View metadata, citation and similar papers at core.ac.uk
brought to CORE
provided by Universiti Teknologi Malaysia

LIST OF CONTENTS

CHAPTER	TITLE	PAGE
	DECLARATION	ii
	DEDICATION	iii
	APPRECIATION	iv
	ABSTRACT	v
	ABSTRAK	vi
	CONTENT	vii
	LIST OF TABLES	x
	LIST OF FIGURES	xi
	LIST OF SYMBOLS	xiii
	LIST OF APPENDIX	xv
CHAPTER I	**INTRODUCTION**	1
	1.1 Introduction	1
	1.2 Problem Background And Motivation	2
	1.3 Objectives Of Study	3
	1.4 Scope Of Study	3
	1.5 Importance Of Study	4
	1.6 Thesis Organisation	4
CHAPTER II	**LITERATURE REVIEW**	
	2.0 Introduction	6

	2.1 End Block	6
	2.2 Analysis Using the Theory of Elasticity	7
	2.3 Photoelastic Investigation	12
	2.4 Finite Element Analysis	13
	2.4.1 Analytical Study by Burdet	13
	2.4.2 Approximate Equations y Burdet	14
	2.5 Strut and Tie Model	16
	2.6 Experimental Investigation	16
	2.7 Problems with End Block	18
	2.7.1 Excessive Cracking	19
	2.7.2 Failure	19
	2.7.3 Lack of Design Specifications	20
	2.7.4 Allocation of Responsibilities	21
	2.8 Code and Design Guidelines	21
CHAPTER III	**RESEARCH METHODOLOGY**	26
	3.0 Overview	26
	3.1 Details of Samples	26
	3.2 End Zone Reinforcement	28
	3.2.1 Designs for Bursting Force	29
	3.3 Design of Bearing Plate	34
	3.4 Materials of Reinforced Concrete	36
	3.4.1 Steel Reinforcement	37
	3.5 Preparation of Test Specimens	38
	3.5.1 Formwork	38
	3.5.2 Reinforcement	39
	3.6 Curing Process	40
	3.7 Testing of concrete	42
	3.7.1 Workability test	42
	3.7.1.1 Slump Test	43
	3.7.2 Compressive Strength Test	44
	3.8 Testing Specimens	46

CHAPTER IV	**RESULTS AND ANALYSIS**	48
	4.0 Introduction	48
	4.1 The Results of Concrete Cubes Strength.	48
	4.2 Spiral Reinforcement and Orthogonal Reinforcement	49
	4.3 Steel for Prestressing	53
	4.4 Factor of Safety	54
	4.4.1 Design Factor and Safety Factor	54
	4.5 Jacking Force	57
	4.5.1 Jacking Methods for Single (Mono) Strand Stressing	58
	4.6 Comparison between Methods of BS8110, CIRIA Guide 1 (1976) and Experimental.	61
CHAPTER V	**DISCUSSION AND CONCLUSION**	63
	6.0 Overview	63
	6.1 Conclusions	63
	6.6 Recommendation and Future Work	65
	REFERENCES	66
	APPENDIX A	69
	APPENDIX B	73
	APPENDIX C	77
	APPENDIX D	84

LIST OF TABLES

LIST	TABLE TITLE	PAGE
Table 2.1	Spalling force according to Guyon	11
Table 2.2	Maximum Bearing Stress under the Anchorage Device According to Various Design Codes and Guidelines	23
Table 2.3	Bursting Force According to Various Codes and Guidelines Details of Specimens	24
Table 3.1	Details of Specimens	27
Table 3.2	Number of Specimen Use for Each Size	27
Table 3.3	Design Bursting Tensile Forces in End Blocks	32
Table 3.4	Description of Workability and Magnitude of Slump	44
Table 4.1	Failure Load of End Block	49
Table 4.2	Properties of Prestressing Steel	53
Table 4.3	Axial load that can be imposed	53
Table 4.4	Factor of Safety for One Bearing Plate	55
Table 4.5	Factor of Safety for Two Bearing Plate	55
Table 4.6	The Value of Jacking Force, Pi for Sample Size is 200x200x150	59
Table 4.7	The Value of Jacking Force, Pi for Sample Size is 150x150x150	60
Table 4.8	Factor of Safety for Sample Size is 200x200x150	60
Table 4.9	Factor of Safety for Sample Size is 300x300x150	61
Table 4.10	Comparison between Different BS 8110, CIRIA Guide 1 (1976).	61

LIST OF FIGURES

LIST	FIGURE TITLE	PAGE
Figure 1.1	Chart of Study Organisations	6
Figure 2.1	Geometry and Stress Distribution along the Axis of a Concentric End Block.	8
Figure 2.2	Bursting Stress Distribution According to Burdet (1990)	9
Figure 2.3	Bursting Force According to Burdet, 1990	9
Figure 2.4	Burdet Symmetrical Prism for Eccentric End Block	10
Figure 2.5	Burdet Symmetrical Prism for Multiple End Block	11
Figure 3.1	General Dimension of End Block Specimen	28
Figure 3.2	Stress trajectories in the end zone of a post-tensioned beam	30
Figure 3.3	Local and general zones in the end zone	31
Figure 3.4	Spalling and bursting forces in the end zone	32
Figure 3.5	Spiral and Orthogonal Reinforcement with Two Bearing Plate	33
Figure 3.6	Spiral and Orthogonal Reinforcement with One Bearing Plate	34
Figure 3.7	Bearing Plate	35
Figure 3.8	End and Isometric Views of End Zone	36
Figure 3.9	Several Sizes of Reinforcement Provide in Structure Laboratory of The Faculty of Civil Engineering.	38
Figure 3.10	Reinforced Placement in Formworks	39

Figure 3.11	Steel Cutter Machine	40
Figure 3.12	Water Tank Curing	41
Figure 3.13	Specimen Curing with Wetted Gunnysack	41
Figure 3.14	Slump Cone (Mould)	43
Figure 3.15	Compressive Strength Machine	45
Figure 3.16	Universal Testing Machine	46
Figure 3.17	Specimen Setup with Different Number of Bearing Plate.	47
Figure 4.1	Poor Self- Compaction	50
Figure 4.2	Good Self-Compaction	50
Figure 4.3	Form of Failure for Samples that Unreinforced	51
Figure 4.4	Failure Load That Using Orthogonal Reinforcement	51
Figure 4.5	Failure Load That Spiral Reinforcement	52
Figure 4.6	Factor of Safety for Two Bearing Plate	55

LIST OF SYMBOLS

T_{burst}	=	the bursting force
d_{burst}	=	the distance of bursting force from bearing plate
f_{ca}	=	the compressive stress at distance equal to ahead of the bearing plate
P_u	=	the factored tendon force
a	=	the side length of the bearing plate in the long direction of the rectangular cross section
b	=	the side length of the bearing plate in the thin direction of the rectangular cross section
t	=	the thickness of the cross section
e	=	the eccentricity of the tendon force with respect to the centroid of the rectangular cross section
h	=	the larger side length of the rectangular cross section
α	=	the angle of inclination of the tendon force
A	=	the area of concrete surrounding the anchorage device with a similar shape, representing the confinement provided by surrounding concrete.
A_b	=	the area of the anchorage device.
PT	=	the time of stressing of the tendons.
SL	=	service loads.
f'_{ci}	=	the concrete strength at stressing, but not more than f'_c.
f'_{cu}	=	the concrete cube strength at stressing.
f'_{ck}	=	the characteristic concrete cube.
K	=	1.0 for isolated anchors, 1.5 for anchors distributed in one direction and 2.0 for anchors distributed in two directions.

P	=	the tendon force.
a_1	=	the dimension of the anchorage device.
a_2	=	the lateral dimension of the member.
c	=	given in function of a_1/a_2
b	=	the width of the section in the plane of potential bursting cracks.
d	=	the effective depth of the end block, where the stresses become linear. Generally taken as the depth of the section.
e	=	the eccentricity of the post-tensioning force measured from the centroid of the section.
h	=	the depth of the section.
A_{st}	=	the amount of end zone reinforcement in each direction.
F_{bst}	=	the bursting force.
f_s	=	the stress in the transverse reinforcement
P_k	=	prestress in the tendon
y_{po}	=	length of a side of bearing plate
y_o	=	transverse dimension of the end zone.
f_{br}	=	prestress in the tendon with one bearing plate.
P_k	=	punching area.
A_{pun}	=	area of contact of bearing plate.
$f_{br,all}$	=	allowable bearing stress.
f_{ci}	=	cube strength at transfer.
A_{br}	=	bearing area or maximum transverse area of end block that is geometrically similar and concentric with punching area.
P_{fail}	=	the value that can bear the burden of the specimen before failure at end block.
$P_{jacking\ foce}$	=	initial force in tendons.

LIST OF APPENDIX

APPENDIX A

i. The Design of End Block for the Size of Specimen is 300 mm x 300 mm x 150 mm. 70

ii. The Design Of End Block for the Size of Specimen is 200 mm x 200 mm x 150 mm. 71

iii. The Design Of End Block for the Size of Specimen is 150 mm x 150 mm x 150 mm. 72

APPENDIX B

i. Reinforcement Design End Zone for Specimen Size is 300 mm x 300 mm x 150 mm 74

ii. Reinforcement Design End Zone for Specimen Size is 200 mm x 200 mm x 150 mm. 75

iii. Reinforcement Design End Zone for Specimen Size is 150 mm x 150 mm x 150 mm. 76

APPENDIX C

i. The amount of reinforcement used for Size sample is 300 mm x 300 mm x 150 mm. 78

ii. The amount of reinforcement used for Size sample is200 mm x 200 mm x 150 mm. 80

iii. The amount of reinforcement used for Size sample is150 mm x 150 mm x 150 mm. 82

APPENDIX D

i. Jacking Force for the Specimen size is 300 mm x 300 mm x 150 mm. 85

ii. Jacking Force for the Specimen size is 200 mm x 200 mm x 150 mm. 86

iii. Jacking Force for the Specimen size is 150 mm x 150 mm x 150 mm. 87