

Rapid Impact[™] Testing of Any Size Structure

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Topics of this Presentation

- Limitations of Single Reference Modal Testing
- **≻Simulated** Rapid Impact[™] Test
- >Modal Residues => Mode Shapes
- First Law of Modal Analysis (1st LoMA): Any object with mass & elasticity will vibrate
- Second Law of Modal Analysis (2nd LoMA): Forces cause vibration
- Third Law of Modal Analysis (3rd LoMA): All vibration is a summation of mode shapes
- Fourth Law of Modal Analysis (4th LoMA): All modes are excited at all frequencies



Modal Parameters from a Roving Impact Test

Modal parameters are extracted by *curve fitting a set of FRFs* calculated from a roving impact test





FRFs From a Roving Impact Test

- Single-reference test: *One row* of the FRF matrix is calculated from *multiple Impact DOFs* and *one Response DOF*
- Multi-reference test: Multiple rows of the FRF matrix are calculated from multiple Impact DOFs and multiple Response DOFs



Modal Parameters From a Roving Response Test

Modal parameters are extracted by *curve fitting a set of FRFs* calculated from a roving response test





FRFs From a Roving Response Test

- > Single-reference test: *One column* of the FRF matrix is calculated from *one Impact DOF* and *multiple Response DOFs*
- Multi-reference test: Multiple columns of the FRF matrix are calculated from multiple Impact DOFs and multiple Response DOFs



Modal Parameters From FRFs

Each mode is *defined with three parameters*

Modal frequency

frequency of its resonance peak

Modal damping

 width of its resonance peak (half power point, 3dB width)

Mode shape

 magnitude & phase of each resonance peak at the same frequency





Rapid Impact[™] Test

The impact DOFs and response sensor DOFs can change between measurements



Multi-Reference Roving Response Impact Test















Multi-Reference Roving Response Impact Test





The grating was *impacted in the X, Y, Z directions* at one corner (Point 1)
 Tri-axial accelerometers were attached to 64 points on the grating
 Data was acquired in *multiple Measurement Sets*



Mode Shapes of the Grating

Five mode shapes were extracted from 576 FRFs (64 points x 3 directions x 3 references) using multi-reference curve fitting





Mode Shapes of the Grating

Each mode shape *participates differently* in each direction of the dynamics

*STR: Renumbered Steel-Rack - 3D View		*SHP: Renu	mbered UMM M	ode Shapes						83	
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or - 1

Multi-Input Multi-Output (MIMO) Simulation

> Third Law of Modal Analysis (3rd LoMA): All vibration is a summation of mode shapes

>A modal model with five flexible modes was used to model the dynamics of the grating





First Six Impacts of Simulated Rapid Impact™



CHNOLOGY

Rapid Impact[™] Test FRF & Coherence Calculation





Rapid Impact[™] Test FRF & Coherence Calculation





Rapid Impact[™] Test FRFs & Coherence





Quick Fit of Rapid Impact[™] FRFs

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Quick Fit of Rapid Impact[™] FRFs

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Modal Residues → Mode Shape

Each modal residue is the product of two mode shape components



Converting Rapid Test Residues to a Mode Shape

Starting with a Driving Point Residue

 $MSC(1) = \sqrt{RES(1:1)} = \sqrt{MSC(1) \times MSC(1)}$

MSC(2) = RES(1:2) / MSC(1)

MSC(3) = RES(1:3) / MSC(1)

MSC(3) = RES(2:3) / MSC(2)

MSC(4) = RES(3:4) / MSC(3) = RES(4:3) / MSC(3)



$$MSC(1) = \sqrt{\frac{RES(1:2) \times RES(1:3)}{RES(2:3)}}$$
$$= \sqrt{\frac{MSC(1) \times MSC(2) \times MSC(1) \times MSC(3)}{MSC(2) \times MSC(3)}}$$



Modal Residues → Mode Shape

Each modal residue is the *product of two mode shape components*

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4	38.3	0.0858	Hz	~	0.224	0.907					4	38.3	0.0858	H	z ~	0.224	0.909				
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M#3	1Z:1Y [1	1] g/lbf-	sec ~		Rapid Test	Residue	~	0.000527	307	0	M#3	3 1Z	in/lbf-sec	~	UMI	M Mode Sha	ape 🗸	Poly	0.665	354	
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M#8	6Y:1Y [3	3] g/lbf-	sec ~		Rapid Test	Residue	~	4.79E-05	306	(M#8	3 3Y	in/lbf-sec	~	UMI	M Mode Sha	ape 🗸	Poly	0.0127	355	
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M#10	6X:1Z [4	4] g/lbf-	sec ~		Rapid Test	Residue	~	0.00976	346	0	M#1	0 4X	in/lbf-sec	~	UMI	M Mode Sha	ape 🗸	Poly	0.0783	353	
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Comparison of Rapid Impact[™] & Original Mode Shapes

🔂 *STR: Renumbered Steel-Rack - 3D View, - [Sweep] SHP: Renumbered UMM Mode Shapes	SHP: Ren	umbered UMM Mo	de Shapes			
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	3	31.3	0.0865	Hz ~	0.276	1X: 0.05 1¥
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	3	31.3	0.0865	Hz ~	0.276	
TEAL	4	38.3	0.0858	Hz ~	0.224	
	5	48.5	0.113	Hz ~	0.233	
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	M#	3 1Z	in/lbf-sec	~ UM	M Mode Sha	pe v Pol
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Comparison of Rapid Impact[™] & Original Mode Shapes

Image:	🤹 VT-950 Visual STN: AppNote55.VTprj					– 🗆 X
Image: Shift: Renumbered UMM Mode Sha Image: Shift: Renumbered UMM Mode Sha Image: Shift: Renumbered UMM Mode Sha Image: Shift: Renumbered UMM Mode Sha Image: Shift: Renumbered UMM Mode Sha Image: Shift: Renumbered UMM Mode Sha Image: Shift: Renumbered UMM Mode Sha Image: Shift: Renumbered UMM Mode Sha Image: Shift: Renumbered UMM Mode Sha Image: Shift: Renumbered UMM Mode Sha Image: Shift: Renumbered UMM Mode Sha Image: Shift: Renumbered UMM Mode Sha Image: Shift: Renumbered UMM Mode Sha Image: Shift: Renumbered UMM Mode Sha Image: Shift: Renumbered UMM Mode Sha Image: Shift: Renumbered UMM Mode Sha Image: Shift: Renumbered UMM Mode Sha Image: Shift: Renumbered UMM Mode Sha Image: Shift: Renumbered UMM Mode Sha Image: Shift: Renumbered UMM Mode Sha Image: Shift: Renumbered UMM Mode Sha Image: Shift: Renumbered UMM Mode Sha Image: Shift: Renumbered UMM Mode Sha Image: Shift: Renumbered UMM Mode Sha Image: Shift: Renumbered UMM Mode Sha Image: Shift: Renumbered UMM Mode Sha Image: Shift: Renumbered UMM Mode Sha Image: Shift: Renumbered UMM Mode Sha Image: Shift: Renumbered UMM Mode Sha Image: Shift: Renumbered UMM Mode Sha Image: Shift: Renumbered UMM Mode Sha Image: Shift: Renumbered UMM Mode Sha Image: Shift: Renumbered UMM Mode Sha Image: Shift: Renumbered UMM Mode Sha Ima	📕 🗄 🗄 🛛 🖉 🗃 🕼 🕼 🕼 🕼 🕄 🕼 🕼 🕼 🕼 🕼 🖉 🕼 🖉 Stop All Scripts 🛛 Project Windows File Edit Display Animate Draw M# Links Video SDM FEA Script Help 🕞 🗔	•				
Current Project Demos Plachinery Vehicles	: 😂 🕋 🚽 SHP: Renumbered ШММ Mode Sha 🕞 < 🖕 💱 🖌 💿 🗑 🖊 ム 🔉 🎘 🦗 米 田 🗉 🍳 🤤 🕂 O 🚽 🏘 - 🖶 🌮 🔛 📓 🗮 🗮 🤹 🏤 👰	« II »	₹ ≵ .			
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Select Frequency Damping Units Damping (%) 1 16.5 0.061 Hz 0.287 3 31.3 0.0865 Hz 0.2276 4 338.3 0.0858 Hz 0.223 5 48.3 0.0858 Hz 0.223 5 48.3 0.0858 Hz 0.223 5 48.5 0.13 Hz 0.233 1 12 in/bf-sec UMM Mode Shi M#1 1X in/bf-sec UMM Mode Shi M#1 15 in/bf-sec UMM Mode Shi M#1 12 in/bf-sec UMM Mode Shi M#1 22 in/bf-sec UMM Mode Shi	STR: Renumbered Steel-Rack - 3L view	SHP: Ren	umbered UMM Mo	de Shapes		
I 1 16.5 0.061 Hz 0.369 Z 2.3.5 0.0675 Hz 0.287 4 38.3 0.0858 Hz 0.224 5 48.5 0.113 Hz 0.223 Image: Select Field Rape Test Made Shape	SL	Select Shape	Frequency (or Time)	Damping	Units	Damping (%)
2 23.5 0.0675 Hz 0.287 3 31.3 0.0665 Hz 0.276 4 83.3 0.0858 Hz 0.233 5 48.5 0.113 Hz 0.233 Select DOFs Units Measureme ^ M#1 1X in/Ibf-sec UNM Mode Sh		1	16.5	0.061	Hz 🗸	0.369
3 31.3 0.0865 Hz 0.226 4 38.3 0.0858 Hz 0.224 5 44.5 0.113 Hz 0.233 Select DOFs Units Measureme ^ Type M#1 1X in/lbf-sec UMM Mode Sh. M#2 1Y in/lbf-sec UMM Mode Sh. M#3 12 in/lbf-sec UMM Mode Sh. M#3 12 in/lbf-sec UMM Mode Sh. M#3 12 in/lbf-sec UMM Mode Sh. M#4 2Y in/lbf-sec UMM Mode Sh. M#5 2Y in/lbf-sec UMM Mode Sh. M#5 2Y in/lbf-sec UMM Mode Sh.		2	23.5	0.0675	Hz 🗸	0.287
4 38.3 0.0658 Hz 0.224 5 48.5 0.113 Hz 0.233 Select DOFs Units Measureme nigge M# DOFs Units Measureme nigge M# 1X in/lbf-sec UMM Mode Sh. Select Measureme nigge Mi# Nits Select Mi# 1X in/lbf-sec UMM Mode Sh. M# DOFs Units Measureme nigge Y M# 1X in/lbf-sec UMM Mode Sh. Y M# 2Y in/lbf-sec UMM Mode Sh. Y M# 2Y in/lbf-sec UMM Mode Sh. Y M# 27 in/lbf-sec UMM Mode Sh. Y		3	31.3	0.0865	Hz 🗸	0.276
Select Frequency Damping Units Damping (%) Select DOFS Units Measureme ^ Select Frequency Damping Units Damping (%) Select Frequency Damping Units Damping (%) Select Frequency Damping Units Damping (%) Select Trequency Damping (%) Selec		4	38.3	0.0858	Hz 🗸	0.224
Select DOFs Units Measureme M#1 1X in/lbf-sec UMM Mode Sh. Select DOFs Units Measureme (%) Select Trequency Damping Units Damping (%) Select DOFs Units Measureme Type M#1 1X in/lbf-sec UMM Mode Sh. M#2 1V in/lbf-sec UMM Mode Sh. M#3 12 in/lbf-sec UMM Mode Sh. M#3 22 in/lbf-sec UMM Mode Sh. M#3 22 in/lbf-sec UMM Mode Sh. M#5 22 in/lbf-sec UMM Mode Sh. M#5 22 in/lbf-sec UMM Mode Sh.		5	48.5	<mark>0.1</mark> 13	Hz ~	0.233
Select DOFs Units Measureme Type M#1 1X in/lbf-sec UMM Mode Sh. Select Frequency Damping Units Damping (%) Select Frequency Damping Units Damping (%) Select Frequency Damping Units Object (%) Select Dofs Units Measureme Type M#1 1X in/lbf-sec UMM Mode Sh. M#2 1Y in/lbf-sec UMM Mode Sh. M#4 2X in/lbf-sec UMM Mode Sh. M#5 2Y in/lbf-sec UMM Mode Sh. M#6 27 in/lbf-sec UMM Mode Sh.		<				>
Z X X in/lbf-sec UMM Mode Shi X Y in/lbf-sec UMM Mode Shi M#1 1X in/lbf-sec UMM Mode Shi M#2 1Y in/lbf-sec UMM Mode Shi M#3 1Z in/lbf-sec UMM Mode Shi M#3 1Z in/lbf-sec UMM Mode Shi M#4 2X in/lbf-sec UMM Mode Shi M#5 2Y in/lbf-sec UMM Mode Shi M#5 27 in/lbf-sec UMM Mode Shi		Select M#	t DOFs	Units		Measureme ^ Type
Z X		M#	1 1X	in/lbf-sec	~ UMI	M Mode Sha
Z X Y in/lbf-sec UMM Mode Sh: M#2 1Y in/lbf-sec UMM Mode Sh: M#4 2X in/lbf-sec UMM Mode Sh: M#4 2X in/lbf-sec UMM Mode Sh: M#4 2X in/lbf-sec UMM Mode Sh: M#5 2Y in/lbf-sec UMM Mode Sh: M#5 2Y in/lbf-sec UMM Mode Sh:		<				>
Select Frequency Damping Units Damping (%) 1 16.5 0.061 Hz 0.369 Select DOFs Units Measureme Type M#1 1X in/lbf-sec UMM Mode Shi M#2 1Y in/lbf-sec UMM Mode Shi M#3 1Z in/lbf-sec UMM Mode Shi M#4 2X in/lbf-sec UMM Mode Shi M#5 2Y in/lbf-sec UMM Mode Shi M#6 27 in/lbf-sec UMM Mode Shi		SHP: Rap	id Test Mode Shape	5		
Z X 1 16.5 0.061 Hz 0.369 Select DOFs Units Measureme ^ Type M#1 1X in/lbf-sec UMM Mode Shi M#2 1Y in/lbf-sec UMM Mode Shi M#3 1Z in/lbf-sec UMM Mode Shi M#5 2Y in/lbf-sec UMM Mode Shi M#5 27 in/lbf-sec UMM Mode Shi		Select Shape	Frequency (or Time)	Damping (1997)	Units	Damping ^ (%)
Z X Select M# DOFs Units Measureme Type M#1 1X in/lbf-sec UMM Mode Shi M#2 1Y in/lbf-sec UMM Mode Shi M#3 1Z in/lbf-sec UMM Mode Shi M#4 2X in/lbf-sec UMM Mode Shi M#5 2Y in/lbf-sec UMM Mode Shi M#6 27 in/lbf-sec UMM Mode Shi		1	16.5	0.061	Hz 🗸	0.369 >
X M#1 1X in/lbf-sec V UMM Mode Shi M#2 1Y in/lbf-sec V UMM Mode Shi M#3 1Z in/lbf-sec V UMM Mode Shi M#4 2X in/lbf-sec V UMM Mode Shi M#5 2Y in/lbf-sec V UMM Mode Shi M#6 27 in/lbf-sec V UMM Mode Shi		Select M#	t _{DOFs}	Units		Measureme ^ Type
z x M#2 1Y in/lbf-sec UMM Mode Shi M#3 1Z in/lbf-sec UMM Mode Shi M#4 2X in/lbf-sec UMM Mode Shi M#5 2Y in/lbf-sec UMM Mode Shi M#6 27 in/lbf-sec UMM Mode Shi	V III	M#	1 1X	in/lbf-sec	V UMI	M Mode Sha
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X X X X X X X X X X X X X X X X X X X		M#:	3 1Z	in/lbf-sec	~ UMI	M Mode Sha
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M#6 27 in/lbf-sec VIMM Mode Sh: *	x ^{aT} *Y	M#!	5 2Y	in/lbf-sec	~ UMI	M Mode Sha
		< M#	6 27	in/lhf-sec		M Mode Sh;*



Rapid Impact[™] Test Summary

t Project Demos Machinery Vehicles									
Renumbered Steel-Rack - 3D View		3 📔 *SHP: Ren	umbered UMM M	ode Shapes					
		S Select F Shape	Frequency (or Time)	Damping	Uni	ts Damping (%)		Modal Participation	า
		1	16.5	0.061	Hz	~ 0.369	1X: -0	0.01 1Y: -0.06	-1Z: -1.0
		2	23.5	0.0675	Hz	· 0.287	1X: -0	0.86 1Y: -0.49	-1Z: 0.1
へ		3	31.3	0.0865	Hz	~ 0.276	1X: (0.05 1Y: 1.00	-1Z: 0.04
		4	38.3	0.0858	Hz	× 0.224	1X: -0	0.04 1Y: 0.16	-1Z: -0.9
		5	48.5	0.113	Hz	× 0.233	1X: -0	0.14 1Y: -0.99	-1Z: -0.0
39 23 20 29		M#	DOID	onita		Туре		Magnitude	Phase
	23 18 18	M#	3Y	in/lbf-sec	~	Type UMM Mode Shap	e 🗸	Magnitude 0.0126	Phase 355
4 39 33 34 29 44 40 34 35 35 52 46 41 42 36 153 417 42 36		M# M#8 M#9	3Y 3Z	in/lbf-sec	>	Type UMM Mode Shap U <mark>MM Mode Shap</mark>	e ~ e ~	Magnitude 0.0126 0.0664	Phase 355 354
4 39 33 34 29 4 40 41 35 34 29 52 46 41 42 35 53 53 47 48 43 59 53 54 54 44	23 18 130 24 25 31 31 33	M# M#8 M#9 M#1	3 3Y 3 3Z 0 4X	in/lbf-sec in/lbf-sec in/lbf-sec	>	Type UMM Mode Shap <mark>UMM Mode Shap</mark> UMM Mode Shap	e ~ e ~	Magnitude 0.0126 0.0664 0.0781	Phase 355 354 353
4 39 33 34 29 52 46 41 35 35 53 53 54 44 43 59 55 54 55 449 59 60 55 55 50 55	22 118 130 224 25 31 31 37 38	M# M#8 M#9 M#1 M#1	3Y 3Z 4X 4Y	in/lbf-sec in/lbf-sec in/lbf-sec in/lbf-sec	 <	Type UMM Mode Shap UMM Mode Shap UMM Mode Shap UMM Mode Shap	e ~ e ~ e ~	Magnitude 0.0126 0.0664 0.0781 0.0401	Phase 355 354 353 175
4 39 33 34 29 52 46 40 41 35 52 46 47 42 36 58 53 54 48 43 44 55 54 55 49 54 55 50 51 55 59 51 51	22 118 130 221 25 31 33 37 38	M# M#8 M#9 M#1 M#1 M#1	3 3Y 3Z 3Z 4X 4Y 4Z 4Z	in/lbf-sec in/lbf-sec in/lbf-sec in/lbf-sec in/lbf-sec		Type UMM Mode Shap UMM Mode Shap UMM Mode Shap UMM Mode Shap UMM Mode Shap	be ~ be ~ be ~ be ~ be ~	Magnitude 0.0126 0.0664 0.0781 0.0401 0.254	Phase 355 354 353 175 173
4 39 33 34 29 52 45 46 41 35 53 54 55 49 44 53 55 49 55 56 57 51 55 53 54 55 50 53 55 55 50 53 55 57 51 53 55 57 51 55 57 51 55	22 18 130 24 25 37 38	M# M#8 M#9 M#1 M#1 M#1 M#1	33 37 32 3Z 0 4X 1 4Y 2 4Z 3 5X	in/lbf-sec in/lbf-sec in/lbf-sec in/lbf-sec in/lbf-sec in/lbf-sec	> > > > > > >	Type UMM Mode Shap UMM Mode Shap UMM Mode Shap UMM Mode Shap UMM Mode Shap	ne v ne v ne v ne v ne v ne v	Magnitude 0.0126 0.0664 0.0781 0.0401 0.254 0.0768	Phase 355 354 353 175 173 353
4 39 40 41 52 46 47 48 43 43 43 44 55 55 55 55 55 55 55 55 55	23 10 24 25 31 37 38 37 38	M# M#8 M#9 M#1 M#1 M#1 M#1 M#1	2013 3Y 3Z 4X 4Y 4Y 5X 5X	in/lbf-sec in/lbf-sec in/lbf-sec in/lbf-sec in/lbf-sec in/lbf-sec in/lbf-sec		Type UMM Mode Shap UMM Mode Shap UMM Mode Shap UMM Mode Shap UMM Mode Shap UMM Mode Shap	be v be v be v be v be v be v be v	Magnitude 0.0126 0.0664 0.0781 0.0401 0.254 0.0768 0.085	Phase 355 354 353 175 173 353 175
4 39 52 52 52 55 55 55 55 55 55 55	22 18 130 224 25 377 38	M# M#8 M#9 M#1 M#1 M#1 M#1 M#1 M#1	2013 3Y 3Z 4X 4X 4Y 2 4Z 5X 4 5Z 5Z	in/lbf-sec in/lbf-sec in/lbf-sec in/lbf-sec in/lbf-sec in/lbf-sec in/lbf-sec	> > > > > > > > > > > > > >	Type UMM Mode Shap UMM Mode Shap UMM Mode Shap UMM Mode Shap UMM Mode Shap UMM Mode Shap UMM Mode Shap	be ve	Magnitude 0.0126 0.0664 0.0781 0.0401 0.254 0.0768 0.085 0.57	Phase 355 354 353 175 173 353 175 174
4 39 52 46 47 52 54 55 55 55 55 55 55 55 55 55	22 30 31 37 38	M# M#8 M#9 M#1 M#1 M#1 M#1 M#1 M#1 M#1	337 32 32 32 4 4 4 5 52 6	in/lbf-sec in/lbf-sec in/lbf-sec in/lbf-sec in/lbf-sec in/lbf-sec in/lbf-sec in/lbf-sec in/lbf-sec	> > > > > > > > > > > > > >	Type UMM Mode Shap UMM Mode Shap	De >	Magnitude 0.0126 0.0664 0.0781 0.254 0.254 0.0768 0.085 0.57 0.0544	Phase 355 354 353 175 173 353 175 174 172
4 39 40 41 52 45 46 47 48 43 44 43 44 44 55 55 55 55 55 55 55 55	22 18 130 224 25 37 38	M# M#8 M#9 M#1 M#1 M#1 M#1 M#1 M#1 M#1	337 32 32 4X 4Y 4Y 5X 5X 52 52 64 57 64 64	in/lbf-sec in/lbf-sec in/lbf-sec in/lbf-sec in/lbf-sec in/lbf-sec in/lbf-sec in/lbf-sec in/lbf-sec in/lbf-sec	> > > > > > > > > > > > > > > > > > > > > > > >	Type UMM Mode Shap UMM Mode Shap	De	Magnitude 0.0126 0.0664 0.0781 0.254 0.0768 0.085 0.085 0.57 0.0544 0.0603	Phase 355 354 353 175 173 353 175 174 172 352
4 39 33 34 29 52 45 40 41 35 52 53 47 48 43 58 53 54 55 49 58 55 49 44 60 55 50 51 60 61 55 50 51 62 63 64 55	23 10 24 25 37 38 37 38 37 38 37 38 37 38 37 38 37 38 37 38 37 38 37 38 37 38 37 38 37 38 37 38 38 38 38 38 38 38 38 38 38	M# M#8 M#9 M#1 M#1 M#1 M#1 M#1 M#1 M#1 M#1	20013 3Y 3Z 4X 4X 4Y 4Z 5X 5X 55 5Z 6 6X 6Y 6X 7X 7X 7X 7X 7X 7X 7X	in/lbf-sec in/lbf-sec in/lbf-sec in/lbf-sec in/lbf-sec in/lbf-sec in/lbf-sec in/lbf-sec in/lbf-sec in/lbf-sec	> >	Type UMM Mode Shap UMM Mode Shap	De	Magnitude 0.0126 0.0664 0.0781 0.254 0.0254 0.085 0.57 0.0544 0.0603 0.793	Phase 355 354 175 173 353 175 174 172 352
4 39 33 34 29 52 45 40 41 35 53 53 54 43 44 59 50 55 50 51 60 61 56 50 51 62 53 64 64	23 130 24 25 37 38 26 27 27 28 28 28 28 28 28 28 28 28 28	M# M#8 M#9 M#1 M#1 M#1 M#1 M#1 M#1 M#1 M#1	2013 32 32 4 47 47 47 57 52 6 6X 7 6Z 6Z 6Z 7	in/lbf-sec in/lbf-sec in/lbf-sec in/lbf-sec in/lbf-sec in/lbf-sec in/lbf-sec in/lbf-sec in/lbf-sec in/lbf-sec in/lbf-sec in/lbf-sec	> > <t< td=""><td>Type UMM Mode Shap UMM Mode Shap</td><td>be > be ></td><td>Magnitude 0.0126 0.0664 0.0781 0.254 0.0768 0.085 0.085 0.577 0.0544 0.0603 0.793 0.013</td><td>Phase 355 354 175 173 353 175 174 172 352 352</td></t<>	Type UMM Mode Shap UMM Mode Shap	be > be >	Magnitude 0.0126 0.0664 0.0781 0.254 0.0768 0.085 0.085 0.577 0.0544 0.0603 0.793 0.013	Phase 355 354 175 173 353 175 174 172 352 352



Conclusions

- In a conventional impact test, the *reference sensor* (either the impact DOF or the accelerometer location) *must remain fixed throughout the test*. Since the reference sensor must be connected by a wire to the data acquisition system, a *very long wires might be required* when testing a large structure
- > Better quality signals are possible if each impact force is applied closer to the response sensor
- ➤ In a Rapid Impact[™] test, either the impact hammer or the accelerometer can be moved to a different DOF between acquisitions
- In a Rapid Impact[™] test, a *chain of acquisitions* (based on Input & Output DOFs) *is required*.
 A *chain* is formed when the *Input & Output DOF of each acquisition has the same DOF as another acquisition in the chain*
- > An FRF chain is calculated from chain of acquisitions
- ➤ After the Rapid Impact[™] FRFs are curve fit, modal residues are converted to mode shapes using the relationship between residues and mode shapes. *Each modal residue is the product of two mode shape components*
- > A Rapid Impact[™] test is *faster and more convenient* for testing *any size structure*

