## Contents

## PART-I

## MOVING LOADS

CHAPTER	1 ROLLING LOADS	
1.1.	INTRODUCTION	3
1.2.	SINGLE CONCENTRATED LOAD	4
1.3.	UNIFORMLY DISTRIBUTED LOAD LONGER THAN THE SPAN OF THE GIRDER	6
1.4.	UNIFORMLY DISTRIBUTED LOAD SHORTER THAN THE SPAN OF THE GIRDER	8
1.5.	TWO POINT LOADS WITH A FIXED DISTANCE BETWEEN THEM	11
1.6.	SEVERAL POINT LOADS : MAXIMUM B.M.	28
1.7.	SEVERAL POINT LOADS : MAX. S.F. AT A SECTION	30
1.8.	EQUIVALENT UNIFORMLY DISTRIBUTED LOAD	34
1.9.	COMBINED DEAD AND MOVING LOAD S.F. DIAGRAMS : FOCAL LENGTH	36
CHAPTER	2 INFLUENCE LINES	
2.1.	DEFINITION	41
2.2	INFLUENCE LINE FOR SHEAR FORCE	41
2.3.	INFLUENCE LINE FOR BENDING MOMENT	43
2.4.	LOAD POSITION FOR MAXIMUM S.F. AT A SECTION	44
2.5.	LOAD POSITION FOR MAXIMUM B.M. AT A SECTION	45
CHAPTER	3 INFLUENCE LINES FOR GIRDERS WITH FLOOR BEAMS	
3.1.	INTRODUCTION	59
3.2.	INFLUENCE LINE OF S.F. FOR GIRDER WITH FLOOR BEAMS	60
3.3.	LOAD POSITIONS FOR MAXIMUM S.F.	61
3.4.	INFLUENCE LINE OF B.M. FOR GIRDER WITH FLOOR BEAMS	62
3.5.	LOAD POSITIONS FOR MAXIMUM B.M.	64
CHAPTER	4 INFLUENCE LINES FOR STRESSES IN FRAMES	
4.1.	INTRODUCTION	67
	PRATT TRUSS WITH PARALLEL CHORDS	68
	PRATT TRUSS WITH INCLINED CHORDS	70
4.4.	WARREN TRUSS WITH PARALLEL CHORDS	72
4.5.	WAREN TRUSS WITH INCLINED CHORDS	73
4.6.	K-TRUSS	75
4.7.	BALTIMORE TRUSS WITH SUB-TIES : THROUGH TYPE	78
4.8.	BALTIMORE TRUSS WITH SUB-TIES : DECK TIPE	or
4.9.	BALTIMORE TRUSS WITH SUB-STRUTS : THROUGH TYPE	83

4.10. PENNSYLVANIA OR PETTIT TRUSS WITH SUB-TIES

	4.11.	PENNSYLVANIA OR PETTIT TRUSS WITH SUB-STRUIS		0,5
	4.12.	BRACED CANTILEVER WITH SUSPENDED SPAN GIRDER		93
CHA	PTER	5 THE MÜLLER-BRESLAU PRINCIPLE		
	5.1.	INTRODUCTION		97
	5.2.	THE MÜLLER-BRESLAU PRINCIPLE		97
	5.3.	INFLUENCE LINES FOR STATICALLY DETERMINATE BEAMS		98
	5.4.	PROPPED CANTILEVERS		102
	5.5.	CONTINUOUS BEAM : INFLUENCE LINE FOR BENDING MOMENT		104
	5.6.	CONTINUOUS BEAM : INFLUENCE LINE FOR SHEAR FORCE		105
	5.7.	INFLUENCE LINE FOR HORIZONTAL REACTION		106
	5.8.	FIXED BEAMS		117
		PART-II		
		FARI-II KAM LOADS MAX II-IAAT		
		STATICALLY INDETERMINATE STRUCTURES		
СНА	PTER	6 STATICALLY INDETERMINATE BEAMS AND FRAMES		
CILA		ESPEL SOMMULEME F		125
	6.1.	INTRODUCTION DE ACTION COMBONENTS		126
	6.2.	TYPES OF SUPPORTS : REACTION COMPONENTS		126
	6.3.	EXTERNAL REDUNDANCY		127
	6.4.	STATICALLY INDETERMINATE BEAMS DEGREE OF REDUNDANCY OF ARTICULATED STRUCTURES	26	128
	6.5.	DEGREE OF REDUNDANCY OF RIGIDLY JOINTED FRAMES		129
	6.6.	METHODS OF ANALYSIS		131
CHA	PTER	7 THE GENERAL METHOD (METHOD OF CONSISTENT DEF	ORMA'	TION)
(0)				
	7.1.	STATICALLY INDETERMINATE BEAMS AND FRAMES		
	72	MAYWELL'S LAW OF RECIPROCAL DEFLECTION		137
	7.4.	GENERALISED MAXWELL'S THEOREM : BETTI'S RECIPROCAL THEOREM		138
	PTER	8 THREE MOMENT EQUATION METHOD		
67		INTRODUCTION : CONTINUOUS BEAMS		141
	8.1. 8.2.	CLAPEYRON'S THEOREM OF THREE MOMENTS : DERIVATION		142
	8.3.	CASE 1 - EL CONSTANT : GENERAL LOADING		143
	8.4.	CASE II . EL CONSTANT . NO SETTI EMENT : GENERAL LOADING		143
	8.5.	CASE III : EI CONSTANT : NO SETTLEMENT : U.D.L. THROUGHOUT		143
	8.6.	THE TAX THE MALLES AND ALIENDANIA OPPOSITE D. LIPE		1 444
	8.7.	VALUES OF FACTOR $\frac{6AF}{L}$ OF $\mu$ -DIAGRAM		- 144
	8.8.	APPLICATION OF CLAPEYRON'S THEOREM FOR FIXED BEAM		151
	8.9.	ADDITIONAL ILLUSTRATIVE EXAMPLES		154
	0.7.			

CHAI	PTER	9 THE SLOPE DEFLECTION METHOD	
	9.1.	INTRODUCTION : SIGN CONVENTIONS	165
	9.2.	FUNDAMENTAL EQUATIONS	166
	9.3.	CONTINUOUS BEAMS AND FRAMES WITHOUT JOINT TRANSLATION	168
	9.4.	PORTAL FRAMES WITH SIDE WAY	177
CHAI	PTER	10 MOMENT DISTRIBUTION METHOD	
CHAI	17.12	DESIGN OF REIS AND SECT WELDS	100
	10.1.	INTRODUCTION: SIGN CONVENTIONS	196
	10.2.	FUNDAMENTAL PROPOSITIONS	200
	10.3.	THE MOMENT DISTRIBUTION METHOD	208
	10.4.	SINKING OF SUPPORTS	209
	10.5.	CONTINUOUS BEAM ON ELASTIC PROPS PORTAL FRAMES WITH NO SIDE SWAY	209
	10.6.	PORTAL FRAMES WITH NO SIDE SWAY	223
	10.7.	PORTAL FRAMES WITH INCLINED MEMBERS	238
AESA	TIES.	TWO HIMOED STEFFERING GIRDER	
CHA	PTER	11 THE COLUMN ANALOGY METHOD	
	11.1.	THE COLUMN ANALOGY	253
	11.2.	APPLICATION OF THE ANALOGY FOR FIXED BEAMS	255
	11.3.	PROPERTIES OF A SYMMETRICAL ANALOGOUS COLUMN	255
	11.4.	PORTAL FRAMES	263
	11.5.	THE GENERALISED COLUMN FLEXURE FORMULA	264
	11.6.	PORTAL FRAME WITH HINGED LEG(S)	265
CHA	PTER	12 METHOD OF STRAIN ENERGY	
	12.1.	GENERAL PRINCIPLES	280
	12.2.	STRAIN ENERGY IN LINEAR ELASTIC SYSTEMS	280
	12.3.	CASTIGLIANO'S FIRST THEOREM	281
	12.4.	DEFLECTION OF BEAMS ETC. BY CASTIGLIANO'S FIRST THEOREM	282
	12.5.	MINIMUM STRAIN ENERGY AND CASTIGLIANO'S SECOND THEOREM	292
	12.6.	ANALYSIS OF STATICALLY INDETERMINATE BEAMS AND	
		PORTAL FRAMES BY MINIMUM STRAIN ENERGY	294
CHA	PTER	13 DEFLECTION OF PERFECT FRAMES	
	13.1.	GENERAL	305
	13.2.	THE UNIT LOAD METHOD	306
	13.3.	JOINT DEFLECTION IF LINEAR DEFORMATION OF ALL THE MEMBERS	
	- MIS	ARE KNOWN	
	13.4.		320
	13.5.	MAXWELL'S RECIPROCAL THEOREM APPLIED TO FRAMES	324
	13.6.	GRAPHICAL METHOD	325
CHA	PTER	14 REDUNDANT FRAMES	
	14.1.	DEGREE OF REDUNDANCY	332

	14.2.	APPLICATION OF CASTIGLIANO'S THEOREM OF MINIMUM STRAIN		202
		ENERGY		333
	14.3.	MAXWELL'S METHOD		346
CHAPT	14.4.	STRESSES DUE TO ERROR IN LENGTH	53	351
	14.5.	COMBINED STRESSES DUE TO EXTERNAL LOAD AND ERROR IN LENGTH	1 10	353
	14.6.	EXTERNALLY INDETERMINATE FRAMES		356
	14.7.	TRUSSED BEAMS		362
CHAP	TER	15 CABLES AND SUSPENSION BRIDGES		
	15.1.	INTRODUCTION		370
	15.2.	EQUILIBRIUM OF LIGHT CABLE : GENERAL CABLE THEOREM		371
	15.3.	UNIFORMLY LOADED CABLE		372
	15.4.	ANCHOR CABLES		376
	15.5.	TEMPERATURE STRESSES IN SUSPENSION CABLE		376
	15.6.	THREE HINGED STIFFENING GIRDER		383
	15.7.	TWO HINGED STIFFENING GIRDER		399
	15.8.	TEMPERATURE STRESS IN TWO HINGED GIRDER		402
CHAI	PTER	16 ARCHES		
	16.1.	INTRODUCTION CALABIT CHARGE FOR YOULAMA SHEET TO MOTTADLISMA		407
	16.2.	LINEAR ARCH (THEORETICAL ARCH)		407
	16.3.	EDDY'S THEOREM		408
264	16.4.	TUPEE LINGED APCH		409
	16.5.	MOVING LOADS ON THREE HINGED ARCHES		418
	16.6.	TWO HINGED ARCH		424
	16.7.	TWO HINGED PARABOLIC ARCH : EXPRESSION FOR H.		425
		TWO HINGED CIRCULAR ARCH : EXPRESSION FOR H		
		MOVING LOADS ON TWO HINGED ARCHES		
		TEMPERATURE EFFECTS		
		REACTION LOCUS FOR TWO HINGED ARCH		437
		FIXED ARCH		439
200		THREE HINGED SPANDREL BRACED ARCH		442
		PART-III		
		MICCELL ANDOLIC TODICS		
	23.	TORIT THEFT. ECTION IF LINEAR THE METHON OF ALL THE ARMIENS		
CHA	PTER	17 WELDED JOINTS		
	17.1.	INTRODUCTION		451
	17.2.	The state of the s		453
	17.3.	DISADVANTAGES OF WELDING		453
	17.4.	TYPES OF WELDS AND WELDED JOINTS		453
	17.5.	BUTT WELD OR GROOVE WELD		454

	17.6.	FILLET WELDS SCIAOL LADITREV ROR SIEVLAMA ALI	456
	17.7.	DEFECTS IN WELDING	457
	17.8.	WORKING STRESSES IN WELDS	458
	17.9.	DESIGN OF FILLET WELDS FOR AXIAL LOADS	459
	17.10.	FILLET WELDING OF UNSYMMETRICAL SECTIONS : AXIAL LOAD	460
		DESIGN OF BUTT WELDS	460
		DESIGN OF PLUG AND SLOT WELDS	461
		ECCENTRICALLY LOADED FILLET WELDED JOINTS	468
	17.14.	ECCENTRICALLY LOADED BUTT WELDED JOINTS	470
CHA	PTER	18 METHOD OF TENSION COEFFICIENTS	
	18.1.	INTRODUCTION	479
	18.2.	TENSION COEFFICIENTS	479
	18.3.	ANALYSIS OF PLANE FRAMES	480
CHA	PTER	19 SPACE FRAMES	
	19.1.	INTRODUCTION	487
	19.2.		487
	19.3.	ILLUSTRATIVE EXAMPLES	489
CHA	PTER	20 PLASTIC THEORY	
020	20.1.	I I I I I I I I I I I I I I I I I I I	497
		THE DUCTILITY OF STEEL	498
		ULTIMATE LOAD CARRYING CAPACITY OF MEMBERS CARRYING	
		AXIAL TENSION	499
	20.4.	PLASTIC BENDING OF BEAMS	505
	20.5	STAGES OF BENDING OF RECTANGULAR SECTIONS	506
	29.6.	EVALUATION OF FULLY PLASTIC MOMENT	508
	20.7.	EVALUATION OF SHAPE FACTOR	509
	20.8.	MOMENT-CURVATURE RELATIONSHIPS	511
	20.9.	PLASTIC HINGE	513
		LOAD FACTOR	513
		CONDITIONS AND BASIC THEOREMS OF PLASTIC ANALYSIS	515
	20.12.	DETERMINATION OF COLLAPSE LOAD FOR SOME STANDARD CASES OF BEAMS	518
	20.13	PORTAL FRAMES	534
		DESIGN RECOMMENDATIONS	540
CHA		21 BUILDING FRAMES	
O.L.		INTRODUCTION : BUILDING FRAMES	557
	21.1.	BRACING OF MULTISTOREY BUILDING FRAMES	558
	21.3.		559
	21.4.		561
		SUBSTITUTE FRAMES	563

	21.6.	ANALYSIS FOR VERTICAL LOADS	565
	21.7.	METHODS OF COMPUTING B.M.	566
	21.8.	ANALYSIS OF FRAMES SUBJECTED TO HORIZONTAL FORCES	573
	21.9.	PORTAL METHOD	574
	21.10.	CANTILEVER METHOD	575
	21.11.	FACTOR METHOD	581
CHA	PTER		
	22.1.	INTRODUCTION	591
	22.2.	CONTINUOUS BEAMS AND FRAMES WITHOUT JOINT TRANSLATION	591
	22.3.	SYMMETRICAL FRAMES	607
	22.4.	FRAMES WITH SIDESWAY	609
CHA	PTER	23 UNSYMMETRICAL BENDING	
	23.1.	INTRODUCTION	623
	23.2.	CENTROIDAL PRINCIPAL AXES OF A SECTION	623
	23.3.	GRAPHICAL METHOD FOR LOCATING PRINCIPAL AXES	625
	23.4.	MOMENTS OF INERTIA REFERRED TO ANY SET OF RECTANGULAR AXES	627
	23.5.	BENDING STRESS IN BEAM SUBJECTED TO UNSYMMETRICAL BENDING	629
	23.6	RESOLUTION OF BENDING MOMENT INTO TWO COMPONENTS	
		ALONG PRINCIPAL AXES	630
	23.7.	RESOLUTION OF B.M. INTO ANY TWO RECTANGULAR AXES THROUGH THE CENTROID	630
	23.8.	LOCATION OF NEUTRAL AXIS	631
	23.9.	GRAPHICAL METHOD : MOMENTAL ELLIPSE	632
	23.10.	THE Z-POLYGON	637
	23.11.	DEFLECTION OF BEAM UNDER UNSYMMETRICAL BENDING	639
	INDE	X THE LUADE OF TWO REMEMBERS PRINCE TO MUSEAULAVE ASS	647

21 BUILDING FRAMES.