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ANALYSIS OF MATERIALS FOR INDIAN LMV SUB-SYSTEMS: A STUDY

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ABSTRACT

In India there is large number of light motor vehicle (LMV) manufacturers producing around twenty lakhs per annum. Each LMV has around 15000 to 20000 parts. LMVs use different materials like grey iron, ductile iron, steel, aluminium alloys, Mg alloys plastics and polymers. The components mass of LMVs has significant impact on fuel efficiency. In the present work an attempt has been made to analyse materials used in various sub-systems of LMVs. The material analysis presented in tables and pie diagrams are plotted. Several useful conclusions have been arrived at.

Keywords- Al alloy, Body, Chassis, Grey iron, Light motor vehicle, Mg alloy, Power train,

I. INTRODUCTION

More than 600 million automobiles are playing globally, 125 million in India, 2 lakhs in Arunachal Pradesh and around 50000 in Itanagar respectively. Automobile industry is one of largest industry catering the mobility requirements of the people of North East in general and Arunachal Pradesh in particular. Arunachal Pradesh is the largest state in area of the NE region and has an average rainfall of 360 cm. large number of light motor vehicle of defence, border roads organisation, central, state and private vehicles are also playing on the roads of Arunachal Pradesh. LMV is a wheeled vehicle that carries its own weight and transports 4 to 10 passengers from one destination to another.

The French engineer captain Nicholas Cugnot of France built the first road vehicle which use steam power for locomotion. German inventor Karl Benz constructed first gasoline powered vehicle in1885. Frame material was tubular steel. In India 1943 and 1944 two Automobile factories namely Hindustan Motor Limited [1-4], Calcutta and Premier Automobiles Limited Bombay were set up. In ambassador car used materials are iron and its alloy Al and Al alloy copper and its alloy. At this time in India many automobile company at present use material are steel cast iron aluminium alloy Carbon Fibre Reinforced plastics material other material. Since materials play a decisive role with regard to both the quality and cost of a car, selection of the correct materials at the earliest possible stage of the development process is of vital importance. The materials used in vehicles [5-6] nowadays are selected so as to optimally fulfill the specific requirements. It is the job of the materials engineer in a car-manufacturing company to ensure that this optimum will be reached. However, the corporation, itself, must

decide what "optimal" actually means in practice. As well as considering the general economic framework, external influences such as the customers selected as the target group, and legal requirements and regulations are particularly relevant here. Newly developed or modified conventional materials on the market represent competition for materials already in use. The application potential of such materials is dependent on how well they satisfy the requirements placed on them. LMV materials usage has been changing continuously but there is no systematic study of sub-systems and materials used and their mass. Hence in the present work an attempt has been made to analyse materials used and their analysis.

II. LITRATURE SURVEY

Various automobile manufacturers those who are manufacturing LMVs are referred to know the important specifications about vehicles the LMV manufacturing companies catalogues [7-11] and manual of LMV manufacturers also taken for reviewing the engine specification transmission details and performance of engine. Various operation and maintenance manuals were studied and mass of components of sub-systems were computed.

III. MATERIALS USED IN LIGHT MOTOR VEHICLES

The most of the LMV part are made up iron, steel, aluminium, magnesium, plastic and copper. In automobiles there are four major systems namely the body, power train, chassis and other system like electrical controls, instrumentation etc. The body comprising of closures and exterior and interior trims and engine and transmission is included under the power transmission. The chassis provides space for accommodating frame, suspension system, brake system and steering system and remaining electrical items, seats, instrument controls and glass have been grouped under the other systems. The major components of the subsystems are shown in table 1. The major materials used in the manufacture of automobiles include iron and its alloys, aluminium and its alloys, magnesium and its alloys and fibre reinforced plastics. The body is the single largest group with about 45% of total mass and consist of steel structural components. Main systems are made primarily from metals with combination of some plastic parts increasing and most lightly stressed housings are moulded from plastics. The power train is about 28% of vehicle mass of comprising of engine and transmission the main system in the vehicle are characterized by complex assemblies of many individual components. The chassis components are weighing 27% of vehicle mass are highly diverse with different functions compared with other mechanisms. The iron and steel play as a major role in construction of automotive components. Suspension and sub frames are dominated by steel but steering and brake systems include more diverse materials for different functions.

IV. ANALYSIS OF MATERIAL FOR LMVS

The existing material would only be replaced where such a measure also resulted in a cost reduction. In general, improved fulfilment of demands already adequately covered by the existing material - for example with regard to increased strength or better corrosion-resistance - does not represent a sufficient reason for a substitution.

Where requirements are modified and where these new requirements, including minimized cost, are not met by the conventional materials, the new materials are substituted for the old. Modified demands result from a change in the social and legal environment and a change in customer attitudes. Conventional automobile materials, like e.g. the metallic materials, are constantly improved. The new materials have a good chance to substitute for the current ones, because developers, materials engineers and production engineers are able to rely on available knowledge and experience. This means that the effect of each modification on quality, production requirements and costs, and thus the risks associated with a conversion, can be well estimated.

The potential for significant weight reduction clearly involves replacement of the almost 68% of the mass constituted by ferrous materials. The average material content percentage of light motor vehicles has been presented in Table 5. The 55% steel is used in construction of body and chassis components in LMVs and 13% cast iron used in marking engine and transmission housings and followed by plastics and aluminum 8% and 6% respectively. The potential applications and challenges of various lightweight materials in automotive applications in terms of strength, cost, manufacturing and recyclability for possible weight reduction in the LMVS also presented. The body which houses passenger compartment luggage space and doors is having 28% of mass of vehicle and chassis which consists frame suspension and brake is weighing 27% of vehicle mass and followed by engine and transmission 28% of vehicle mass and other accessories of percentages is 17% of mass are presented.

Table1: Analysis of Mass of Sub- Systems of LMV

Name of sub systems	Name of the components	Mass of Steel Component	% of component of total mass	Mass of Al Component	% of component of total mass	Mass of Mg Component	% of component of total mass
Power Train	Cylinder block	63.8	5.32	22.9	3.19	14.72	2.30
	Cylinder head	28.4	2.37	10.19	1.42	6.55	1.03
	Inlet manifold	5.5	0.46	1.97	0.28	1.26	0.19
	Exhaust manifold	4.5	0.38	1.61	0.23	1.03	0.17
	Gear box case	10.5	0.87	3.76	0.53	2.42	0.39
	Other casting	94	7.83	33.74	4.70	21.69	3.4
	Other Steel components	130	10.83	130	18.12	130	20.36
	Sub total	336.7	28.06	204.17	28.47	177.67	27.84
Body	Bonnet Lid	20.8	1.73	7.46	1.04	4.77	0.75
	Doors	80	6.67	28.71	4.00	18.46	2.9
	Roof	62.17	5.18	22.31	3.10	14.29	2.24
	Floor	91	7.58	32.76	4.56	20.93	3.28
	Fender Front	30	2.5	10.8	1.55	6.9	1.08
	Fender Rear	38	3.17	13.68	1.90	8.74	1.37
	Deck Lid	20.53	1.71	7.39	1.03	4.7	0.74
	Other body structures	60.8	5.07	21.88	3.05	13.98	2.19

	Sub total	403.3	33.61	144.99	20.23	92.77	14.53
Chassis	Frame and other system	280	23.33	224	31.23	224	35.08
Other Systems	Seat and other systems	180	15	144	20.07	144	22.55
Total Mass(Kg)		1200		717.16		638.44	
% Material saving				40.23		46.79	

In Table 1 the mass of different systems and components for entire vehicle have been considered for mass reduction for improvement in mileage. Chassis and some of steel components have not been considered for replacement with aluminum and magnesium alloys as these components has to have more strength for operation of vehicles. As a whole mass of vehicle the considerable mass savings was achieved by replacing the ferrous materials with auminum and magnesium alloy materials. The saving in mass by using aluminum components is 717.16 kg and by using magnesium components changing from 638.44.

Analysis of power train and their sub-components mass and percentages are presented in Table 2. It was found that percentage mass saving for aluminium alloys is 39.36 followed by magnesium alloys 47.23. Analysis of body components are presented in Table 3 and major components of sub-systems of LMVs are presented in Table 4. Analysis of average mass of alloywise is shown in Table 5 and analysis of subsystems is presented in Table 6. Percentage mass of iron and steel shown in Fig.1, Al alloys in Fig.2 and Mg alloy in Fig.3

Table 2: Analysis of Power Train Components for Three Types of Materials

	% Ferrous alloys	% Al alloys	%Mg alloys
Cylinder block	18.95	11.26	8.28
Cylinder head	8.43	4.98	3.68
Inlet manifold	1.63	0.96	0.72
Exhaust manifold	1.33	0.78	0.59
Gear box case	3.11	1.84	1.36
Other casting	27.93	16.52	12.2
Other Steel components	38.62	63.66	73.17
Total of power train (kg)	336.7	204.17	177.67
% of mass saving		39.36	47.23

Table 3: Analysis of body components for three types of materials

Component of body part	% Ferrous alloys	% Al alloys	Mg alloys
Bonnet Lid	5.15	5.15	5.14
Doors	19.84	19.80	19.8
Roof	15.42	15.39	15.3
Floor	22.56	22.59	22.46
Fender Front	7.44	7.45	7.33
Fender Rear	9.42	9.43	9.32
Deck Lid	5.09	5.1	5.05
Other body structures	15.08	15.09	15.6
Total of body Part (Kg)	403.3	144.99	92.77
% of mass saving		64.04	76.99

LMVs are divided in four major section power train, body, chassis, and other system. If steel components are used then the weight percentage are 28.06, 33.61, 23.33 and 15 % respectively. If aluminium components are used then the weight percentage of these section are 28.47, 20.23, 31.23,and 20.07 respectively. If magnesium components are used then the weight percentage of these section are 27.84, 14.53, 35.08, and 22.55 respectively.

Table4: Components of Sub-systems for LMVs

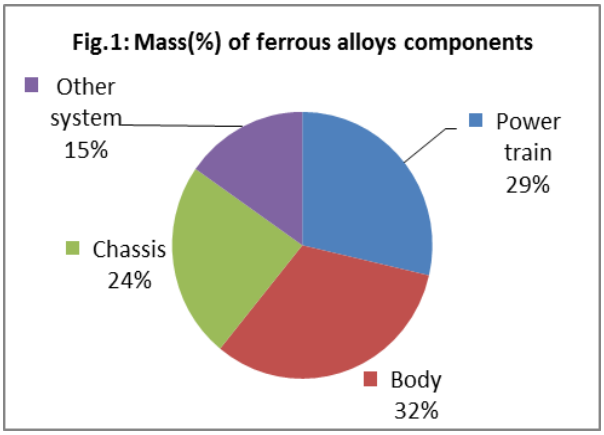
Power train	Body	Chassis	Other Systems
Engine and accessories Engine controls Engine cooling system Transmission Transaxle Clutch Drive line (Rear wheel drive) Differential Exhaust system	Uni body and closures Hardware Exterior and interior Trim Body electricals	Suspension steering system Bumper system Brake system Sub frames Fuel storage system Wheel and tires	Electrical system Instruments and controls Climate control Engine electricals Glass Seats

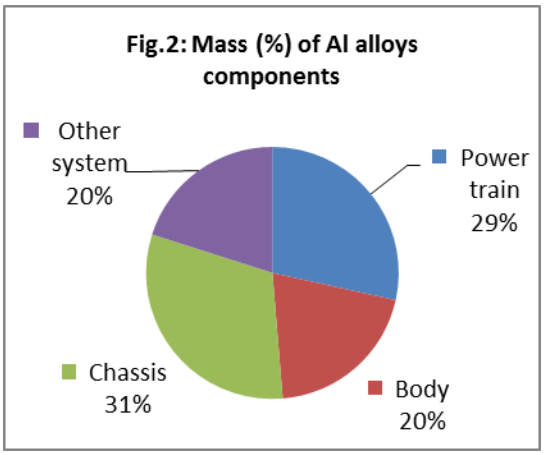
Table 5: Analysis of Average Materials Alloywise in LMV

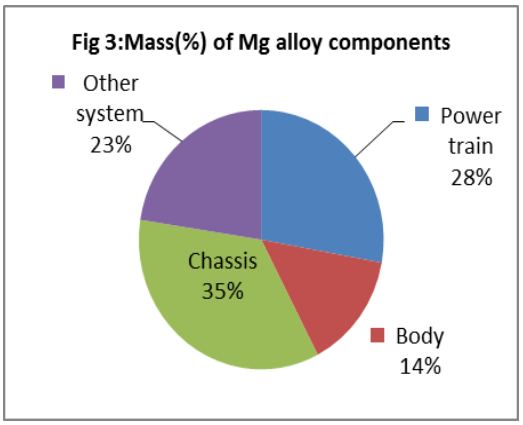
Materials	Percentage of material of total mass of vehicle
Steel	55%
Cast iron	13%
Plastics/Composites	8%
Aluminum	6%
Rubber	4%
Glass	3%
Copper	1%
Other materials	10%
Total	100%

Table 6: Analysis of Mass of Sub-systems of LMV

Name of subsystem	Percentage of weight
Body	28%
Chassis	27%
Engine	14%
Transmission	14%
Other accessories	17%
Total	100%







V. CONCLUSIONS

In the present investigation material analysis for different components of LMVs was carried out for various sub-systems. Three materials were used for analysis i.e grey iron and steel, aluminium alloys and magnesium alloys. The percentage material saving component wise was computed. There is a lot of scope for magnesium alloys followed by aluminium alloys for LMV components.

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