STRUCTURAL **DYNAMICS AND PROBABILISTIC** GIORA MAYMON **ANALYSES FOR ENGINEERS**

Contents

List of Figures							
Lis	List of Tables						
Foreword							
Pre	Preface						
Cŀ	IAPT	ER					
1	Some Basics of the Theory of Vibrations						
	1.1	A Single Degree of Freedom System	1				
	1.2	Response of a SDOF to (Any) Transient Load	7				
	1.3	Multiple-Degrees-of-Freedom (MDOF) System	11				
	1.4	Infinite-Degrees-of-Freedom (Continuous) System	18				
	1.5	Mounted Mass	19				
CI	HAPT	TER					
2	Dyn	amic Response of Beams and Other Structures					
	to Deterministic Excitation						
	2.1	A Generic Example of a Cantilever Beam	21				
	2.2	Some Basics of the Slender Beam Theory	21				
	2.3	Modal Analysis of a Slender Cantilever Beam					
	2.4	Stress Modes of a Slender Cantilever Beam	29				
	2.5	Response of a Slender Beam to Harmonic Excitation	35				
		2.5.1 Response of beams to base excitation	37				
		2.5.2 Response of a cantilever beam to harmonic tip force	38				
		2.5.3 Response of a cantilever beam to harmonic base excitation2.5.4 Two external forces	41 44				

	2.6 Response of a Structure with Mounted Mass to Harmonic		;	
		Excitation	45	
	2.7	Symmetric and Anti-symmetric Modes and Loads	52	
	2.8			
		Excitation	57	
	2.9	Vibrations of Shells	66	
Cı	НАРТ	TER		
3	Dynamic Response of a Structure to Random Excitation			
	3.1	Random Excitation and Response	70	
	3.2	Response of an Elastic Structure to Random Excitation	78	
		3.2.1 Closed form solution	85	
	3.3	Response of a Cantilever Beam to Clamp Displacement		
		Excitation	88	
	3.4	Response of a Cantilever Beam to Tip Displacement		
		Excitation	92	
	3.5	Simulation of an Important Structural Parameter		
		in a Vibration Test	96	
		3.5.1 Two examples	97	
	3.6	Response of a Structure to Acoustic Excitation	116	
	3.7	An Example of a Frame Structure	125	
	3.8	Response of a Structure with Mounted Mass to Random		
		Excitation	132	
	3.9	Response of a Simply Supported Plate to Random		
		Excitation	140	
Cı	HAPT	TER		
4	Con	tacts In Structural Systems	146	
	4.1	Static Contact	146	
		4.1.1 An example of a static contact problem	147	
	4.2	Analytical Solution for a Dynamic Contact Problem	150	
	4.3	The Two DOF Contact Problem	157	
	4.4	Numerical Solution of a Dynamic Contact		
		Problem—Force Excitation	162	
	4.5	Numerical Solution of a Dynamic Contact		
		Problem—Base Excitation	167	

CHAPTER

5	Nondeterministic Behavior of Structures		173
	5.1	Probabilistic Analysis of Structures	173
		5.1.1 The basic stress-strength case	177
	5.2	Solutions for the Probability of Failure	180
		 5.2.1 Analytical solution—the Lagrange multiplier method 5.2.2 The monte carlo simulation 5.2.3 Solution with a probabilistic analysis program 5.2.4 Solutions for cases where no closed-form expressions exist 	180 183 184 185
	5.3	Solution with a Commercial Finite Element Program	191
	5.4	Probability of Failure of Dynamically Excited Structures	192
	5.5	Structural Systems	198
	5.6	Model Uncertainties	208
CI	HAPI	ER	
6	Random Crack Propagation		
	6.1	Crack Propagation in a Structural Element	217
	6.2	Effects of a Static Bias on the Dynamic Crack Growth	223
	6.3	Stochastic Crack Growth and the Probability of Failure	
		for Harmonic Excitation	228
	6.4	Initial Cracks and Flaws	
	6.5	Probabilistic Crack Growth Using the "Unified"	
		Approach	246
	6.6	.6 Stochastic Crack Growth and the Probability of Failure	
		for Random Excitation	266
CI	HAPT	TER	
7	Design Criteria		
	7.1	Dynamic Design Criteria	275
٠		7.1.1 Case of under-design 7.1.2 Case of over-design	276 277
	7.2	The Factor of Safety	283
		7.2.1 Factor of safety	283
	7.3	Reliability Demonstration of Structural Systems	289
		7.3.1 Reliability demonstration (verification) is integrated into the design process	293

		7.3.2	Analysis of failure mechanism and failure modes	293			
		7.3.3	Modeling the structural behavior, and verifying the model	294			
		7.3.4	by tests Design of structural development tests to surface failure	49 4			
		7.5	modes	294			
		7.3.5	Design of structural development tests to surface				
		- 2 -	unpredicted failure modes	295			
		7.3.6 7.3.7	"Cleaning" failure mechanism and failure modes Determination of the required safety margins, the	295			
		7.3.7	confidence in the models and the relevant parameters	296			
		7.3.8	Determination of the demonstrated reliability by "orders of	2,0			
			magnitude"	296			
Cı	ТАРТ	TER .					
8	Son	ne Impo	ortant Computer Programs for Structural Analysis	300			
	8.1	Finite	e Elements Programs	300			
	8.2	Proba	abilistic Analysis Programs	301			
	8.3	Cracl	k Propagation Programs	304			
	8.4		nematical Solvers	305			
Cı	HAPT	TE R					
9	Con	clusion	ns—Do and Don't Do in Dynamic and Probabilistic				
	Analyses						
APPENDIX							
	Con	nputer	Files for the Demonstration Problems	313			
	1	Intro	duction	313			
	2	List o	of Files	314			
	3	Files	Listing	317			
Re	References						
Inc	dex			427			

^{*} A CD-ROM with all these files is attached to this publication.