

The Dynamic Tool

User MANUAL

PLPAKTM Version 2.00

STRUCTURAL ANALYSIS SOFTWARE USING THE BOUNDARY ELEMENTS METHOD

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1 Introduction

In this manual, Dynamic tool manual steps using Autodesk Revit addins tool is demonstrated. In the Autodesk Revit addins tool dynamics wizard can be used to solve a building supported on fixed base under dynamic loads. The user chooses Dynamics package, from Analysis and Design tool as shown in Figure 1

2 Browse for the PLPAK installation folder

The user browses for the directory of PLPAK installation folder (C:\Program Files\PLPAK) as shown in Figure 2



Figure 1 Dynamics Package wizard

🖳 Dynamic Analysis	- 🗆 X
Dynamic Analysis MR-Damper Control	
The following is the process for dynamics analysis of a tall building on fixed support	 owse for Installation Folder
Follow, the steps below sequentially.	.:\Program Files\PLPAK Browse
1- Export text files for PLPAK.	Log of actions:
Export Textfiles	Structural components and loading have been exp
2- Convert and create all BEFILEs.	
Create BEFILES	
Extract Stiffness only for Dynamic Analysis	
3- Run the TBPAK to solve your structure.	
Evtract Stiffness	
4. Rup Dupamic Analusis	
1. Generate Condensed Stiffness and	Damping Properties
Mass matrices	Damping Ratio:
2.1. Run UnDamped Time History	Damping Technique:
Anayoto	Ground Acceleration
2.2. Run Modal Analysis and Generate Damping matrix	Direction of Vibration:
	Number of Steps:
3. Run Damped Time History Analysis	Time Step (seconds):
	Add Ground Acceleration
OpenGL Viewer	
Save Results	

Figure 2 Browse for installation folder

3 Export text file

The user clicks on export text files to export all required text files for solving the super structure under dynamic load such as \$mat\$ text file as shown in Figure 3

🛃 Dynamic Analysis	- 🗆 X
Dynamic Analysis MR-Damper Control	
The following is the process for dynamics analysis of a tall building on fixed supports Follow, the steps below sequentially.	owse for Installation Folder
1- Export text files for PLPAK	Log of actions:
	Structural components and loading have been exp
2-Convert and create all BEFILEs.	
Create BEFILES	
Extract Stiffness only for Dynamic Analysis 3- Run the TBPAK to solve your structure.	
Extract Stiffness	
4- Bun Dynamic Analysis.	
1. Generate Condensed Stiffness and Mass matrices	Damping Properties Damping Ratio:
2.1. Run UnDamped Time History Analysis	Damping Technique:
2.2. Run Modal Analysis and Generate Damping matrix	Ground Acceleration Direction of Vibration:
3 Bun Damped Time History Analysis	Time Step (seconds):
	Add Ground Acceleration
OpenGL Viewer	
Save Results	
Load Results	Remove Ground Acceleration

Figure 3 Export text files button

4 Create **BEFILES**

The user clicks on Befiles as shown in Figure 4 to Convert text files into numerical boundary elements models for each floor.

Dynamic Analysis	:
Dynamic Analysis MR-Damper Control	
The following is the process for dynami analysis of a tall building on fixed supp Follow, the steps below sequentially.	cs orts, owse for Installation Folder _:\Program Files\PLPAK Browse
1- Export text files for PLPAK. Export Textfiles 2- Convert and create all BEFILEs.	Log of actions: Structural components and loading have been exp Boundary element files have been created for each
Create BEFILES Extract Stiffness only for Dynamic Analy 3- Bun the TBPAK to solve your structure	sis
Solve on GPU (check to solve on GP	U)
4- Run Dynamic Analysis.	
1. Generate Condensed Stiffness and Mass matrices	Damping Properties
2.1. Run UnDamped Time History Analysis	Damping Technique:
2.2. Run Modal Analysis and Generate Damping matrix	Direction of Vibration:
3. Run Damped Time History Analysis	Time Step (seconds):
OpenGL Viewer	Add Ground Acceleration
Caus Paulta	
Save nesults	Bemove Ground Acceleration
Load Results	Temore ground Accelerator

Figure 4 Create all BEFILES

5 GPU/CPU SOLVER

The user selects either select to perform structure stiffness matrix calculations using GPU or CPU solver. GPU solver is faster than CPU option. To use GPU option check on solve on GPU as shown in Figure 4

6 Extract Stiffness

The user click on Extract stiffness to construct structure stiffness matrix as shown in Figure 5

Dynamic Analysis MR-Damper Control	
The following is the process for dynamics analysis of a tall building on fixed support	s. owse for Installation Folder
Follow, the steps below sequentially.	.:\Program Files\PLPAK Browse
1- Export text files for PLPAK.	Log of actions:
Export Textfiles	Structural components and loading have been
2. Convert and create all REEU Es	Boundary element files have been created for e Translator has modified Revit files
Crosto REEU ES	BEAMMODE has been modified.
	Extracting, please wait
Extract Stiffness only for Dynamic Analysis 3- Bun the TBPAK to solve your structure	TBPAK has run successfully to extract Stiffness
Solve on GPU (check to solve on GPU)	1
Extract Stiffness	
4- Run Dynamic Analysis.	_
1. Generate Condensed Stiffness and	Damping Properties
Mass mances	
2.1. Run UnDamped Time History Analysis	Damping Lechnique:
	Ground Acceleration
2.2. Run Modal Analysis and Generate	Direction of Vibration:
Damping matrix	Number of Steps:
3. Run Damped Time History Analysis	Time Step (seconds):
	Add Ground Acceleration
OpenGL Viewer	
Save Results	
Load Results	Remove Ground Acceleration

Figure 5 Extract structure stiffness matrix button

7 Generate condensed stiffness and mass matrices

The user clicks on Generate condensed stiffness and mass matrices to construct structure stiffness and mass matrix as shown in Figure 6

骎 Dynamic Analysis		– 🗆 X
Dynamic Analysis MR-Damper Control		
The following is the process for dynamics analysis of a tall building on fixed supports Follow, the steps below sequentially. 1 - Export text files for PLPAK. Export Textfiles 2 - Convert and create all BEFILES. Create BEFILES Extract Stiffness only for Dynamic Analysis 3 - Run the TBPAK to solve your structure. Solve on GPU (check to solve on GPU)	owse for Installation Fold ::\Program Files\PLPAK Log of actions: Structural components an Boundary element files ha Translator has modified R BEAMMODE has been m RUNCONTROL has been Extracting, please wait TBPAK has run successfu	der Browse Id loading have been we been created for e evit files. odified. In modified. ally to extract Stiffness
Extract Stiffness		
 4- Run Dynamic Analysis. 1. Generate Condensed Stiffness and Mass matrices 2.1. Run UnDamped Time History Analysis 2.2. Run Modal Analysis and Generate Damping matrix 3. Run Damped Time History Analysis OpenGL Viewer 	Damping Properties Damping Ratio: Damping Technique: Ground Acceleration Direction of Vibration: Number of Steps: Time Step (seconds): Add Ground Name: (sin 500 point 0.0	0 Rayleigh Method V X-direction V 500 0.01 Acceleration D1.txt), No. of timesteps: 500
Save Results	Remove Ground	d Acceleration

Figure 6 Generate stiffness and mass matrices button

8 Perform undamped time history analysis

The user clicks on Run Undamped Time History Analysis to perform undamped time history analysis where equation of motion is solved to get the structure time history responses. The user should insert the following inputs for ground acceleration: the direction of vibration, number of ground accelerations steps and time step as shown in Figure 7

🖳 Dynamic Analysis	-	- 🗆 X
Dynamic Analysis MR-Damper Control		
The following is the process for dynamics analysis of a tall building on fixed supports Follow, the steps below sequentially. 1- Export text files for PLPAK. Export Textfiles	s, owse for Installation Folder c:\Program Files\PLPAK Log of actions: Structural components and loading Boundary element files have been	Browse
2- Convert and create all BEFILEs. Create BEFILES Extract Stiffness only for Dynamic Analysis 3- Run the TBPAK to solve your structure. Solve on GPU (check to solve on GPU)	Translator has modified Revit files. BEAMMODE has been modified. RUNCONTROL has been modified Extracting, please wait TBPAK has run successfully to extr	I. ract Stiffnes:
Extract Stiffness		
 4- Run Dynamic Analysis. 1. Generate Condensed Stiffness and Mass matrices 2.1. Run UnDamped Time History Analysis 2.2. Run Modal Analysis and Generate Damping matrix 3. Run Damped Time History Analysis 	Damping Properties 0 Damping Ratio: 0 Damping Technique: Rayleig Ground Acceleration 0 Direction of Vibration: X-direction Number of Steps: 500 Time Step (seconds): 0.01 Add Ground Acceleration	h Method v
OpenGL Viewer	Name: (sin 500 point 0.01.txt), No	o. of timesteps: 500
Load Results	Remove Ground Acceler	ation

Figure 7 Running undamped time history analysis button

9 Perform modal analysis and generate damping matrix

The user clicks on Run modal analysis and Generating Damping matrix to perform modal analysis, calculating mode shapes as shown in Figure 8. The user should insert damping properties: Damping techniques either using Caughey or Rayleigh method.

Dynamic Analysis	- 0
Dynamic Analysis MR-Damper Control	
The following is the process for dynamics analysis of a tall building on fixed supports Follow, the steps below sequentially. 1- Export text files for PLPAK. Export Textfiles 2- Convert and create all BEFILEs. Create BEFILES Extract Stiffness only for Dynamic Analysis 3- Run the TBPAK to solve your structure. Solve on GPU (check to solve on GPU) Extract Stiffness	s owse for Installation Folder ::\Program Files\PLPAK Browse Log of actions: Structural components and loading have been Boundary element files have been created for e Translator has modified Revit files. BEAMMODE has been modified. BUNCONTROL has been modified. Extracting, please wait TBPAK has run successfully to extract Stiffness
4- Run Dynamic Analysis. 1. Generate Condensed Stiffness and Mass matrices	Damping Properties Damping Ratio: 0
2.1. Run UnDamped Time History Analysis	Damping Technique: Rayleigh Method
2.2. Run Modal Analysis and Generate Damping matrix	Direction of Vibration: X-direction ~ Number of Steps: 500
3. Run Damped Time History Analysis	Time Step (seconds): 0.01 Add Ground Acceleration
OpenGL Viewer	Name: (sin 500 point 0.01.txt), No. of timesteps: 5
Save Results	Remove Ground Acceleration

Figure 8 Performing modal analysis and generating damping matrix button

10 Perform damped time history analysis

The user clicks on Run Damped Time History Analysis to performing damped time history analysis to get the structure responses. The user should insert the following input for ground accelerations: the direction of vibration, number of ground accelerations steps and time step and damping properties: Damping techniques either using Caughey or Rayleigh method as shown in Figure 9.

•	Dynamic Analy	ysis				_		\times
)vnamic Analysis	MR-Damper Control						
-	The following is analysis of a tall	the process for dynam building on fixed supp	nics ports.	owse for Installation Fol	der			
	Fullow, the steps	below sequencially.		J:\Program Files\PLPAK			Browse	
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	2-Convert and cr	reate all BEFILEs.		Translator has modified F	Revit file	S.	1	
	Creat	e BEFILES		RUNCONTROL has bee	n modifi	ed.		
	Extract Stiffness	only for Dynamic Anal	ysis	TBPAK has run success	ully to e	xtract S	itiffnes:	
	3- Run the TBPA	K to solve your structur U (check to solve on Gi	e. PU1					
	Extra	ct Stiffness	-,					
	4- Run Dynamic /	Analysis.						
	1. Generate Co	ondensed Stiffness and		Damping Properties				
	Ма	iss matrices	-	Damping Ratio:	0		01	
	2.1. Run Un	Damped Time History		Damping Lechnique:	Rayle	eign Me	tnod 🗸	
	Analysis		_	Ground Acceleration				
	2.2. Run Moda	Analysis and Generate		Direction of Vibration:	X-dire	ection	~	
	Dar	mping matrix		Number of Steps:	500			
L	2 D	d Time I linkers Asselutio		Time Step (seconds):	0.01			
	3. Hun Dampe	a Time History Analysis	4	Add Ground	Accele	ration		
	Oper	nGL Viewer		Name: (sin 500 point 0.	01.txt),	No.oft	mesteps:	500
	Sau	e Beculto						
	794	erresuits						
	Loa	d Results		Remove Grour	id Accel	eration		

Figure 9 Running damped time history analysis button

11 Open GL

The user can use OpenGL viewer to display the structure 3D VIEW and toggle drawing mode as shown in Figure 10 and Figure 11 respectively

- The user should load \$FG\$ from PLPAK installation folder as shown in Figure 12
- The user can display toggle mode by click on toggle drawing mode as shown in Figure 11
- The user can display time history text file "Y-HT1.txt" file from dynamic folder as shown in Figure 13
- The user should load time history file "Y-HT1.txt" file from dynamic folder as shown in Figure 14 and Figure 15 to display structure time history response.
- The user should load mode file "Mode.txt" file from dynamic folder to display structure mode shapes as shown in Figure 14 and Figure 16



Figure 11 Toggle drawing model



Figure 12 Selection of \$FG\$ text file from PLPAK installation folder

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1	0.000000E+00	0.156981E-05	0.941280E-05	0.297780E-04	0.688663E-04	0.132806E-03	0.2276
2	0.00000E+00	-0.174599E-11	-0.179655E-10	-0.941157E-10	-0.341633E-09	-0.997391E-09	-0.2588
	0.000000E+00	-0.218910E-12	-0.226034E-11	-0.117333E-10	-0.410906E-10	-0.112843E-09	-0.2858
	0.00000E+00	0.156977E-05	0.941236E-05	0.297757E-04	0.688582E-04	0.132787E-03	0.2276
	0.00000E+00	0.192348E-12	0.979313E-12	-0.306870E-11	-0.552999E-10	-0.291247E-09	-0.7636
	0.000000E+00	0.410305E-13	0.349462E-12	0.104307E-11	-0.381861E-11	-0.539480E-10	-0.2542
	0.00000E+00	0.156977E-05	0.941239E-05	0.297761E-04	0.688621E-04	0.132808E-03	0.2276
	0.000000E+00	-0.177591E-12	-0.253180E-11	-0.163981E-10	-0.311742E-10	0.245521E-09	0.2052
	0.00000E+00	0.105070E-13	-0.117003E-12	-0.365228E-11	-0.264588E-10	-0.701534E-10	0.1040
	0.000000E+00	0.156978E-05	0.941270E-05	0.297789E-04	0.688716E-04	0.132798E-03	0.2274
	0.00000E+00	-0.436462E-12	-0.197023E-11	0.306197E-10	0.349232E-09	0.155067E-08	0.320
	0.00000E+00	-0.106885E-12	-0.167970E-11	-0.598583E-11	0.355041E-10	0.405554E-09	0.171
	0.00000E+00	0.156985E-05	0.941305E-05	0.297740E-04	0.688112E-04	0.132510E-03	0.226
	0.00000E+00	0.103061E-11	0.235002E-10	0.147936E-09	0.186670E-09	-0.214535E-08	-0.144
	0.000000E+00	-0.204610E-13	0.451019E-11	0.625548E-10	0.344952E-09	0.916116E-09	0.5612
	0.00000E+00	0.156954E-05	0.940608E-05	0.297239E-04	0.686616E-04	0.132473E-03	0.2280
	0.000000E+00	0.212681E-11	-0.290815E-10	-0.614658E-09	-0.409333E-08	-0.152247E-07	-0.3640
	0.00000E+00	0.216242E-11	0.265659E-10	0.893817E-10	-0.177296E-09	-0.243682E-08	-0.9644
	0.000000E+00	0.156779E-05	0.939928E-05	0.297999E-04	0.693827E-04	0.135367E-03	0.2351
	0.00000E+00	-0.308393E-10	-0.414748E-09	-0.210087E-08	-0.496260E-08	-0.143853E-08	0.3143
	0.000000E+00	-0.394146E-12	-0.648568E-10	-0.652443E-09	-0.298188E-08	-0.790485E-08	-0.1269
	0.00000E+00	0.157861E-05	0.955692E-05	0.306506E-04	0.718061E-04	0.139185E-03	0.2368
	0.00000E+00	-0.268744E-10	0.312457E-09	0.446124E-08	0.240261E-07	0.818939E-07	0.2089
	0.00000E+00	-0.378943E-10	-0.345186E-09	-0.118876E-08	-0.132474E-08	0.401116E-08	0.2184
	0.00000E+00	0.162669E-05	0.972902E-05	0.302224E-04	0.672377E-04	0.122569E-03	0.196
	0.00000E+00	0.459732E-09	0.421337E-08	0.191090E-07	0.582954E-07	0.137288E-06	0.2708
	0.00000E+00	0.165810E-10	0.509429E-09	0.363942E-08	0.137136E-07	0.347266E-07	0.6790
	0.000000E+00	0.125284E-05	0.670237E-05	0.183442E-04	0.363139E-04	0.605368E-04	0.9123
	0.000000E+00	0.164722E-09	0.140700E-08	0.599082E-08	0.173337E-07	0.389687E-07	0.7339
	0.000000E+00	0.324598E-09	0.237911E-08	0.827833E-08	0.189334E-07	0.338475E-07	0.5312

Figure 13 "Y-HT1" text file

Name	Date modified	Туре	Size
SAS	6/21/2022 11:14 PM	File	21 KB
CMATRIX	6/21/2022 11:13 PM	File	24 KB
DampingParameters	6/21/2022 11:11 PM	File	1 KB
🗋 ғ-нті	6/21/2022 11:14 PM	File	337 KB
🗋 FT	6/21/2022 11:14 PM	File	191 KB
K-COND	6/21/2022 11:14 PM	File	517,496 KB
🗋 КМ	6/21/2022 11:14 PM	File	17 KB
M-COND	6/21/2022 11:14 PM	File	427,486 KB
🗋 Mode	6/21/2022 11:14 PM	File	74 KB
📔 TH-DAT_sin 500 point 0.01.txt	6/21/2022 11:13 PM	TXT File	6 KB
□ xm	6/21/2022 11:14 PM	File	17 KB
🗋 XM1	6/21/2022 11:06 PM	File	0 KB
🗅 Ү-НВ	6/21/2022 11:10 PM	File	0 KB
Y-HT1_sin 500 point 0.01.txt	6/21/2022 11:14 PM	TXT File	337 KB

Figure 14 Dynamics created folder



Figure 15 Structure time history displacement



Figure 16 Structure mode shape

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