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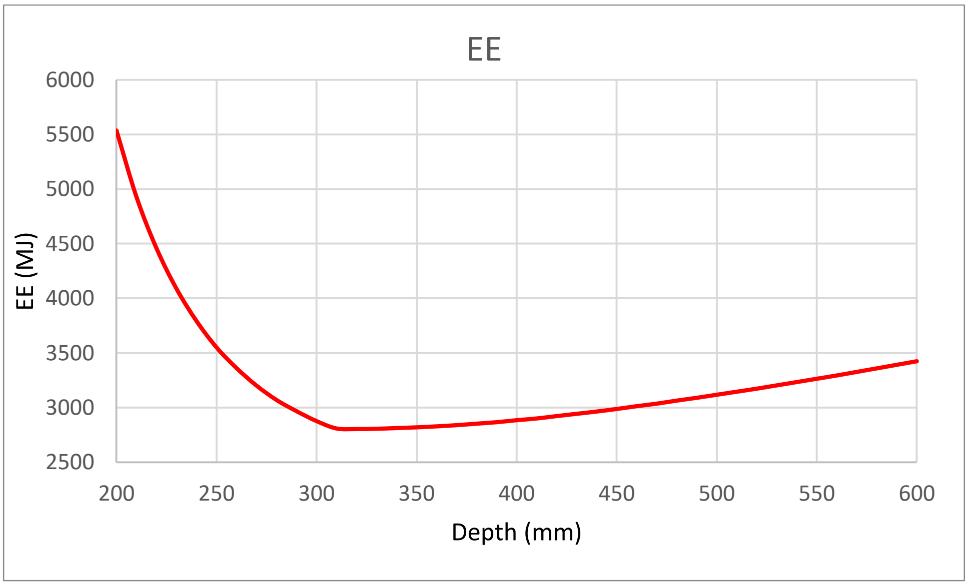
PhD Progress as at March 2019

Objective

Initially, the objective was set to develop further optimised alternative reinforcement system for fabric formed beams using UHPFRC and flexible FRP. Now the objective was set at a step backward, to identify the most optimum form of reinforcement for floor beams. In this study, use of active reinforcement vs passive reinforcement, Steel vs FRP and shape optimised cages vs prismatic cages are to be looked at.

Illustration of the selected scenario:

- Prismatic beams passively reinforced with steel
- Simply supported beam of 6m long
- Loads for an office building
- A constant web width of 300mm, flange width is for 6m×6m bay according to BS EN 1992
- Considered flexural, deflection and shear capacity
- The depth was varied from 200mm to 600mm to identify the most optimum depth for Embodied Energy
- Embodied energy is considered only for the web part since slab thickness was considered to be constant for every web depth
- Only the materials required to construct the beams were considered, the energy for the construction process has not been counted

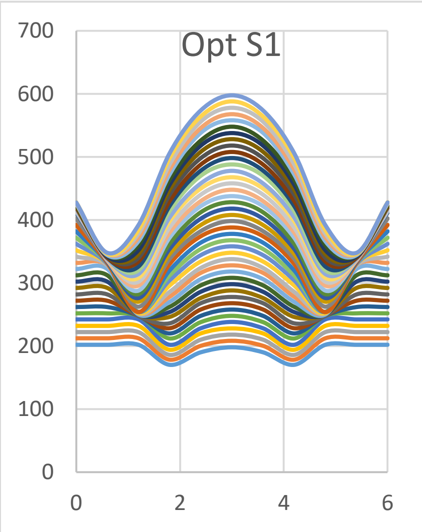


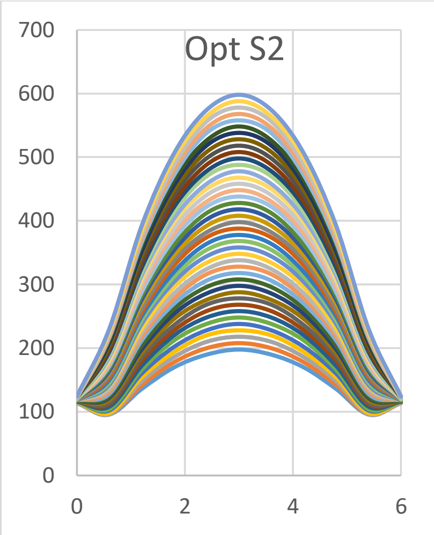
With this kind of graphs, the optimum depth for a given set of conditions can be identified, hence the minimum embodied energy possible for the selected construction technique.

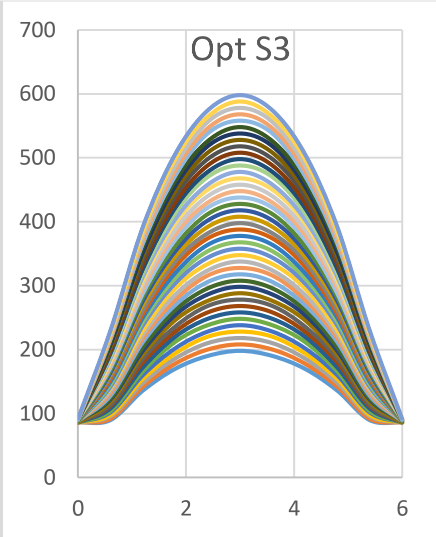
This process is to be carried out for the other construction alternatives as well.

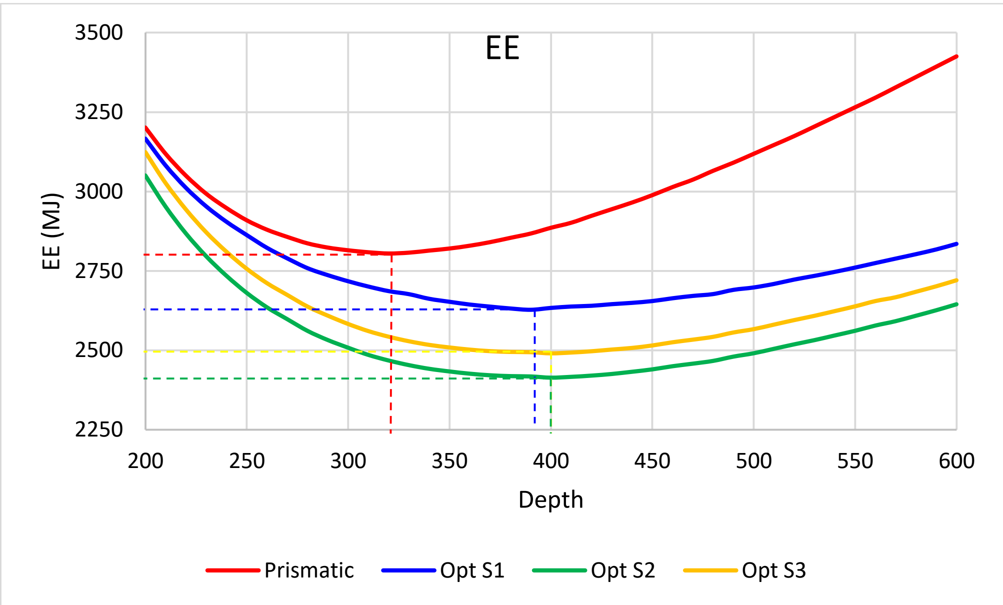
Variable depth beams passively reinforced with steel

- Other than the variable depth profile, the rest of the conditions were set as the previous illustration
- Longitudinal RF is calculated for flexural reinforcement ONLY (stiffness not considered yet)
- Opt S1: Depth reduced keeping shear reinforcement as minimum possible
- Opt S2: Depth reduced until Cot (θ)=2.5 can satisfy shear requirement
- Opt S3: Depth reduced until Cot (θ)=1.0 can satisfy shear requirement
- Purpose of Opt S1, 2 & 3 was to check whether it is worthwhile to have increased amount of shear RF to reduce amount of concrete
- Optimised shapes are not practical (Especially Opt S1) but the smoothed shapes should be higher in Embodied Energy because of the higher materials required









For Prismatic vs Optimised beams, Optimum depth changes!!

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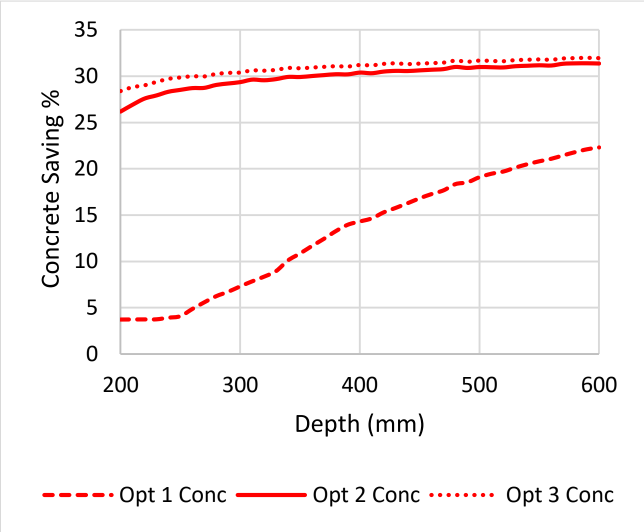

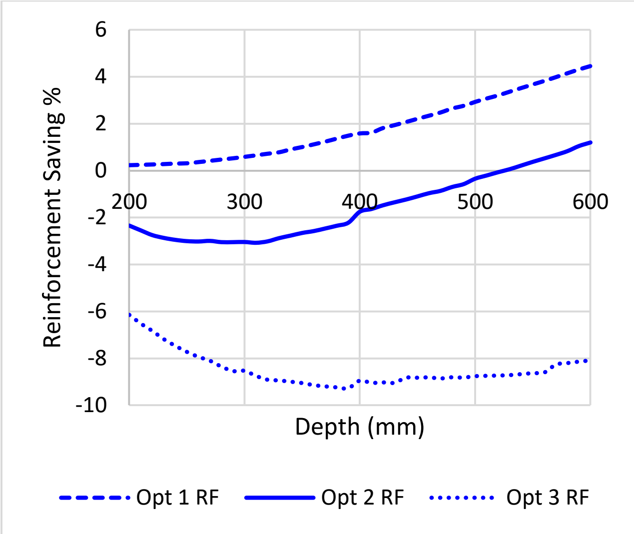

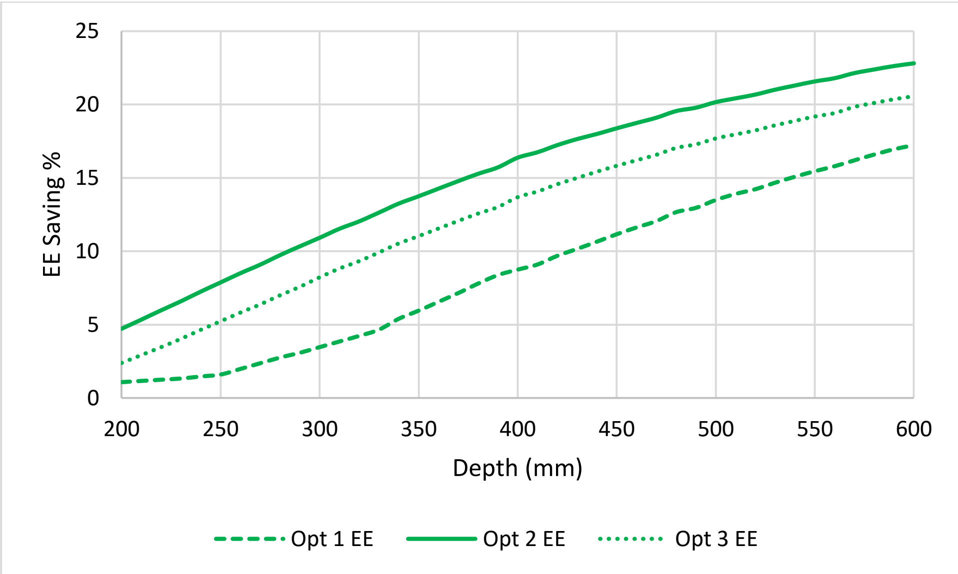

For Min EE				
	Prismatic	Opt S1	Opt S2	Opt S3
Depth (mm)	320	390	400	400
Con (m3)	0.56827	0.59833	0.49672	0.49085
RF (m3)	0.00773	0.00647	0.00656	0.00703
EE (MJ)	2805	2633	2413	2490
EE Saving %		**6.13**	**13.98**	**11.21**
Con Saving%		**-5.29**	**12.59**	**13.62**
RF Saving%		**16.30**	**15.14**	**9.12**

- Concrete saving can be up to 30% for a given depth easily with Opt S2 and Opt S3
- Longitudinal RF is not changed
- Reduction in EE is increasing with depth because of the removal of concrete further
- Shear RF is increased at the ends, but the size of link reduces with the change in depth
- There is a limit to optimum depth profile compromising shear reinforcement (Opt S2 is better than Opt S3)