7 CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

Pre-stressed concrete precast members consisting of slabs, beams and columns have been presented as an alternative to the insitu cast construction. This is gradually becoming a need due to shortage of construction labour. These precast systems also allow the construction to be carried out at a rapid rate.

The structural design aspects related to pre-stressed concrete columns have been dealt with in detail. Column interaction charts also have been presented.

Another system that can be combined with the precast system is foam concrete based panel system. This also can allow rapid construction. In order to assess the structural performance, an experimental program was carried out to identify an EPS based lightweight concrete mix with a density in the range of 600-700 kg/m^3 with 50% of the EPS content being replaced with mechanically recycled EPS. In addition, testing was carried out to identify the strength properties of a wall panel. It is advisable to have the cement fibre sheets for the partition panels though foam concrete on its own would have sufficient compressive strength. One of the key parameters that are important for a wall panel is its elastic modulus in the working stress region. It is shown that this value could be in the range of 1 kN/mm^2 even when the cement fibre boards provide an additional stiffness. Hence, these panels can be recommended primarily for non-loadbearing partitions. One encouraging observation was the ability of the cement fibre boards to retain the composite action until the ultimate loads where the failure was generally due to crushing at the bottom. Even for partition walls, certain degree of robustness is needed. It is shown that when foam concrete is cast between the cement fibre sheets, the flexural capacity of a panel is reasonably high.

With the cement fibre boards and with tongue and groove joint for connections, these panels could allow a rapid construction rate. It is possible to finish the walls without any plaster. It would need a thin fibre based tape at the joint to provide a neat finish.

With the ability to contain up to 50% recycled EPS, the wider usage of this panel could have many benefits environmentally.

7.2 Future studies

- The performance of the wall panels under dynamic loading needs to be studied and the results of a full scale model testing can be used to model its behaviour for future designs.

- The construction of a two-storey house by incorporating both these systems could be studied. However, this would require testing of a real scale model to identify the load transferring mechanism between the pre-stressed concrete elements and the EPS based lightweight concrete wall panels.

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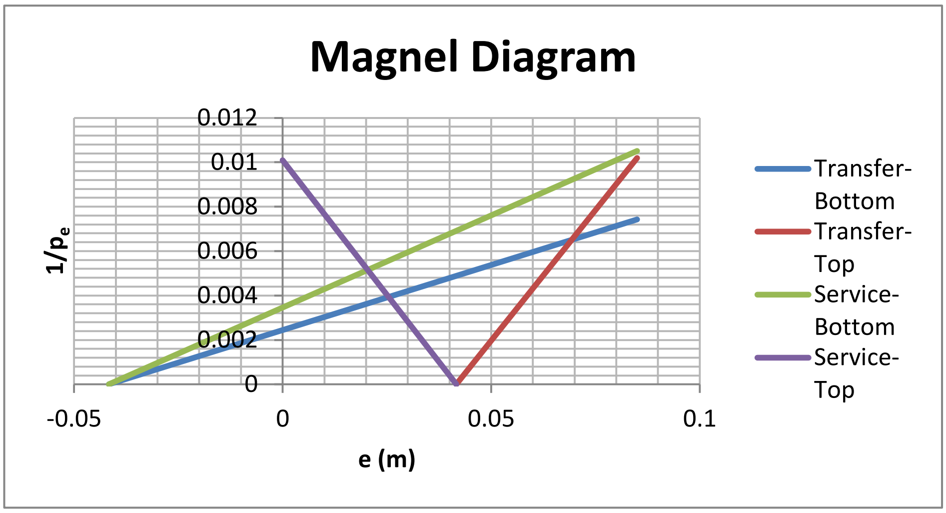
Step 2:

Trial Section sizes were chosen and checked for its adequacy based on the expected loadings.

Section Properties		
Length	4	m
Breadth	0.15	m
Depth	0.25	m
Y bottom(Y1)	0.125	m
Y top(Y2)	0.125	m
Cross sectional area	0.0375	m2
Second moment of area	0.000195313	m4
Section modulus bottom (Z1)	0.0015625	m3
Section modulus top (Z2)	0.0015625	m3
Applied Stresses		
Loads		
Self weight	0.9	kN/m
Super imposed dead weight	5.77	kN/m
Imposed Load	1.58	kN/m
M0	1.8	kNm/m
Mdl	11.544	kNm/m
Mil	3.15	kNm/m
Msmax	16.494	kNm/m
Msmin	13.344	kNm/m
Suitability of Section Sizes		
Achieved section modulus	0.00019631	m3
Result-bottom	HENCE OK	
Result-top	HENCE OK	

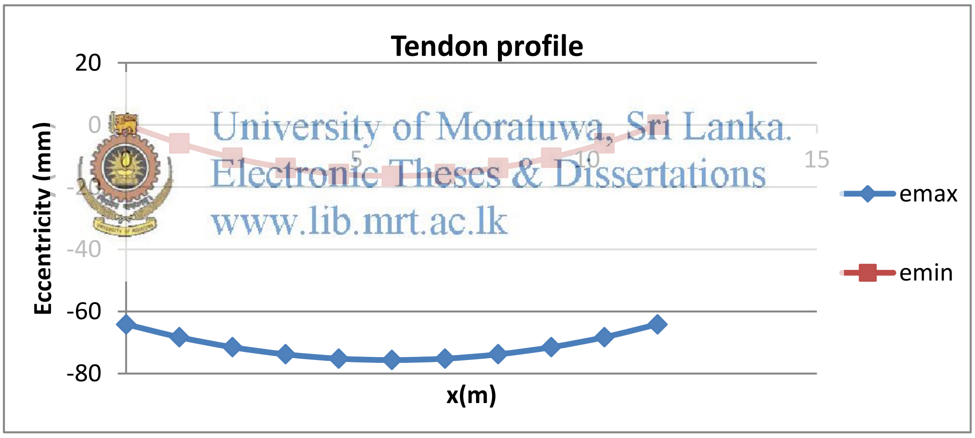
Step 3:

The Magnel Diagram was developed based on the inequalities developed for limiting the tensile and compressive stresses at the top and bottom most fibres at the mid-section. (Where the bending moment and hence the bending stresses are greatest)



Step 4:

A suitable combination for P_e and e were chosen from the Magnel Diagram and the expected tendon profile for this combination was developed in order to determine the possibility of maintaining a linear tendon profile.



Step 5:

The requirement of pre-stressed strands was determined for the chosen P_e and e value.

Number of Tendons		
Selected 1/pe	0.008	1/kN
Selected pe	125	kN
Breaking load of a tendon(pb)	34.7	kN
Number of tendons required	7	
Diameter of pre stress wire/strand/bar	5	mm
Selected e	60	mm

Step 6:

The expected short and long term losses were determined to see if the pre-determined loss ratio is adequate.

Short term losses		
Elastic Shortening of Concrete		
Pj	166.6667	kN
A	0.0375	m2
e	0.06	m
I	0.000195	m4
M	1.8	kNm
fco	6963.484	kN/m2
Esteel	205	kN/mm2
Econc	28	kN/mm2
Δfps	50.98265	N/mm2
Loss due to elastic shortening(Δpse)	6.869575	kN
Long term losses		
Steel Relaxation		
Pj	166.6667	kN
Relaxation factor	1.2	
1000h relaxation test value	2.5	%
Loss due to steel relaxation(Δpsr)	5	kN
Shrinkage of Concrete		
Shrinkage strain	0.0003	
Esteel	205	kN/mm2
Loss due to shrinkage of concrete(Δpss)	8.286718	kN
Creep of Concrete		
Creep coefficient Φ	1.8	
Econc	28	kN/mm2
Esteel	205	kN/mm2
fco	6963.484	kN/m2
Loss due to creep of concrete(Δpsc)	12.36524	kN
Total short term losses	6.869575	kN
Total long term losses	25.65195	kN
Total losses	32.52153	kN
Pi	159.7971	kN
Pe	134.1451	kN
α	83.94717	HENCE OK

A.2 Pre-stressed concrete slab design

Since these panels are one way spanning slabs, the procedure for beams could be followed. However, the effect of the screed concrete must also be taken in to consideration.

Step 1: First the allowable stresses for compression and tension under transfer and service conditions were determined.

Allowable Stresses			
Concrete cube strength(fcu)		40	N/mm2
Strength of Concrete at transfer(fci)		25	N/mm2
Density of concrete		24	kN/m3
Loss ratio		0.8	
Compressive			
At Transfer			
Select Stress distribution type	Triangular stress distribution		
Allowable stress(famaxt)		12.5	N/mm2
Under service loads			
Select loading type	Loaded in bending		
Allowable stress(famax)		13.2	N/mm2
Tensile			
At transfer			
Select class	Class 2		
Select type of pre stressing	Pre tensioning		
Allowable stress(famint)		-2.25	N/mm2
Under service loads			
Select class	Class 2		
Select type of pre stressing	Pre tensioning		
Allowable stress(famin)		-2.85	N/mm2

Step 2:

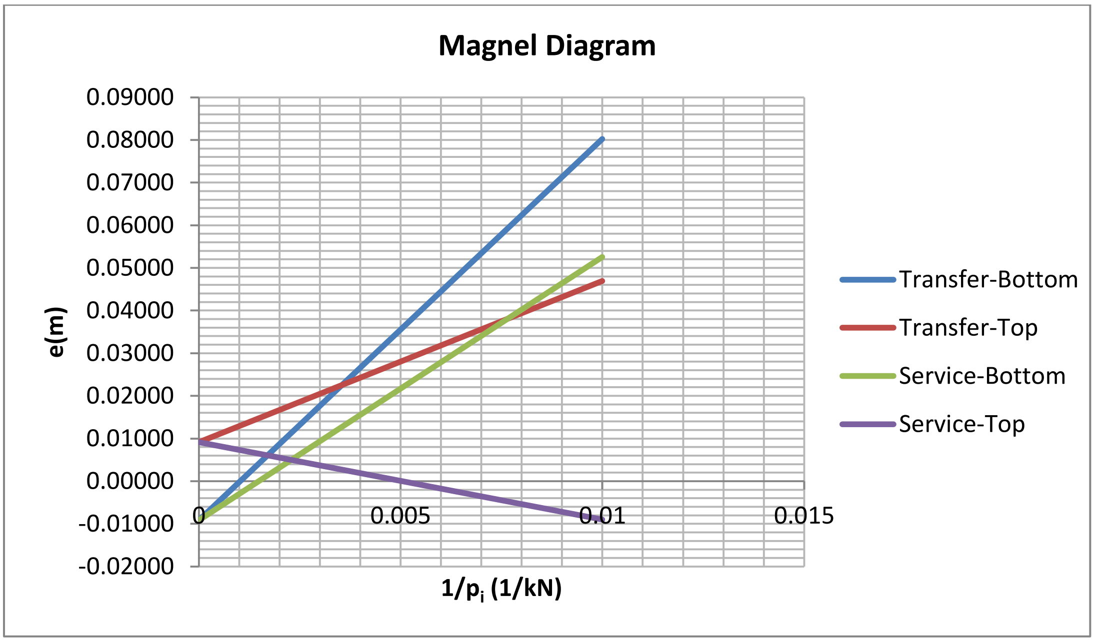
The expected loading was calculated by incorporating the effect of the screed.

Section Properties		
Length	4	m
Breadth	1	m
Depth	0.055	m
Screed thickness	0.05	m
Y top(Y1)	-0.0275	m
Y bottom(Y2)	0.0275	m
Cross sectional area	0.055	m2
Second moment of area	1.38646E-05	m4
Section modulus top (Z1)	-0.000504167	m3
Section modulus bottom (Z2)	0.000504167	m3
Ic	9.64688E-05	m4
Z1c	-0.0385875	m3
Z2c	0.0018375	m3

Applied Stresses		
Loads		
Self weight	1.32	kN/m
Super imposed dead weight_1	1.25	kN/m
Super imposed dead weight_2	0.25	kN/m
Imposed Loads	2.00	kN/m
M0	2.64	kNm/m
Mdl_1	2.5	kNm/m
Mdl_2	0.5	kNm/m
Mil	4	kNm/m
Msmax	9.14	kNm/m
Msmin	5.14	kNm/m

Step 3:

The Magnel Diagram was developed based on the inequalities developed for limiting the tensile and compressive stresses at the top and bottom most fibres at the mid-section. (Where the bending moment and hence the bending stresses are greatest)



Step 5:

The requirement of pre-stressed strands was determined for the chosen P_i and e value.

1/pi	0.0032	
pi	312.5	kN
Breaking load of a tendon	34.7	kN
Number of tendons	13	