokollerinin belirlenmesi	AG	▼	▼	▼	▼	▼	▼	▼	P ▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼
	2.5: Yükleme protokollerini uygulanması	ZM	▼	▼	▼	▼	▼	▼	▼	▼	P ▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼
	2.6: Tüketilen enerjinin hesaplanması	AG	▼	▼	▼	▼	▼	▼	▼	▼	▼	P ▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼
	2.7: Tüketilen enerji sınıflandırılması	AB	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	P ▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼
	2.8: Enerji tüketme kapasite modelleri	HÖ	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	P ▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼
	2.9: Gelişigüzel kesitlerin enerji esaslı hasar belirlemesi	HÖ	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	P ▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼
	2.10: Hasar durumlarının karşılaştırması	AG	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	P ▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼
	2.11: Yakın ve aykırı durumların belirlenmesi	AB	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	P ▼	▼	▼	▼	▼	▼	▼	▼	▼	▼
	2.12: Aykırı durumların kök neden analizi	AB	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	P ▼	▼	▼	▼	▼	▼	▼	▼	▼
	2.13: Kapasite modeli revizyonu	AB	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	P ▼	▼	▼	▼	▼	▼	▼	▼
	2.14: Hesap algoritmasının oluşturulması	HÖ	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	P ▼	▼	▼	▼	▼	▼	▼
İP3	3.1:Tasarım hesap adımlarının belirlenmesi	*AB*	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	P ▼	▼	▼	▼	▼	▼
	3.2: Enerji isteminin belirlenmesi	AAD	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	P ▼	▼	▼	▼	▼	▼
	3.3: Talep modelinin uyarlaması	AG	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	P ▼	▼	▼	▼	▼
	3.4: Enerji kapasite tahmin esaslı performans belirlenmesi	AAD	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	P ▼	▼	▼	▼
	3.5: Zayıf giriş-Güçlü kolon prensibinin geçerlilik kontrolü	ALL	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	P ▼	▼	▼
	3.6: Yapı performansının belirlenmesi	ALL	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	P ▼	P ▼



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