Theory of Bridge Aerodynamics



CONTENTS

	Preface Notation					
1	INTRODUCTION					
	1.1	General considerations	1			
	1.2	Random variables and stochastic processes	4			
	1.3	Basic flow and structural axis definitions	6			
	1.4	Structural design quantities	10			
2	SOME BASIC STATISTICAL CONCEPTS					
	IN WIND ENGINEERING					
	2.1	Parent probability distributions, mean value and variance	13			
	2.2	Time domain and ensemble statistics	15			
	2.3	Threshold crossing and peaks	27			
	2.4	Extreme values	30			
	2.5	Auto spectral density	33			
	2.6	Cross spectral density	38			
	2.7	The connection between spectra and covariance	41			
	2.8	Coherence function and normalized co-spectrum	43			
	2.9	The spectral density of derivatives of processes	44			
	2.10	Spatial averaging in structural response calculations	45			
3	STO	CHASTIC DESCRIPTION OF				
	TUR	RBULENT WIND	53			
	3.1	Mean wind velocity	53			
	3.2	Single point statistics of wind turbulence	58			
	3.3	The spatial properties of wind turbulence	63			
4	BAS	IC THEORY OF STOCHASTIC DYNAMIC				
	RES	PONSE CALCULATIONS	69			
	4.1	Modal analysis and dynamic equilibrium equations	69			
	4.2	Single mode single component response calculations	76			
	4.3	Single mode three component response calculations	81			
	4.4	General multi-mode response calculations	84			
5	WIND AND MOTION INDUCED LOADS					
	5.1	The buffeting theory	91			
	5.2	Aerodynamic derivatives	97			
	5.3	Vortex shedding	102			

			CONTENTS	Х		
6	WI	ND IND	UCED STATIC AND DYNAMIC			
	RES	RESPONSE CALCULATIONS				
	6.1 Introdu			109 109		
	6.2	The me	ean value of the response	113		
	6.3		ng response	116		
	6.4	Vortex	shedding	142		
7	DETERMINATION OF CROSS SECTIONAL					
	FORCES					
	7.1	Introdu	iction	157		
	7.2	The me	ean value	163		
	7.3	The ba	ckground quasi static part	163		
	7.4	The res	sonant part	182		
8	MOTION INDUCED INSTABILITIES					
	8.1	Introdu	iction	195		
	8.2	Static o	livergence	199		
	8.3	Gallop	ing	200		
	8.4	Dynam	nic stability limit in torsion	201		
	8.5	Flutter		203		
Aı	opend	lix A:	TIME DOMAIN SIMULATIONS	209		
1	A.1	Introdu		209		
	A.2	Simula	tion of single point time series	210		
	A.3		tion of spatially non-coherent time series	213		
	A.4 The Cholesky decomposition					
A	ppend	lix B:	DETERMINATION OF THE JOINT			
-			ACCEPTANCE FUNCTION	223		
	B .1	Closed	form solutions	223		
	B.2	Numer	ical solutions	223		
Appendix C:			AERODYNAMIC DERIVATIVES FROM			
			SECTION MODEL DECAYS	227		
R	eferen	ices		233		
	Index					

2