AUTOMOTIVE NOISE AND VIBRATION CONTROL

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ABSTRACT

The prime factors governing the automobile industry today are that of safety, efficiency and above all comfort, a lot of research has gone in to meet the above objectives. NVH is the industry term used to cover the subject of vibration and sounds.

Weight reduction of automobiles is necessary in improving fuel efficiency, but this would worsen the noise, vibration and harshness (NVH) characteristics of the vehicles, resulting in bad ride comfort. On the other hand, use of damping materials to improve the NVH characteristics would increase the weight of the vehicles, resulting in poor fuel efficiency. Important noise and vibration sources in automobiles are engine, "exterior air flow, road profile, and exhaust noise, power train noise. Among all these, the engine generated considerable noise and vibration in either running or standstill states, hence we can consider the engine one of the most important noise and vibration sources in automobiles.

The main noise sources in the engine are the combustion noise, fuel injector noise, mechanical noise, and inlet and exhaust noise, cooling fan noise from the ancillaries such as the generator or compressor.

But in all the noise most of them so well attenuated. Hence engineering focus is switching to power train noise, road noise and tyre noise. Power train noise is reduced largely by improvements in engines, transmission – housing and transfer core design, semiconductor technology that could lead to frictionless bearing and the possibilities using energy fields to transmit power verses solid media.

In the following presentation we have focused on the recent development with the use of upcoming material for cabin, have drastically cut down the noise level and also beefed up the fuel economy.

Keyword *Automotive, Vibration, Elastocell, Polyurethane,NHV etc…*

1. INTRODUCTION

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The reference number should be shown in square bracket [1]. However the authors name can be used along with the reference number in the running text. The order of reference in the running text should match with the list of references at the end of the paper.

Eg1: As per Kong, the density of X increases with Y [3].
Eg 2: It is reported that X increase with Y [2].

Reducing noise, vibration, and harshness (NVH) generated in vehicles is a major priority within the automotive industry. Overall noise and vibration levels now are directly linked to vehicle quality. Development engineering are expending considerable effort to eliminate or reduce noise sources and determine their transmission path so the coupling of these sources to chassis modes can be eliminated.

NVH (noise, vibration, and harshness) is the industry term used to cover the subject of vibration and sounds. Unwanted sound regarded as noise. Vibration is typically felt rather than heard, and tends to be low frequency. Harshness usually means sudden events of short duration at higher frequencies.

During 1980 to 2000, the noise level inside a vehicle has been decreased by an average of 0.3 dB per year. As a vehicle gets quieter, the objective becomes one of tuning and balancing the sound rather than eliminating it, and new sources of noise become significant.

Older engine with a lumpy idle had a cam shaft with a lot of overlap, which was good for power and performance but bad for NVH. Also not all noise is bad. We want to manage the noise rather than eliminate it, where it is very specific segment. Costumers for S-class Mercedes want an absence of noise.

We have more than 1000 NVH targets that fell into three main categories:-

1. Road Noise 2. Wind Noise 3.Power Train Noise

The main source of pass by noise had conditionally been the exhaust system but it is now so well attenuated that engineering focus is switching to power train and tyre noise. The new wide ratio, five speeds automatic transmission is dynamically balanced internally for enhance NVH characteristics. It provide further NVH benefits through increased power train stiffness with its 20 Kg(44-lb), one piece aluminum casting (rather than two piece aluminum casting on the previous model) for the transmission housing which is fully sealed.

2. CLASSIFICATION OF NVH

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2.1 Road noise: -

Road noise can be minimized by reducing air leakage, hence a noise path. Window and dual door seats that reduce air leakage by about 50% over the previous model. The vehicle's body was also redesigned for less wind resistance by shifting the glass and door edge out of the air flow. Entering the passenger area include a dash panel made of laminated steel, a magnesium cross beam and additional sound insulation in the dash, rear quarters, wheel wells, hood fenders, pillars and drive shaft tunnel. For example, Ford conducted a road noise analysis of an early vehicle prototype that turned up a low frequency burst at a 37 and 49 Hz, which was traced to the rear roof panel and frame rail, minute vibration were attributed to the lift get glass, door panels, wind shield. As a result, the vehicle body mounts, rear frame turning, rear roof adhesives were revised. According to company, the revised, microcellular body mounts-made of a vibration-damping combination of urethane and rubber as oppose to the previous, all-rubber mounts-alone reduced noise by 3.6 dB on average. All three modifications in combination to reduce interior sound by other 3 dB.

2.2 Power steering noise: -

Power steering noise and vibration are potential areas of costumer's classification. These disturbances can manifest themselves in numerous ways- higher frequency vibrations as the 'buzz' felt through the steering wheel or the 'chunk' and 'shudder' as lock is applied and hydraulic ' moan' that accompanies low speed parking maneuvers.
By employing noise path analysis and unique virtual test rig (UVTR) which predicts flow ripple in hydraulic systems. This allows engineers to predict fluid pulses and then minimize any vibration they might cause before the system is produced are installed in a vehicle.

2.3Power train noise: -

Power train noise is one of the major and latest problems for which engineers and researchers are looking for better and an economic solution. There are several researches had comes on this and many more to come. since the power train is a large vehicle subsystem mass, optimization of the engine mount system was seen as shake improvement strategy. Power train noise is reduced largely by improvements in engines, transmission-housing and transfer core design, semiconductor technology that could lead to frictionless bearing and the possibilities using

energy fields to transmit power verses solid media. The process that proved effective in reducing lateral shake was to uncouple the power train lateral DOF from the other power train DOF s.

There are following ways to shake reduction:-

- Mount focusing, Stiffness roll axis, Focusing to uncouple DOFs ,Focusing process ,Revised mount system ,Evaluation of redesign,
- Sources of ugly noise emanating from the power train, the road way and wind impact, design engineers cues on Neon 2000 (sod as ply mouth Neon, Dodge Neon and Chrysler Neon)
- Neon 2000 NVH attributes include:
- A higher volume muffler and an exhaust flex joint to make engine operation quieter.
- A four point engine mounts system to reduce steering wheel vibration at idle speed.
- Stiffer suspension cross members and controls arms to minimize the resonance from power train vibrations.
- Full frame doors (replacing glass roll up side windows) to form a tight-fitting body seal/noise barrier.
- All-season single ply tires (replacing previous Neon's two-ply tires) to dampen road noise and beef up fuel economy.

2.4 Wind noise:

Reduced wind noise created by slippery aerodynamics, muted engine and exhaust notes demanded by legislation.

3. PRESENT WORK AND INNOVATIONS

3.1 Material innovation

Many suppliers invest heavily in research to develop materials that will improve passenger materials that will improve passenger comfort, especially if considered in the early stages of design.

1. Elastically, from BASF, is an open-cell micro cellar polyurethane material that has high damping at high amplitudes, low damping at low amplitudes, and has good resistance to temperature extremes. Low lateral expansion and improved durability are other advantages over natural rubber.
2. It has developed an advanced acoustic interlayer for laminated glass that helps to optimize noise attenuation in the vehicle. Laminated glass is now being used in doors as well as windshields, and offers advantages over tempered glass-increased, intrusion resistance, reduced ultraviolet penetration, and reduced mass.

Fig -1BASF supplies Elastocell components for the BMW S-Type strut assembly

3. Quiet blend material is new blend of man-made and natural fibers that has demonstrated better sound absorption properties at lower mass than current fiberglass mat. The material will not melt or break down at typical engine and exhaust temperatures, it meets federal flammability guidelines, and low dust and fiber fallout means handling is easier.

4. Vibracoustic N.A. has developed a microcellular urethane material (MCU) for engine and body mounting, and a process for optimizing the material usage. The company also supplies other products such as linear mass dampers that can be tuned to attenuate unwanted vibrations, and a dual-mode crankshaft damper for engines.
5. Versa Mat is a family of thermal and acoustic insulating materials. Versa Mat 1000 is developed for interior applications, and versa mat 4800 is specially formulated for severe conditions. Improved acoustical and structural performance with lower mass is the advantages over traditional materials.

3.2. Vibracoustic's answer to rubber engine mounts

Traditional product used for engine mounting is rubber," and there has been no dramatic change to that material in decades.

Vibracoustics' microcellular polyurethane (MCU) material isn't new, either, but its application in engine mounts is. The foam product is "extremely durable, highly effective in insulation, and very flexible in its design and application to the vehicle"

Fig -2 High-temperature MCU is already being used by Vibracoustics in jounce bumpers, shown here.

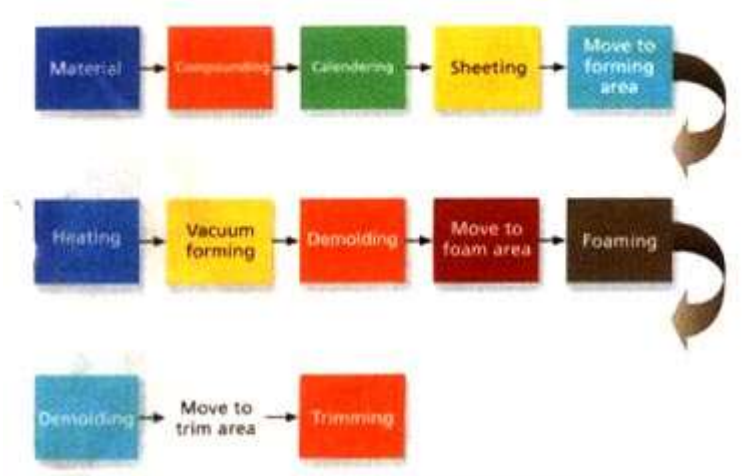
The material's primary use over the past 20 years has been in jounce bumpers, but the company is now looking at engine and body mounts as well as the coil spring. "It was found to be very effective and in some cases superior to rubber, it is up to 40% lighter than rubber."

MCU has advantages in dynamics properties as well, In terms of dynamic stiffness; it's more linear than rubber. Stiffness tends to increase as the frequency goes up with rubber. Not so with micro cellular polyurethane."

"While conventional MCU degrades at lower temperature than rubber, an improved formulation outperforms rubber in high-temperature applications, now making it suitable for use in engine mounts, Testing of the "high-temperature MCU" is underway and the results to date have been great.

3.3: Polyurethane:

One that it is eager to deploy is a polyurethane (PU) spray elastomer technology for dashboard insulators. "Cost, weight and acoustics are what we are looking for", in dash board insulator "it is a technology for which the material and processes are repeatable and flexible".



The conventional process for creating dashboard mats involves 12 steps.

The process developed by Collins & Aikman and Bayer takes less time, space, and labor.

The PU spray elastomer has several advantages, it is said that over the most conventional material and method for making dashboard insulators: polyvinylchloride (PVC) and two step injection molding. The latter is a 12-step approach that involves moving the product several times during processing "It's a dirty and time consuming process".

The comparison, the PU spray approach has only five steps in cell oriented process using a much smaller amount of floor space. Moreover, several of the steps are automated, resulting in reduced labor costs.

In the PU spray method, which is patent-pending, a robot applies a mold release agent and thin a thin coat of the polyurethane onto a tool located inside an injection molding machine. The robot then applies an additional layer on "acoustical hot spots." It is finding that the process in some cases works better when the hot spots are treated first, with the second layer being applies to the entire tool.

The mold then closes, and immediately sound-absorbing foam is injected. Shortly after these two automated operations, the mold reopens, and the dashboard mat is removed manually for trimming via water jet or 3-D die. Whereas the process uses a single injection molding machine for two operations, competing approaches use two machines-one for making the insulator mat and other to make foam sound absorbing sheet.

Preformed sheet foam sound absorbing material is popular because it is inexpensive to produce. But what the customers will most appreciate about the PU spray technology. It is ability to apply the elastomer material in varying thicknesses according to the specific application. All that need be done to accomplish this is reprogramming of the applicator robot.

This feature will have special appeal that uses multiple engine/transmission combinations on a particular vehicle. Rather than use one dashboard insulator with uniform mat thickness for all vehicles, variable thickness technology allows for production of mats that are matched in mat material thickness to the specific noise profile produced by each power train configuration. The robot applicator can be programmed for extremely precise application thickness.

We will need to make sure that our sheet metal is within tolerance because the definition of the mat is good. Typically with PVC parts, there may be some gaps and variances. It is interesting that of the eight dashboard mats as part of its research, non featured variable thickness even though that is possible (although expensive) with the injection molding method most often used at the moment. Another advantage is that it provides for better sealing of grommets, which are installed on the mold tool prior to application of the spray, the grommets is actually built into a mat when the spray coat is applied.

3.4 Advantages of Reducing NVH:

There are many advantages of reducing NVH. But some are listed below:-

- It improves vehicle quality.
- Mechanical parts life can be increased.
- By reducing vibration the pay of is not only comfort but also fuel economy improvements.
- Vehicle's weight-saving beef up fuel economy.
- Quality drives can be achieved.
- Safety and security are also enhanced.
- Reduce noise pollutions.
- Improves sound quality reduces human fatigue.
- Performance, handling and overall styling can be enhanced.

4. CONCLUSIONS

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As we know that researches are going on to reduce NVH in the vehicle. There have been significant breakthroughs in this field and further improvements are coming on. Development engineering are expanding considerable effort to eliminate or reduce noise sources and determine their transmission path so the coupling of these sources to chassis modes can be eliminated. The new development have eliminated problems of the previous one like first PVC was used as a NVH reducing material but now PU is a new material which has many advantages, like, automation results in reduced labor cost, easy method of production, sound absorbing foam, less cost of production as compared to PVC. In coming years there will be the use of predictive method /model to solve NVH that will enable us to conduct noise screening on the computer using entire system models, before prototype parts are built. As Engine accelerates through higher and higher rpms electronics could be used to null and void certain frequencies that occur only at certain rpm, which is different from passive resonators that only address one noise frequency. By using electronics to cancel or enhance sounds, plastic hollow resonator could be eliminated.

5. REFERENCES

[1]. Reference 1www.natc-ht.com
[2]. Reference 2 www.elastoplast.com.au
[3]. Reference 3Automotive NHV Technology by Rakuten Kobo
[4]. Yujie Shen, Long Chen, Xiaofeng Yang, Dehua Shi, Jun Yang 'Improved design of dynamic vibration absorber by using the inerter and its application in vehicle suspension' Journal of noise and vibrations, January 2016, Pages 148-158
[5]. Mohamad S. Qatu ,Jian Pang 'Overview of automotive noise and vibration' International journal of vehicle noise and vibration 2016
[6]. S.K. Jha 'Characteristics and sources of noise and vibration and their control in motor cars' Journal of Sound and Vibration, August 1976, Pages 543-558