FEASIBILITY STUDY ON POLYURATHENE SANDWICH PANEL FOR DOMESTIC CONSTRUCTION

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Degree of Master of Engineering in Structural Engineering Designs

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DECLARATION

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Abstract

The place to live is the third need of mankind. Everybody try to build up a suitable mean to meet their own requirements. The Sri Lankan need always changes drastically after two decades from initial construction as the social and economical changes in the society. The use of none renewable material for short period may degrade the scarce resources. And also generate ample amount of green house gasses, which lead the global warming. Therefore in time to come, we have to switch to renewable material or reusing material. There are some materials, those are produced from garbage. This creates regenerative products on earth resource extraction circle. The polyurethane sandwich panel is a reusing material which is produced from garbage. This thesis is on feasibility study on polyurethane sandwich panel for domestic constructions. The product establishment is a derivation as a regenerative product to meet the human need of this scenario.

Additionally there is a shortage of skilled labour in the country. And the cost of labour for domestic construction is a considerable portion. The time consumed for domestic construction is more than months. Therefore by introduction of polyurethane sandwich panels for domestic constructions may resolve the major problems in the domestic construction field in the country.

The aim of this thesis is to introduce an engineered solution from polyurethane sandwich panel to aforesaid problems. The only drawback is the less fire rating. But currently produced materials meet the legislative and regulatory stipulations. The science and technology on this field is to be improved in time to come.

The sandwich panels are having very high stiffness compared to weight and a cost effective product. Polyurethane sandwich panel material may last more than two decades without much maintenance.

The polyurethane sandwich panels are used for the construction of walls and ceiling on the cold room constructions as a good thermal barrier. This thesis is to see the validity on cold room construction material for the domestic constructions.

The material properties changes from supplier to supplier. Therefore it is very difficult to adopt the standard practice in design. Even though “European Recommendations for Sandwich Panels Part 1; Design”;[14] has released on year 2000. The publication has been criticized by various researches such as Narayan Pokharel and Mahen Mahendran on their publication to “Thin Walled Structures” [13]. In addition the both published documents’ equation ranges on “European Recommendations for Sandwich Panels Part 1; Design” [14] and “Thin Walled Structures” [13] do not comply with the encountered polyurethane insulative sandwich panel. Therefore the serviceability limit published by “European Recommendations for Sandwich Panels Part 1; Design” [14] has been incorporated for design serviceability limit checking.

This thesis is on feasibility study of sandwich material for house constructions by means of walls, slabs and roofs. The typical two-story house and the two story cluster houses are modelled to see the engineering viability under standard loadings. The outcome revealed that the construction up to two stories is safe. Therefore further studies in this stream shall be followed in future. As per the project outcome on the clause 6.6; it reveals that the domestic constructions up to two stories may be possible under some form of local capacity enhancement methods adapted to high stresses applied locations.

The economical analysis is also made in Chapter five. Accordingly the cost on individual houses and cluster houses do not change and it revealed that there is more than 41% saving compared to the conventional constructions.

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NOTATIONS

Greek Symbols

α	-	Honeycomb cell size
δ	-	Length of contact between the central roller and the top skin or Length of top distributed-load
υ_{cxz}	-	Out of plane honeycomb Poisson's ratio
υ_{fxy}	-	Poisson's ratio of the skin material
ρ_c	-	Honeycomb core density
ρ_s	-	Honeycomb constituent material density
σ	-	Out of plane stress
σ_{cc}	-	Out of plane compressive strength of the honeycomb core
σ_{fi}	-	In plane compressive stress for intracellular buckling of the skin
σ_{fw}	-	In plane wrinkling strength of the skin
σ_{fy}	-	In plane yield strength of the skin
σ_{txx}, $\sigma_{txx\ i}$	-	In plane normal stress in the skin
σ_{txx}	-	Out of plane normal stresses in the core
τ_{31}, τ_{32},	-	Out of plane shear strength of the honeycomb for transverse and longitudinal directions.

Latin Symbols

A_t, A_b	-	In plane rigidity of top and bottom skin
b	-	Beam width
c	-	Core thickness
D	-	Flexural stiffness of the beam
D_t,D_b	-	Flexural rigidity of top and bottom skin
d	-	Distance between the mid planes of top and bottom skin
E_c or E_3	-	Out of plane Young's modulus of the honeycomb core
E_s	-	In plane Young's modulus of the honeycomb core in the x direction.
G_{31},G_{32}	-	Out of plane shear module of the honeycomb for transverse and Longitudinal ribbon direction respectively
G_s	-	Shear modulus of the honeycombs solid material
I	-	Second moment of area of the sandwich beam
I_f	-	Second moment of area of the skins with respect to their own Centroidal
L	-	Span of the sandwich beam
M	-	Maximum beam bending moment
t,(t_t ,t_b)	-	Skin thickness (top/ bottom)
u_t ,u_b	-	In plane centroidal displacements of top or bottom skin
v	-	Base width of triangular pressure elements
w	-	Load per unit width
y	-	Leaver arm to the point considered

Note - Other symbols not mentioned are defined in the text or figure whenever they appear.