Design and Development of Secondary Glass Fiber Roving Waste Prototype for Preventing Environmental Hazard

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Abstract

Glass fibre roving waste generated during the manufacture of automobile interiors lack a proper way to dispose and hence cause environmental hazard. To overcome this issue, a potential way to reuse the roving waste has been explored. Two prototypes were designed and developed for dispensing the secondary roving glass fibre waste by dispenser mechanism. The proposed dispenser mechanism was reintroduced with unutilized roving into the process line of automobile interior to attain proper output. Results showed the requirement of roving per headliner as 400 g/headliner. But the further optimization of this dispensing mechanism could help to reuse the glass fibre waste efficiently.

Keywords - *Glass fibre, Hazard, Roving waste*

I. INTRODUCTION

Automobile industry is notable for its vast consumption of fibre reinforced polymeric composites (FRPC) due to its properties to afford endurance, flame resistance, low cost and light weightiness. FRPs are made of reinforced fibres *viz.* glass, carbon and aramid with a polymer matrix. These composites possess high strength-to-weight ratio and hence are ideal for high performance in automotive components. Currently, the emphasis on their reusability and disposal has imposed major stress on the manufacture industry. Normally these FRPCs are deposited in landfills or incinerated, imposing environmental damage. The introduction of bio-based composites has been addressing the problem but there still exists an urgent need to develop recycling technologies for conventional polymeric composites. If not identified, the development and continued use of conventional composites will soon cease in the industry [1].

Recycling of FRPCs has become a vital area of research where the manufacturers are ready to invest in. A researcher proposed a hierarchy of waste as a potential way for waste reduction, where waste minimization tops the ladder followed by reuse, recycling, incineration, energy recovery and finally composting [2]. These processes would likely reduce the burden imposed on the environment. In order to recycle FRPCs, a new recycling technique which would lessen the environmental damage caused by the existing technology should be considered. Among the FRPCs, glass fibre reinforced polymer composites (GFRPC) usually exists as long or short glass fibre reinforced with polypropylene, is widely used for the manufacture of automobile headliners [3]. Commercially available glass fibres are strands with a collection of parallel filaments of nearly 204 or more. Roving is a process where group of untwisted parallel strands would be wound on cylindrical package. The roving process can preimpregnate with a thin layer of polymeric resin matrix to form prepregs. These prepregs cut into required dimensions, stacked and cured into a final stage during batch moulding operations such as compression and hand layup moulding as well for continuous moulding such as filament winding. The main objective of the present study is to design and develop a secondary glass fibre roving waste dispenser mechanism for reintroducing the unutilized roving waste into the process line of the automotive headliner by attaining the needed GSM. By this dispenser, we intend to reduce and reuse C-type glass fibre, economically.

II. MATERIALS AND METHODS

A. Functional Unit -Mechanical process

For the present study, a single car headliner manufacturing waste 321made up of glass fiber composites about 1 kg were collected from the process line. In the plant where the study was performed, about 72 Kg of glass fiber roving was found to be declared waste. This observation revealed the existing high potential for reusing the generated scrap waste with the help of two prototypes.

B. Prototype I - for reuse

The roving waste strands were introduced into the roving wastage strands in a repeated sequential manner for fabricating it into the required pattern (Figure 1). The prototype planned to be fabricated was made first using a wire mesh and was tested with the secondary dispenser.

Fig. 1: Prototype Model I made using wire mesh

C. Prototype II - for reuse

The product of the prototype 1 was planned to be introduced into second prototype (Figure 2), there two shaft will be implemented, one to remain stationary while the other forms the driving part. The latter part was supported with brushes or bristles in order to offer supporting role for segregating the roving wastage.

Fig. 2: Prototype Model II made before development

III. RESULTS AND DISCUSSION

The roving glass fiber waste tested with the type 1 prototype failed to dispense the roving material at 450 to 500 g in 13 seconds. Also, a motor power of nearly 1 HP was needed to drive the type 1 prototype. The failure prototype 1 was modified as type 2 prototype for achieving the necessary 450 to 500 g within 14 secs.

Table 1 - Time duration taken by PART passing through dispenser

S.NO	PART travelling speed (s)
1	12.48
2	12.25
3	12.36
4	12.32
5	12.91
6	12.16
7	12.17
8	12.19
9	12.98
10	12.65

A. Calculation of GSM

Successive trials were conducted to calculate the GSM using sample sheet.The dimension of the sample sheet is one-tenth of the total size is the PART.

The following tabular column represents the roving quantity from the sample paper.

Table 2 - Calculation of GSM

S NO.	Sample paper thickness (mm)	Total quantity (roving + sheet) (mm)	Required Quantity (Total quantity – Sample sheet thickess (mm)
1	0.5	11.51	11.3
2	0.49	11.54	11.76
3	0.51	11.34	11.12
4	0.54	11.67	12.03

B. Calculation of area of Part and Roving

The dimension of PART varies from hatchback to SUV , so the largest dimensional consideration; length (l) = 2100mm, breadth (b) = 1600mm, area (a) = l*b = 3.36 mm^2.Therefore, required quantity of roving per headliner is given by, Required quantity = 120*3.36 = 403.2 gms (i.e. 400 gms /headliner (approx.))

So, the product from prototype 1 which is a partially enclosed arrangement of two hollow shaft like assemblies were feed into prototype 2 for obtaining a wire-mesh materials at the end of prototype 2. The prototype 2 yield a product where the mesh was found modified to vanes for dispensing the glass fiber (Figure 3,4,5 and 6).

C. Designs for Prototype 2

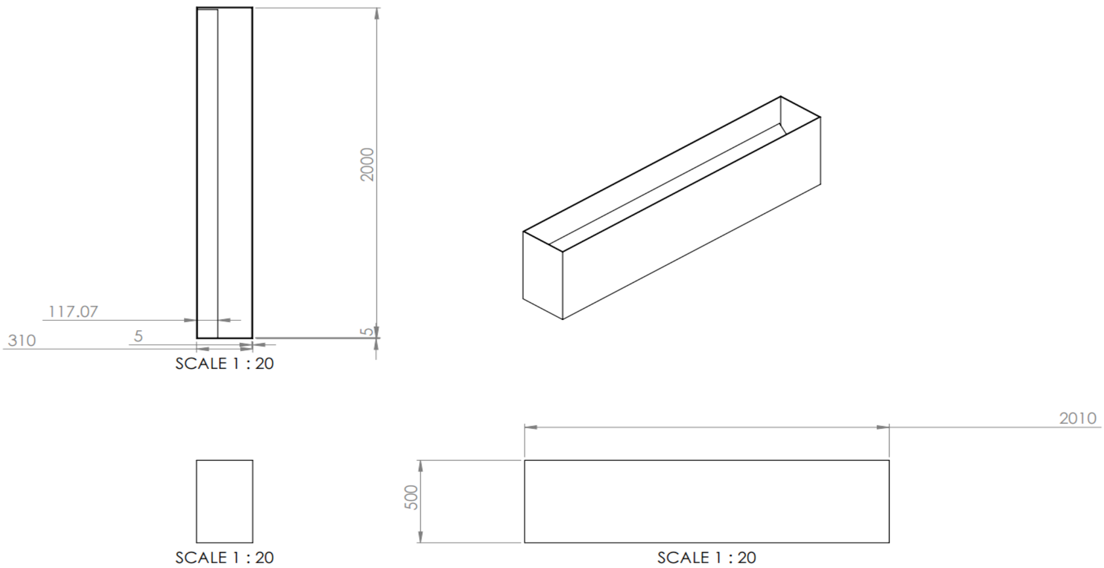

Fig. 3: Shows the Hopper in Prototype 2 where the Scale is Taken as 1:20

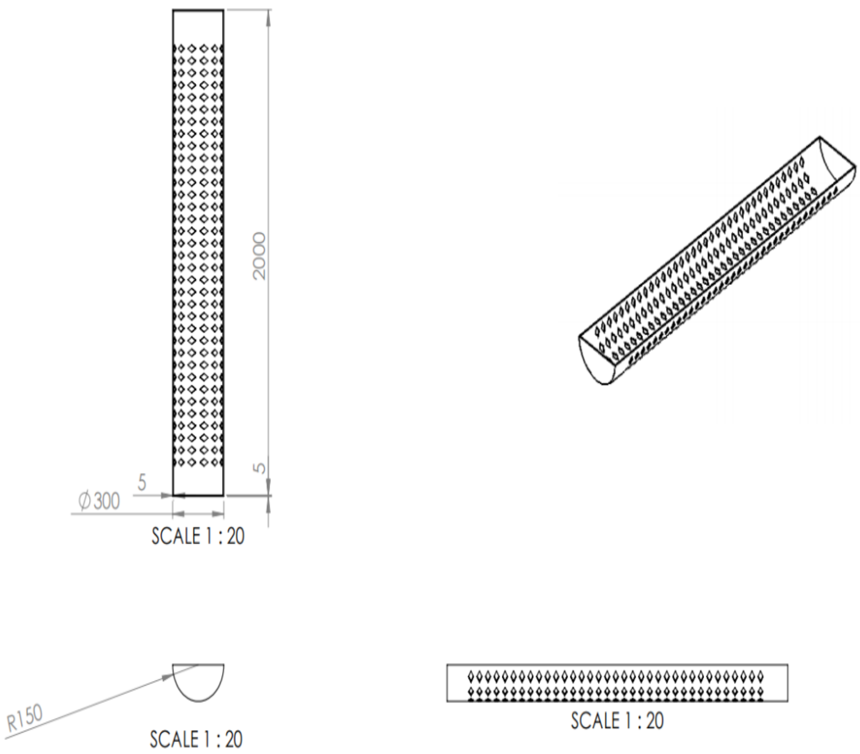

Fig. 4: Shows the Design of Dispensing Panel that was Used in Prototype 2 with an Scale of 1:20.

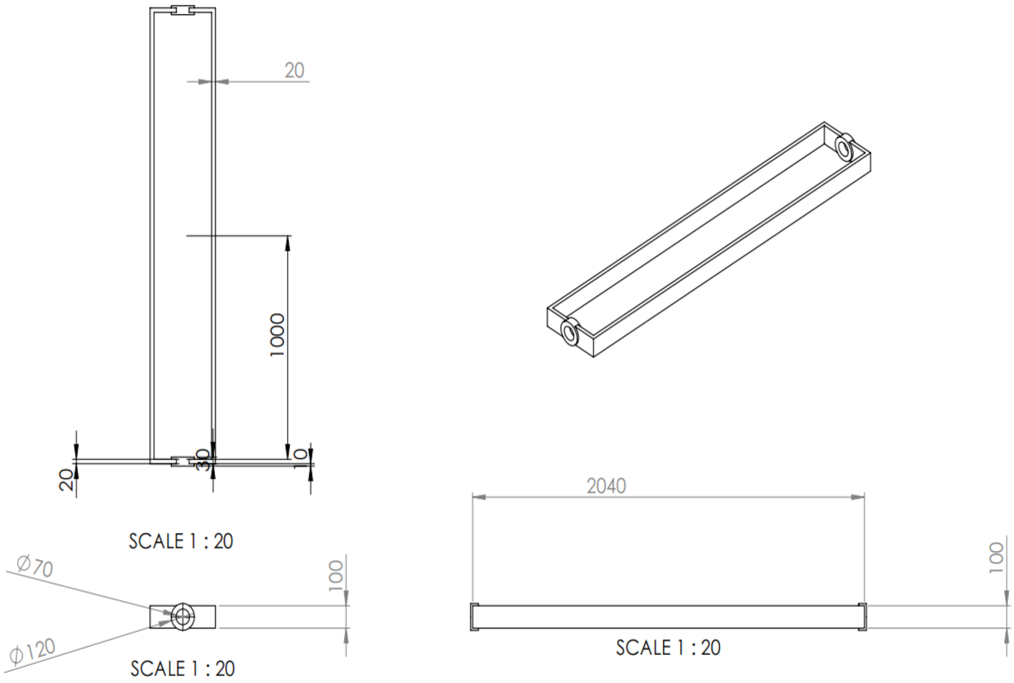

Fig. 5: Shows the Design of Bearing Plate used in Prototype 2 with an Scale of 1:20.

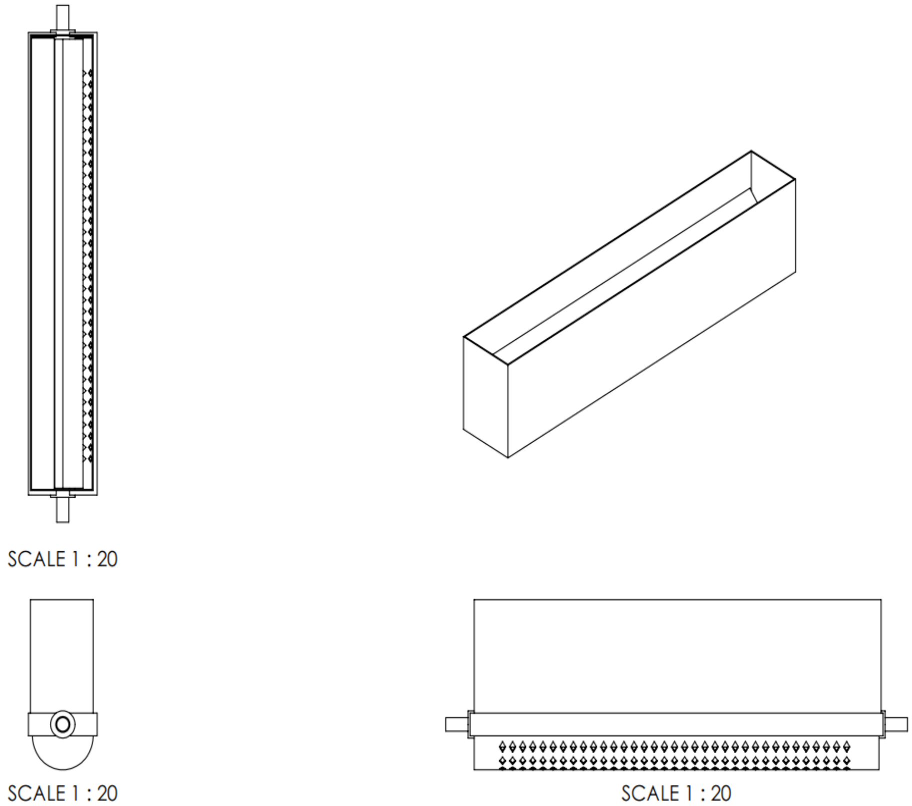

Fig. 6: Assembly used in making prototype 2 with an scale of 1:20.

IV. CONCLUSION

As the existing trends utilized in automobile interiors sectors till date were studied, the lack models for sucessfully reusing the generated glass fibre waste, these present prototype described in our studied were developed. These tested protypes were expected to give a roving quantity per headliner of about 40 g/ headliner. The drawback of the obtained required output is that the required GSM of 100±20 could not be achieved. So in conclusion, a optimization work is mandatory for eventually achieving a effective and efficient test prototype for best reuse of the environmentally hazards glass fibre waste.

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