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Automatic Hydraulic Bumper System

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ABSTRACT

Crashing of vehicle is governed mainly by dynamic phenomenon which involves a complex interaction between structure and interior behaviour. Whenever a structure is subjected to high intensive loading it results in transient deformation. The design of the vehicle should be able of absorbing energy (K.E.) generated during impact (collision) & the passenger compartment should be able to retain the rigidity. The present work deals with providing front bumper system mounted with suitable sensors. The bumper system should be able to come out in case of as and when needed and protect human being as well as vehicle. The design is based on sensing the speed of the vehicle and passing the signal to the control unit of the bumper system.

Keywords— **crashing, dynamicbumper, rigidity sensor.**

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I. Introduction

The aim is to design and develop a control system based an intelligent electronically controlled automotive bumper activation system "AUTOMATIC HYDRAULIC BUMPER. This system is consists of IR transmitter and receiver circuit, control unit, hydraulic bumper system. The IR sensor is used to detect the obstacle. There is any obstacle closer to the vehicle; the control signal is given to the bumper activation system.

The hydraulic bumper system is used to protect the man and vehicle. This bumper activation system is only activated at the vehicle speed above 40-50 km per hour. This vehicle speed is sensed by the proximity sensor which gives a signal to control unit and hydraulic bumper activation system. Which is fully equipped by IR sensors circuit and hydraulic bumper activation circuit. It is a genuine project which is fully equipped and designed for automobile vehicles. This forms an integral part of best quality.

A. *Need for automation:*

Automation can be achieved through computers, hydraulics, pneumatics, robotics, etc., of these sources, pneumatics form an attractive medium for low cost automation. The main advantages of all pneumatic systems are economy and simplicity. Automation plays an important role in mass production.

For mass production of the product, the machining operations decide the sequence of machining. The machines designed for producing a particular product are called transfer machines. The components must be moved automatically from the bins to various machines sequentially and the final component can be placed separately for packaging. Materials can also be repeatedly transferred from the moving conveyors to the work place and vice versa. Nowadays almost all the manufacturing process is being atomized in order to deliver the products at a faster rate.

The manufacturing operation is being automated for the following reasons to,

- Achieve mass production
- Reduce man power

- Increase the efficiency of the plant
- Reduce the work load
- Reduce the production cost
- Reduce the production time
- Reduce the material handling
- Reduce the fatigue of workers
- Achieve good product quality
- Less Maintenance

B. Safety systems:

The aim is to design and develop a control system based on hydraulic/pneumatic energized bumpers for automobiles. Preliminary modeling and simulation work considers a quarter cars initially followed by a natural progression to the half car and full four wheel station cases. The model is to be constructed in modular form thus allowing the replacement / interchange of the various blocks and their associated technologies. Upon completion of the full fluid operated bumpers, sensitivity analyses will be carried out. Once the preliminary simulation model has been thoroughly benchmarked and existing control system strategies evaluated,an audit of the technology used is to take place and this will provide a basis for comparison of iterative technologies/ techniques.

The final phase of the new modern bumpers will include:

- Development of automated bumpers.
- Development of speed limiting system
- Assessing sensor failure and fault tolerant control system design
- Preliminary studies into an electrically actuated system
- Re-engineering using simplified models.

C. Problem Statements:

- During accident vehicles get heavily damaged.
- Impact on vehicle during accident damages the front parts like bumper, radiator grill, headlamp, fog lamp.
- Instead of all above part can we minimizes the damages parts during accident?
- Another thing can we reduce the impact of accident?

D. Function of bumper:

- Safety
- Most Prominent fascia of a vehicle
- Exterior trim component
- Most important aesthetic parts
- Designed to specific shapes
- Absorbs some of the impacts
- Acts as a barrier to any object coming in contact with the vehicle

E. *Introductions to FPB:*

- When an object comes near the vehicle, thesensors get actuated and provide the actuating signal to the hydraulic actuators.
- Hydraulic cylinder supplies the fluid to the expandable bumpers which subsequently move outward providing resisting force against an impact force caused by an object on the vehicle.

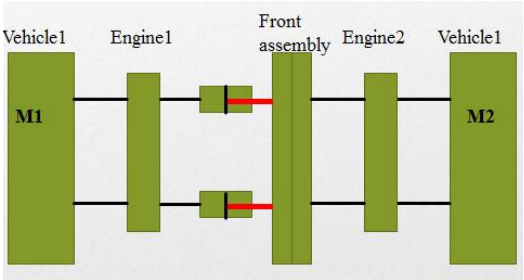

Figure 1.Model of crash system

F. IR Sensor:

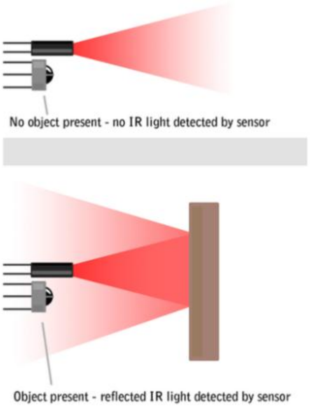

Figure 2.IR Sensor

1) Basic Operating Principle:

- The infrared proximity sensor consists of two components: Emitter and Detector.
- Infrared light is emitted by the emitter in the direction to be tested.
- Any object in the path of the emitted light will reflect some amount of light back toward the sensor.
- The detector collects the reflected light and determines the distance of the object from the sensor.
- A sensor is a transducer used to make a measurement of a physical variable. Any sensor requires calibration in order to be useful as a measuring device.
- Optical sensors are characterized specified by spectral, radiometric and geometric performance.
- The transmitted signal reflected by the obstacle and the IR receiver circuit receives the signal which further gives control signal to the control unit. The control unit activates the pneumatic breaking system, so that break will be applied.

- If the solenoid valve is activated, the oil passes to the Double Acting Hydraulic Cylinder. Whichfurther moves the piston rod.

2) Types of the sensor for distance calculate:

- Reflected IR strength
- Modulated IR signal
- Triangulation

G. SELECTION OF HYDRAULICS:

Mechanization is broadly defined as the replacement of manual effort by mechanical power. Hydraulics is an attractive medium for low cost mechanization particularly for sequential or repetitive operations. Many factories and plants already have this system, which is capable of providing both the power or energy requirements and the control system.

The main advantages of an all-hydraulic systems are usually robust and its high power to weight ratio, the latter reducing maintenance to a low level. It can also have out standing advantages in terms of safety..

1) Hydraulic system components

- Hydraulic double acting cylinder
- Solenoid valve
- Flow control valve
- IR sensor unit
- Wheel and speed limiting system arrangement
- Single phase induction motor & gear pump

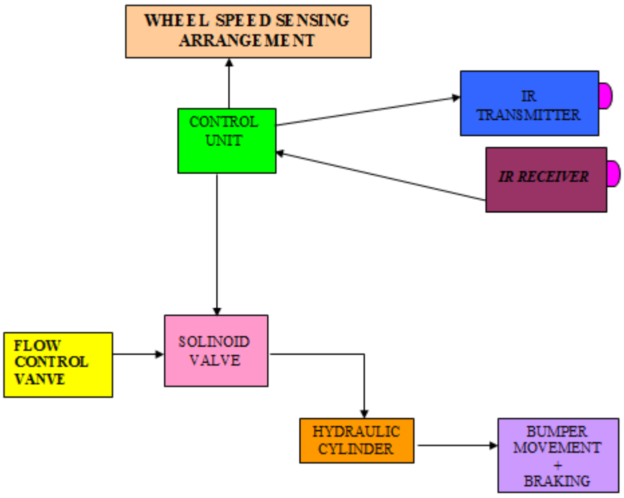

Figure 3: Block diagram

II.LITERATURE REVIEW

frontal collision mitigation, SAE 2002 world congress detroit, michiganmarch 4-7, 2002the ideal structure for frontal collisions needs to maximize the deformation zone, and adapt to impact conditions by stiffening at severe impacts and softening otherwise. Smart hydraulic structures are proposed to meet these ideal requirements. Sample “Hydraulic smart structures” were designed and tested for feasibility of crash under high pressure and high impact speed conditions.

Adrian k. Lund and joseph m. Nolan insurance institute for highway safety [2] changes in vehicle designs from frontal offset and side impact crash testing, 2003 sae world congress detroit, michigan march 3-6, 2003, the insurance institute for highway safety (IIHS) has been conducting frontal offset crash tests of new passenger vehicles& providing comparative crashworthiness information to the public. This program has resulted in large improvements in frontal crashworthiness largely because vehicle structures have been redesigned to prevent significant collapse of the occupant compartment.

James A. neptuneneptune engineering, inc.[3] a comparison of crush stiffness characteristics from partial-overlap and full-overlap frontal crash tests, international congress and exposition detroit, michigan march 1-4, 1999, recently partial-overlap crash tests have been performed and the test data has been made available to the public. A comparison of crush stiffness characteristics from partial-overlap, and full-overlap, frontal crash tests is presented in this paper.

G. Benet , f. Blanes, J.E. Simó, P. Pérez[4], using infrared sensors for distance measurement in mobile robots, universidad politecnica de valencia,spain 27march2002, the amplitude response of infrared (IR) sensors based on reflected amplitude of the surrounding objects is non-linear and depends on the reflectance characteristics of the object surface. As a result, the main use of IR sensors in robotics is for obstacle avoidance.

Jae-Wan Lee Kyong-Han Yoon Korea, Automobile test and research institute korea, Youn-Soo Kang The Korea Transport Institute korea Gyung-Jin Park hanyang university[5],vehicle hood and bumper structure design to mitigate casualties of pedestrian accidents ,hanyang university korea paper no 05-0105,In this research, a method, which uses an experiment and simulation simultaneously, is developed. Orthogonal arrays are employed to link the two methods. The minimum number of experiments is allocated to some rows of an orthogonal array and the simulations are allocated to the rest of the rows. Experiments should be allocated to have the cases of the experiments orthogonal. Mathematical error analysis is conducted.

Peter J. Schuster[6],Current trends in bumper design for pedestrian impact, california polytechnic state university 2006-01-0464,The most common method proposed for cushioning the lower limb in an impact uses an energy absorber (plastic foam or 'egg-crate') in front of a semi-rigid (steel or aluminum) beam. There are also proposals for 'spring steel', steel-foam composites, crush-cans, and plastic beams. The most common method proposed for supporting the lower limb in an impact is a secondary lower beam, known as a 'stiffener' or 'spoiler'. Most proposed lower stiffeners are plastic plates or metal beams supported by the engine under tray, the radiator support, or the front-end module. In addition to these concepts, there are a number of design proposals involving a deploying bumper or lower stiffener.

III. Behavior of an automobile during accident (front impact) &importance of crumple zone:

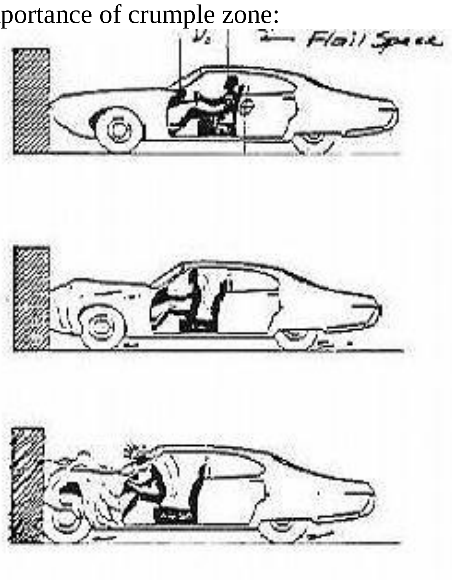

Figure.4 Crash Test of Car

In typical collision, it is the outer envelope, which experiences the impact and undergoes deformation locally in the impact region. The occupants only later experience the impact. Thus one can define the encounter of the outer envelope of an automotive vehicle with an external object at the first collision and the subsequent collision undergone by the occupants within the passenger compartments as the second collision. Obviously the severity of the second collision involving occupant motion is of the primary concern in occupant protection from injuries and collisions; in general severity of second collision is strongly related to first collision. So for past several years much attention has been directed to the design analysis of passenger compartment integrity and energy absorption mechanism of front and rear structure which usually experiences extremely large plastic flow of metals due to severe deformation of structure.

Occasionally when objects collide, either they bounce off each other or stick to each other and travel with the same speed after the collision. Rebounding involves a change in direction of an object. Thus rebounding situations are characterized by a large velocity change and a large momentum change. From the impulse-momentum change theorem, we could reduce that a rebounding situation must also be accompanied by a large impulse. Since the impulse experienced by an object equals the momentum change of the object, a collision characterized by a large momentum change must also be characterized by a large impulse.

The importance of rebounding is critical to outcome automobile accidents. In an automobile accident, two cars can either collide and bounce off each other or collide and crumple together and travel together with the same speed after the collision. But which would be more damaging to the occupants of the automobiles the rebounding of the cars or the crumpling up of the cars? Contrary to popular opinion, the crumpling up of cars is the safest type of automobile collision. If cars rebound upon collision, the momentum change will be larger and so will the impulse. A greater impulse will typically be associated with a bigger force. Occupants of automobiles would certainly prefer small forces upon their bodies during collisions. In fact, automobile designers and safety engineers have found ways to reduce the harm done to occupants of automobiles by designing cars, which crumple upon impact. Crumple zones are sections in cars, which are designed to crumple up when the car encounters a collision. By crumpling, the car is less likely to rebound upon impact, thus minimizing the momentum change and the impulse. Crumple zones minimize the effect of the force in an automobile collision.

The most dangerous case is that of a head on collision during which the front compartment is brought into play. In a more typical frontal collision it is not surprising to find collapsing of the dashboard, piercing of the steering column, intrusion of engine assembly, pedals, and other miscellaneous part into the occupant compartment, shattering of windshield in occupant compartment, thereby endangering occupants' life. In case of a rear impact, it may happen that the fuel tank might be damaged due to the collision making it susceptible to explosions. There by also putting the safety of rear passengers at stake. In case of side impact, the whole vehicle experiences a sideways force. This exerts a large amount of force on the occupant's neck, as it is not used to sideways thrusts. Also, it is common that the occupant is jolted in opposite direction and might hit the opposite window.

The next intrusion is the displacement of the steering assembly with the buckling around of column forcing the steering wheel backwards and possibly upwards. This used to be the major cause of fatalities amongst drivers but some designs now reduce the displacement to small amounts. Hence one way to minimize the impact on occupants is to maximize the impact on the automobile. (The impact energy is absorbed by the automobile itself and very little is passed on to the passenger compartment.) Ideally the car has seat belt pretension and force limiters which tighten up the seat belts as soon as the car hits the barrier, but before the airbag deploys. The seatbelt then absorbs some of the kinetic energy as you move forward towards the airbag. Milliseconds later the force limiters kick in making sure the force in the seatbelts doesn't get too high. Next the air bag deploys and absorbs some more of the forward motion for protecting you from hitting anything hard.

To minimize the risk of injury, the kinetic energy has to be removed as slowly and evenly as possible. In recent years, the automobile industry has attempted to improve safety through a number of technological developments. One technique, which has been proven to be successful, involves the use of crumple zones positioned in specific areas of an automobile. The effect of collisions in cars having crumple zones is less serve due to prolonged time of impact in comparison with cars without crumple zones.

A Principle:

Before looking at the specifics, let's review the knowledge of the laws of motion. We know that moving objects have momentum. Unless an outside force acts on it, the object will continue to move at its present speed and direction. When your body is moving at the speed of 35 Mph, it has a certain amount of kinetic energy. After the crash, when you come to a complete stop, you will have zero kinetic energy. To minimize the risk of injury, the kinetic energy has to be removed as slowly and evenly as possible.

Crumple zones are created by the integration of variable grades of steel and fiberglass into the front and rear-end assemblies of the automobile. Occasionally, crumple zones are used in the actual frame of the automobile creating a point for the frame to buckle when subjected to extreme stress. These crumple zones yield during impact, redirecting the energy of the collision- often reducing the chance of injury to the driver.The following diagrams illustrate the effect of crumple zones in automobiles. In figure 5(A), 5(B), a steel block travels at a constant velocity towards a cement wall, representing an automobile without crumple zones. Initially, the block has kinetic energy, represented by the expression, $Mv^2/2$. As the block collides with the wall, it exerts a force on the wall, after which the wall exerts an equal and opposite force on the block.

The magnitude of this force is illustrated by the amount of kinetic energy regained by the block. At the moment of impact, the steel block immediately rebounds in an elastic manner, regaining nearly all of its kinetic energy, and consequently experiencing a large force. In figure 6, aluminum can travels at a constant velocity towards a cement wall, representing an automobile with crumple zones. As the car collides with the wall, it does not regain all of its initial kinetic energy. Instead, some of the kinetic energy is transferred into heat and sound energy, resulting in a smaller force experienced by the car. Amount of force experienced by the car as shown in the example has been lessened by the action of crumple zones. Crumple zones also decrease the severity of an accident by creating a phenomenon known in the automobile industry as 'Controlled deceleration' Generally, this means that if the time it takes for an automobile to come to rest or change direction is increased, the force experienced by the automobile is decreased.

M - is mass

Vo- Is initial velocity

V_f- is the final velocity and

KE - is the non-conservative kinetic energy, or the sound and heat energy lost in the collision.

This phenomenon is expressed more formally through the application of Newton's second law of motion, as: -

F = M * a

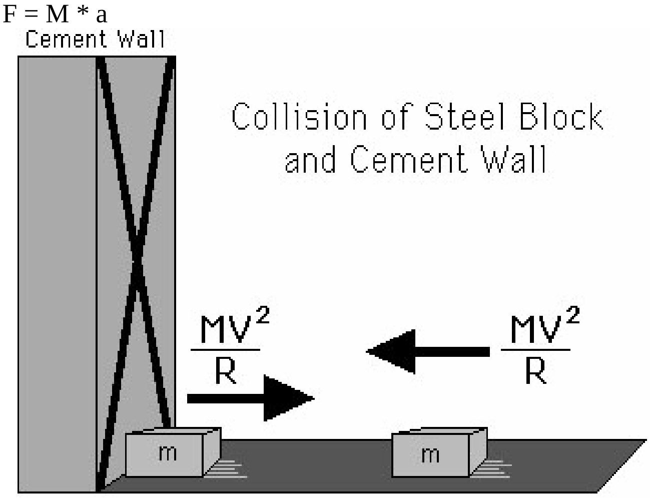

*Figure.5 (A)*Collision of steel block & cement wall

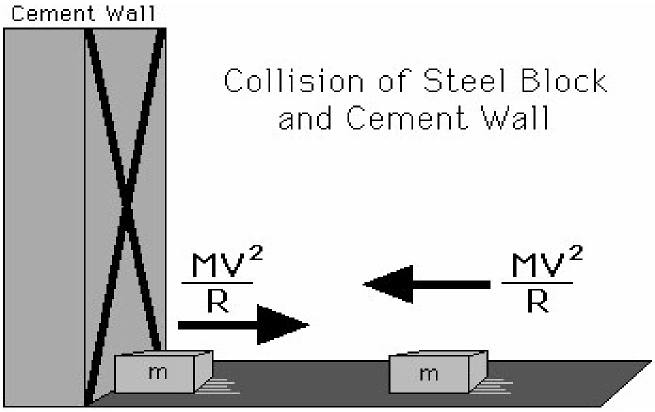

Figure.5 (B) Collision of steel block & cement wall

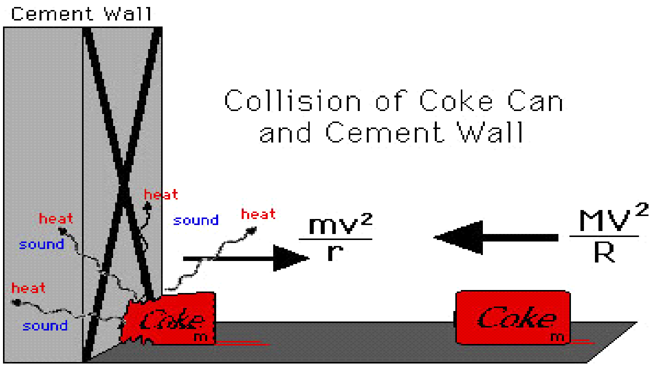

Figure.6 Collision of coke can & cement wall

The energy equation governing

$$\frac{1}{2}m_1v_0^2+\frac{1}{2}m_2v_0^2=\frac{1}{2}m_1v_t^2+\frac{1}{2}m_2v_t^2+KE_{NC}$$ Also,

$$a=\frac{V_f-V_0}{\Delta t}$$

Substituting the previous equation for 'a' in Newton's second law yields:

$$F=m\frac{V_f-V_0}{\Delta t}$$

From this equation, it is clear that as the time of the collision decreases, the force experienced by the automobile increases dramatically.

For example, if a 1000 Kg. Car collides with a wall at 14 m/s (32 mph), the force experienced by the car is expressed as:

$$F = 1000(2-14) / \Delta t$$

The resulting negative sign indicates direction of the force.The graph of this function is shown in figure 5, illustrating how force changes as time changes. Observe that the greater the time over which the collision occurs, the smaller the force acting upon the object. Thus, to minimize the effect of the force on an object involved in a collision, the time must be increased, and to maximize the effect of the force on an object involved in a collision, the time must be decreased. The better the crumple zone, the more effective it is in increasing the time of a collision.

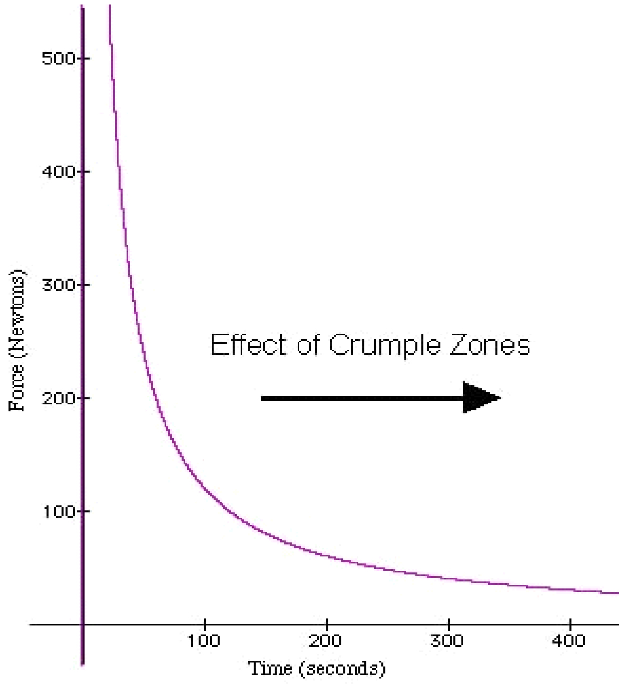

Figure7. Forces vs. Time

- During the deformation of the front crumple zone, the engine, transmission and other components in the engine compartment may undergo multiple collisions, forming a block, which might intrude, into the interior. To reduce this risk, engineers arrange the components to prevent formation of such a block and/or mount them so that they will turn, slide or be removed.
- In addition to a conventional front crumple zone built into the nose of the vehicle, today's vehicles incorporate a special structure around the windshield pillars. In a severe collision, this extra crumple zones can actually help dissipate some of the crash energy around the sides of the vehicle, providing even more protection for the occupants of both vehicles.
- In addition to the crumple zones, which can deform exactly as calculated, the car must have a safe space, which resists severe impacts. Cars should have a stiff passenger cell surrounded by structural elements made of high tensile steel sheets, which are 1.6 times as strong as normal steel sheets. These elements include the transmission tunnel, longitudinal members, pillars and the roof frame. Combined with the soft crumple zones at the front and rear, the passenger compartment provides an undeform able survival space in the event of a severe impact. The integral support frame is a single carrier, which mounts the engine, steering unit and front suspension support in the event of a severe frontal impact, the support frame slides underneath the passenger compartment. This helps the crumple zone provide full protection while at the same time preventing the engine compartment components from penetrating into the passenger compartment. In reality all frontal collisions are, offset crashes. The three-forked member damping mechanism is one of the safety features developed on the basis of this analysis. The safety mechanism dissipates impact energy concentrated on one area of the bodywork to the exterior, center, and floor. It thus minimizes deformation of the passenger cell. The forks distribute impact energy in three directions to dissipate it throughout whole of the body, thereby minimizing deformation of the interior space.

B.STRUCTURE USED IN AUTOMOBILE:

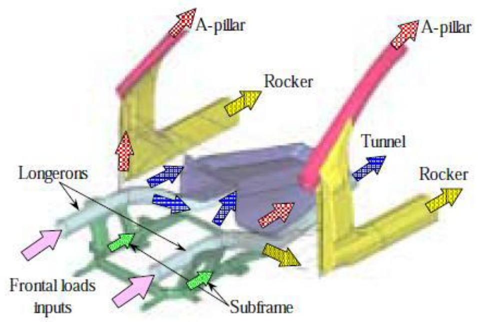

Figure 8.Load paths on car body elements during frontal impact

One of the conditions imposed to car design andmanufacture in order to achieve occupant's safety in frontal collisions is that the passenger cell should not deform and not allow objects from outside to enter by intrusion in the occupants' compartment. To that it is necessary that the front part of the car structure should take enough energy out of any real collision. Therefore, the deformation distance in front of the passenger cell, also called deformation area, should be used efficiently enough in order to ensure the wished deceleration to passenger cell.

With full overlap frontal collisions to an obstacle, the two front longitudinal members absorb the greatest amount of energy by progressive deformation of the tubular metallic structure. Frontal loading and distribution rate to the resistance structure of nowadays cars is shown in Figure 8. The main problem of this kind of structure is that in real-life collisions the two front longitudinal members are not often simultaneously solicited, and therefore their load is not purely axial. Most frontal car crashes occur with partial frontal overlap, where there is only one longitudinal member bearing the stress, or the stress is not on an axial direction. Given such collision circumstances, the situation is extremely frequent where longitudinal members yield prematurely by bending before absorbing the energy through axial deformation.

Therefore, the front part of the resistance structure in nowadays cars, having the role of taking in the impact load by deformation, is confronted to two major issues:

- The same amount of energy should be absorbed by one longitudinal member as well as both longitudinal members;
- The same amount of energy should be absorbed in case of a frontal impact on an axial direction, and with a frontal impact frontal on an oblique direction.

These issues cannot be solved by the increase of longitudinal members rigidity only, so that each longitudinal member would absorb the entire amount of energy in offset collisions, because in full overlap collisions the same longitudinal member should be a lot more softer, with a lower rigidity, so that it might take with the other longitudinal member the same amount of energy. Likewise, a highly rigid longitudinal member is necessary with frontal collisions in which loading is oblique, as it has a higher bending resistance, which helps with transforming the oblique load into an axial load and prevents crash by bending. The same longitudinal member, much softer, is necessary in the event of axial load frontal collision in order to prevent the occurrence of too strong deceleration forces.

In order to absorb the entire amount of kinetic energy, proportional to the square of speed, the deformable structure should have specific rigidity. This rigidity is expressed by the average force that, multiplied with the deformation distance results in the energy absorbed. For an acceptable rate of occupant injury, total deceleration should be as low as possible, by using the maximum available deformation length without the deformation of the passenger cell.

The superiority of "hydraulic smart structures" over passive structures is based on three fundamental characteristics of the "hydraulic smart structures":

- Energy absorption capacity
- Speed sensitivity
- Load controllability

1) Energy absorption

The ability of "Smart Structures" to use more distance available for crush, which is otherwise occupied by the folded material of the passive structure, makes it higher capacity of energy absorption than passive structures. This feature is clearly demonstrated by noting the lower intrusion displacement of the "smart vehicle" compared with that of the "standard vehicle". The reason behind this reduction in

Intrusion is that the front hydraulic section absorbs higher proportion of the impact energy leaving the backup section of the structure to absorb less energy and produce lower intrusion.

Figure.9. Presents an estimation of the distribution of energy absorbed by the front structure of a car crashing against a fixed non-deformable barrier, at a speed of 56 km/h .

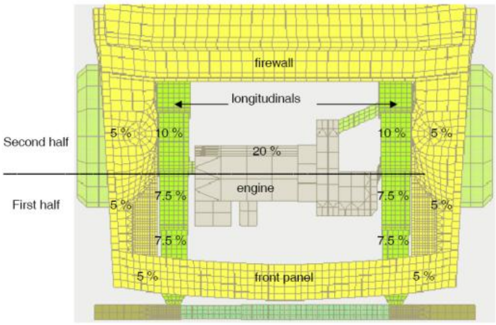

Figure 9.Estimated energy absorption percentages in the frontal structure.

2) Speed sensitivity:

The collapse load of "Smart structure" is speed sensitive. The load is expected to increase proportional to the square of the impact speed. This feature is very important with offset crashes where the impacted side suffers higher local collision speed than the non-impacted side. The implication in an offset frontal impact scenario is that the impacted side produces higher resistance or collapse load than the non-impacted side.

3) Load controllability:

The "Smart Structure" is controlled by orifice(s) of adjustable sizes. The smart features are introduced due to adjustment of orifice size as a function of deformation distance and/or time, pressure or other relevant parameters. The results is tailored or shaped deformation characteristics of the "Smart Structure" according to crash conditions or scenario. The function of the orifice size in terms of the deformation distance can be tailored to any particular application.

C The concept of smart structure:

The frontal smart structure generally follows the following concept:

1. Collision-aware rate control
2. Charge transfer between longitudinal members

1) Optimal Deceleration Pulses:

Feasibility of the crash pulses, have one major difficulty that a vehicle structure will always start buckling or bending at its weakest point. This means that even if the front structure is stronger in its most forward parts, but weaker in parts closer to the firewall, the weaker part will always buckle first. Thus a pulse with an initial deceleration peak can almost only be created by inertial effects or by actively controlling the stiffness of the energy absorbing members during deformation. Motazawa and kamei have designed a structural concept that is able to create a fixed pulse. The fundamental model is a hollow member designed to act as a longitudinal. It consists of a front zone for axial collapse, and a center zone for bending. The axial collapse zone incorporates a stress concentration in order to induce regular buckling deformation, while the bending zone has a mildly cranked shape to stabilize the bending deformation direction. Each of the cross-sections is set so that the deformation load of the axial collapse zone will be slightly less than the maximum load of the bending zone.

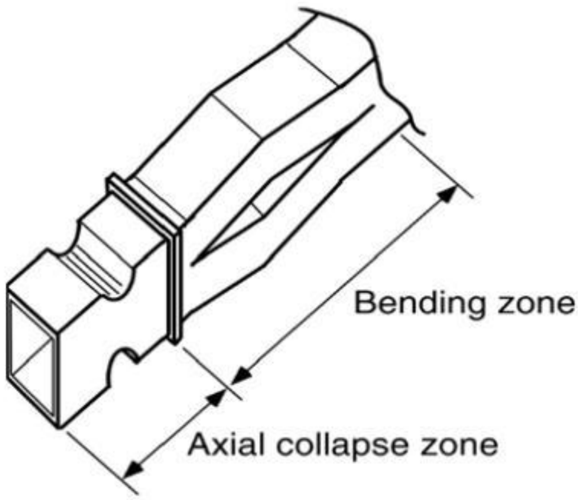

Figure10. Fundamental model of a crash load control structure

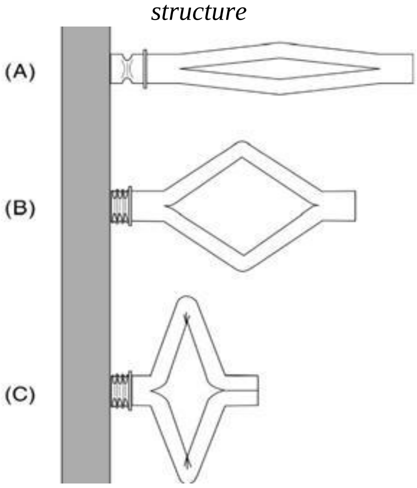

Figure 11. Deformation process in the fundamental model

Figure 10shows the deformation process of the fundamental model. In the first phase of collision, soon after the first moments of impact, the axial crash area starts to deform because of load (A) concentration. Axial load remains constant until total deformation of this area. When the load reaches deformation by bending zone buckling, the second phase of the deformation process is practically starting, the structure being quickly deformed in this phase (B). After full bending deformation is complete, the thirdphase (C) starts, the increase of load rate on the longitudinal members determining their deformation.

2) Transfer load between longitudinal rails:

In frontal collisions, a series of parameters such as: collision location and direction, collision speed and the type of obstacle significantly influence the deceleration rate of passengers' cell and implicitly their risk of injury. The kinetic energy of the car for a certain impact speed rate is the same regardless of the type of frontal collision (full overlap or partial overlap), the amount of energy that should be absorbed by the vehicle/obstacle system is the same. In this sense, it is important that the front structure of the vehicle should be conceived in such a way that the impact load should be distributed as evenly as possible to the elements destined to the absorption of energy (longitudinal members). A concept of front smart structure resides in transferring the load from the solicited longitudinal member to the other longitudinal member, unloaded, for better energy absorption, and the optimization of passengers' compartment deceleration. From a constructive point of view, a solution for such an smart structure system is one that transfers the load by using two hydraulic cylinders attached to the two longitudinal members so that the axial deformation of the loaded longitudinal member would determine the compression movement of the piston attached to that cylinder transferring hydraulic fluid for the opposite cylinder, forcing the compression of its piston (Figure 12). Implementing the system would lead to vehicle mass and cost increase and would require a considerable space for assembly.

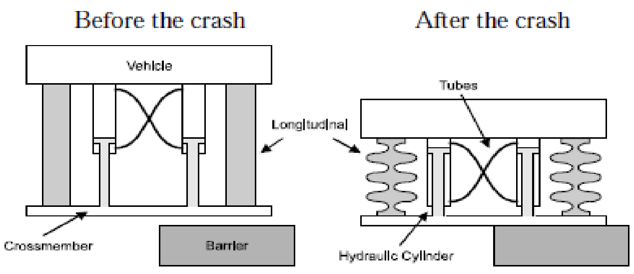

Figure 12.A hydraulically controlled frontal car

As a constructive solution, the frontal structure proposed is displayed in figure 13. The deformation area is attached to the longitudinal members by a detachable connection facilitating car repair after the accident by replacing this sub-structure. The shape of the anterior deformation longitudinal member has been conceived after the fundamental model allowing the collision-aware rate control.

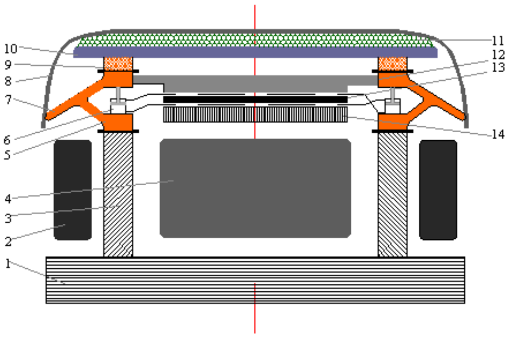

Figure 13.Adaptive structure for frontal collisions: 1-firewall, 2-wheel, 3-longitudinal member, 4-engine, 5-adaptive part, 6-hidraulic cylinder, 7-deflecting device, 8-bumper, 9-collapse member, 10-transversal member, 11-shock absorber, 12-tragger, 13-AC condenser, 14-cooler.

At the beginning of the impact occurs axial deformation of the longitudinal member end, when deceleration should be high, then deformation by bending of the bent structure zone starts, deceleration being reduced. After the anterior deformation area crashes in strong collisions, the axial deformation of the actual longitudinal members and the involvement of the engine ensemble into the load taking-over rate start. Hydraulic pistons installed in the anterior longitudinal member arc have the role to ensure load transfer from the loaded longitudinal member to the other longitudinal member by means of hydraulic liquid, for better energy absorption and optimization of passenger cell deceleration. The installing place of hydraulic pistons solves the issue of the space necessary to the implementation of this concept.

The third concept is implemented in the new adaptive structure by the construction of the quarter-light situated in front of the wheel. It has the role to protect the front wheel area, is less rigid than the central car body, with a more reduced energy absorption capacity, presenting a high risk of passenger cell deformation. Another important role of this quarter-light is transforming the partial overlap frontal impact into a glance-off impact, by this substantially diminishing the risk of occupants' injury.

IV. Simulation of smart structure

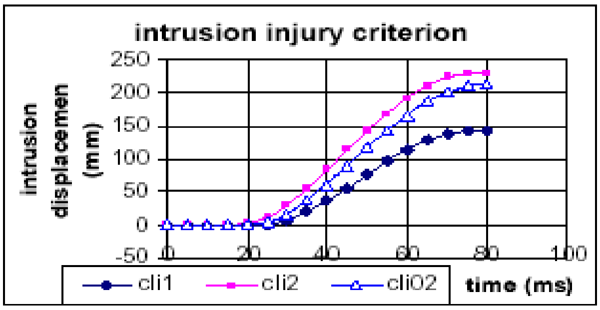

Figure 14. Backup rail deformation of 35mph soft impact

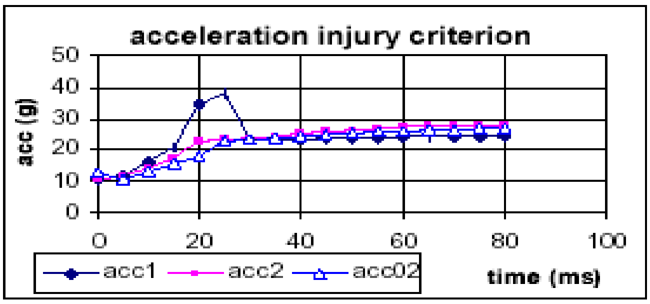

Figure 15.Acceleration signatures of 35mph stiff impact

Figures 14 and 15 show acceleration signature and intrusion displacement of a 35 mph set of impacts using soft smart hydraulic control. The acceleration pulse of the “smart vehicle” shown in Figure 14 has a small blip at the beginning of impact. This blip is considered within the average acceleration level allowed in the pulse signature. The latter is clearly reshaped towards a square shape thus absorbing more energy at the front section of the structure. The intrusion displacement of the “smart vehicle” is again reduced from 210 mm to 140 indicating positive effects of the “Smart Structure” at more severe high speed frontal impact. Figure 15 backup rail deformation of 35mph soft impact show acceleration signature and intrusion displacement of a 35 mph set of impacts using stiff smart hydraulic control.

III.COCLUSION

In conclusion remarks of our project work, we will provide benefit of automated movable bumpers to avoid accidents. It is possible to achieve adaptive car frontal structures, which should ensure an optimum deceleration rate for the passenger cell, regardless of the collision circumstances, and which should ensure transformation, under certain circumstances, of full collision into glance-off collision. The solution for the frontal structure proposed in this work includes two distinct concepts integrated into a technically feasible constructive form. A great advantage is the deformable structure zone (crumple zone) that was so conceived as to be replaced. It is possible that from an economic point of view implementing this solution might increase a lot the costs of a car. One of the disadvantages of the structure would be a shorter deformable area, which would be partially compensated by the hydraulic system ensuring better energy absorption.

Regarding crumple zone they play an important role in securing the passenger compartment. Crumple zones are designed to sponge up the impact energy. Hence crumple zones play an important role in the safety of the occupant of the car by deforming exactly as calculated and absorbing most of the impact energy. As a result of crumple zones

- Front and rear crumple zones deform predictably by absorbing the impact energy.
- An engine travels no further back than the cabin
- Structures are optimized to dissipate as much as possible of the energy released on impact.
- A stiffened cabin structure protects the passenger.

It is shown that "Smart Structures" employing two hydraulic cylinders integrated within the front longitudinal members is capable of absorbing more impact energy for the same crush distance and for the same maximum load level compared with passive structures. It was also seen that a “smart vehicle” of smart structure involved in head-on collision with a “standard vehicle” of passive structure produces significantly lower intrusions than that of a “standard vehicle” of passive structure in head collision with the same “standard vehicle”.

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