Use of Galvanized Steels for Automotive Body - Car Survey Results at Coastal Areas, Mumbai

A. S. Khanna
Department of Metallurgy Engineering
Indian Institute of Technology, Bombay, India

Rahul Sharma
International Zinc, India

Kenneth D'Souza
International Zinc, Canada

Abstract

An extensive study of automotive body corrosion was conducted in Mumbai area to track corrosion performance of currently used materials of construction for automotive, especially cars with low end cost. The study consisted of a wide range of areas, starting from a closed car parking to several coastal and other humid regions such as Juhu Beach, Varsova beach and other adjoining areas. Data such as visible perforations, paint blisters, and surface rust were seen especially at vulnerable areas such as doors, mudguards, bonnet areas etc. Also, a comparison was done with low cost cars built with normal steel with those built using galvanized steels.

Keywords: Automobile, Galvanization, Surveys, Corrosion, Perforation, Blisters

I. INTRODUCTION

Since the liberalisation of economy in the early 90's, India has seen a steady rise in the automotive sector. By early 2000s, there were 12 large automotive companies in the Indian market, most of them offshoots of global companies.

With the growing number of cars on roads, the automotive industry became increasingly aware of the vulnerability of car body panels to corrosion arising from aggressive climate in the humid environment and pollutants from the nearby marine and industrial sectors. Although, considerable efforts were put in to find a solution to this problem by using different coatings and surface treatments, there isn't any information or study available that provides an estimate of base line corrosion performance of cold rolled steel body panels or improvements in corrosion through the use of car body panels made from galvanized steel.

The present study, was conducted as a joint collaboration between the International Zinc Association, India and IIT Bombay. Surveys were carried out around the three coastal and other humid regions of Mumbai to systematically assess the performance of car body panels made from cold rolled steel or improvements in the corrosion performance in car models. Each survey consisted of a parking lot survey of all major exterior car panels for imperfections such panel perforations, paint blisters, and surface rust. The surveys involved inspecting approximately 450 vehicles ranging in age from 5-10 years old. The parking lot survey methodology used in conduction this project was similar to that used in previous work conducted in North America in the 1990s (Ref 1,2). This allowed comparisons to be made from the North American surveys and this particular Indian Survey.

II. SURVEY METHOD

A. Location

Places close to the sea (Juhu, Gorai) and water bodies (Powai) were chosen as the site of our surveys primarily for two reasons. First, being close to the sea and humid regions, the area presents a combination of aggressive chloride ions and significant industrial pollutants. Secondly, the high density of cars in this region, presented a good sample set for the study.

Most of the cars which were evaluated were small sub-compacts belonging to the region under survey, for effective consideration of location parameter. For this reason, effort was to consider cars from the nearby housing society parking lots and not from commercial office areas.

B. Vehicle Age

The survey was carried out in the summer of 2015. The general consensus was to evaluate cars that were typically 5-15 year old for several reasons:

- All manufacturers' systems and body parts would show some degree of corrosion failure at this time frame.
- The time period marked a dramatic increase in inflow of different models of vehicles in the Indian market and also purchase of these models.

III. MODEL SURVEYED

One of the essential features of this study was to survey cars that were used by an average Indian family. For this purpose, car models that fall typically below Rs. 10 lakh range were inspected for corrosion damage. Under this category, all car models, across manufacturers (Maruti, Hyundai, Honda, etc.) and segments (Sedan, Hatchback) were inspected.

A. Type of Survey

The survey was a "closed car" or "parking lot" survey. Only external metal body panels could be inspected since we were unable to have the owners open the doors or raise the hoods and boots (deck lids). This meant, of course, that inner panels and under body panels could not be inspected.

B. Corrosion Imperfection Categories

While tabulating the corrosion damages, all incidents of corrosion were placed in one of the three following categories:

1) Blister

A blister was defined as any bubbling of the paint on the surface of painted car metal body.

2) Surface Rust

This was defined as any area where the paint has been removed and the underlying steel surface was rusted.

3) Perforation

A perforation was defined as any complete penetration of the sheet metal that leaves a hole visible to the naked eye.

C. Determination of Imperfection Size

The use of plastic grid/scale was avoided to address any reservations that might arise from car owner/security of the housing society. Any imperfection was deemed present on the car body panel if its size was approximately more than one centimetre by one centimetre. Additionally, a group of imperfections with collective size of more than one centimetre were also noted.
Surface rust in the immediate area of perforation were considered part of the perforation problem and were not listed separately.

D. Panels Surveyed

The survey included mainly most of the exterior body panels: however it became clear that most of the corrosion damage noted occurred mainly on the following 4 body panels:

- Bonnet (hood)
- Boot (deck lid) or Hatchback
- Rocker (Sill) Panel
- Door panels around the handles

Schematic diagrams of cars were printed and provided to each surveyor to mark the imperfections on the above parts. A sample survey sheet is shown in Figure 1.

E. Vehicle Identification

The car model and brand were noted from the back boot or hatchback. The year of manufacture was deduced from the last two digits of VIN or Vehicle Identification Number. VIN is visible through the windshield on all vehicles.

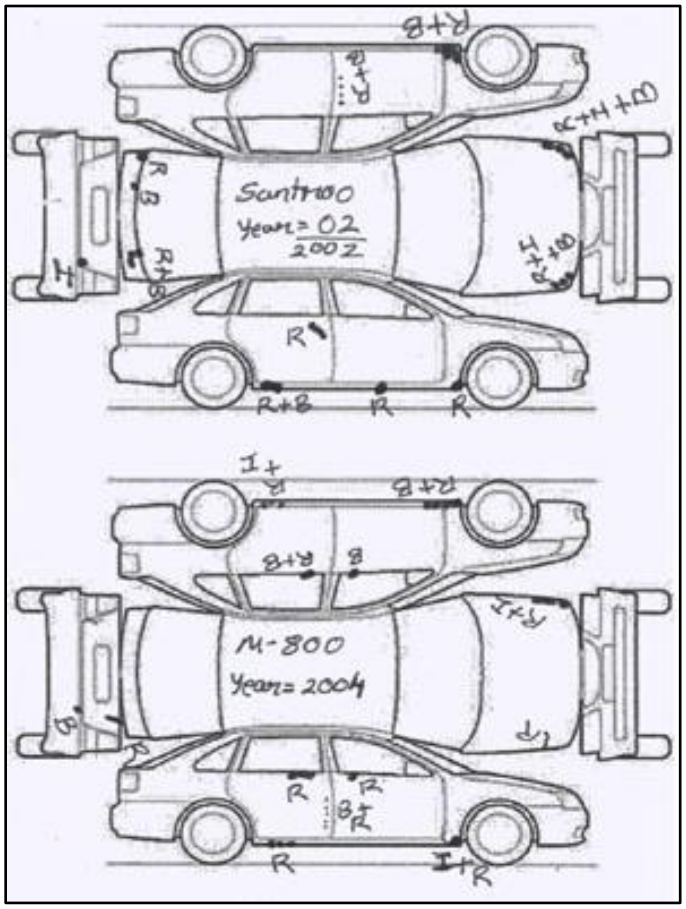

Fig. 1: Schematic Diagram of Car Panels Used for Survey. R-Rust, B- Blister, P- Perforation

F. Conducting the Survey

Each survey team consisted of two members, one member to inspect the vehicle and a second to mark defects on the schematic map provided. In a day about 30-40 cars were inspected by each team. A total of about 450 cars were surveyed. The names of the participating members are given in the acknowledgement section.

IV. SUMMARY OF RESULTS

Table – 1
Breakdown of Survey by Model Years

Model Year	*Approximate age of Vehicle (years)*	*Quantity*
2000	***15***	***1***
2001	***14***	***5***
2002	***13***	***5***
2003	***12***	***14***
2004	***11***	***15***
2005	***10***	***14***
2006	***9***	***41***
2007	***8***	***46***
2008	***7***	***91***
2009	***6***	***91***
2010	***5***	***133***

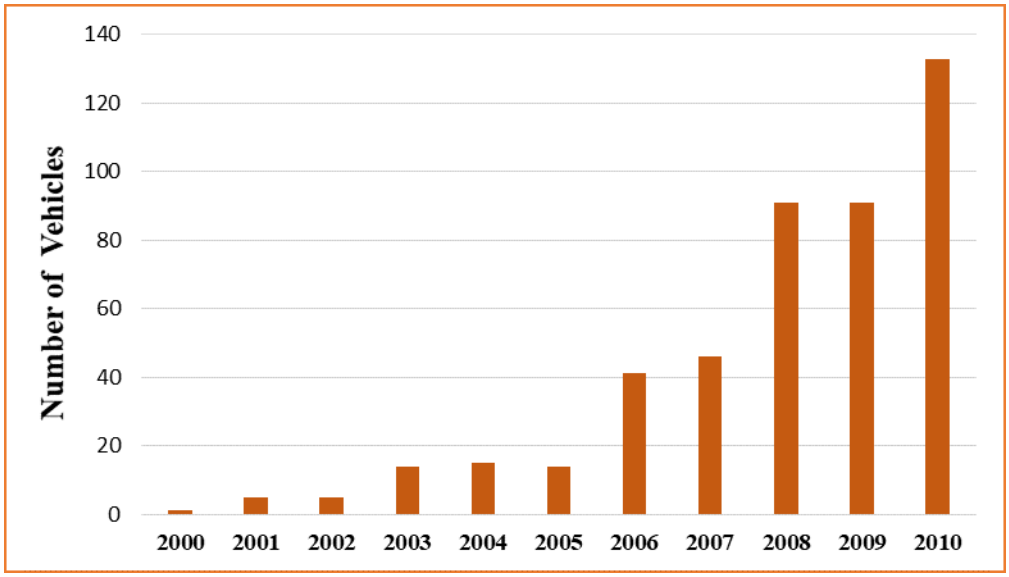

Fig. 2: Graphical Representation of the Breakdown of the Survey by Model Years

Table 1 and Figure 2 summarize the vehicles inspected in the survey in terms of model year, approximate age of vehicle and number of vehicles. From the above illustrations, it is clear that 2006-2010 model year vehicles made up most of the 450 vehicles surveyed. Therefore, this survey has most statistical significance for the corrosion of vehicles 5-9 years old.

Table 2 and Figure 3 provide further insight into to vehicle composition of the survey. Maruti, Hyundai and Honda vehicles comprise nearly eighty percent of the vehicles surveyed.

Table – 2
Breakdown of Survey in Terms of Model Year and Manufacturer

Model Year	***Manufacturer***						
	Maruti	***Honda***	***Hyundai***	***Tata***	***Chevrolet***	***Ford***	***Mahindra***
2000	***0***	***0***	***1***	***0***	***0***	***0***	***0***
2001	***2***	***0***	***3***	***0***	***0***	***0***	***0***
2002	***4***	***0***	***1***	***0***	***0***	***0***	***0***
2003	***8***	***1***	***3***	***2***	***0***	***0***	***0***
2004	***5***	***3***	***4***	***2***	***0***	***0***	***1***
2005	***2***	***1***	***7***	***3***	***1***	***0***	***0***
2006	***16***	***7***	***4***	***5***	***2***	***7***	***0***
2007	***18***	***7***	***12***	***7***	***1***	***1***	***0***
2008	***34***	***16***	***22***	***14***	***1***	***4***	***0***
2009	***31***	***18***	***29***	***10***	***2***	***0***	***1***
2010	***43***	***24***	***37***	***24***	***3***	***0***	***2***

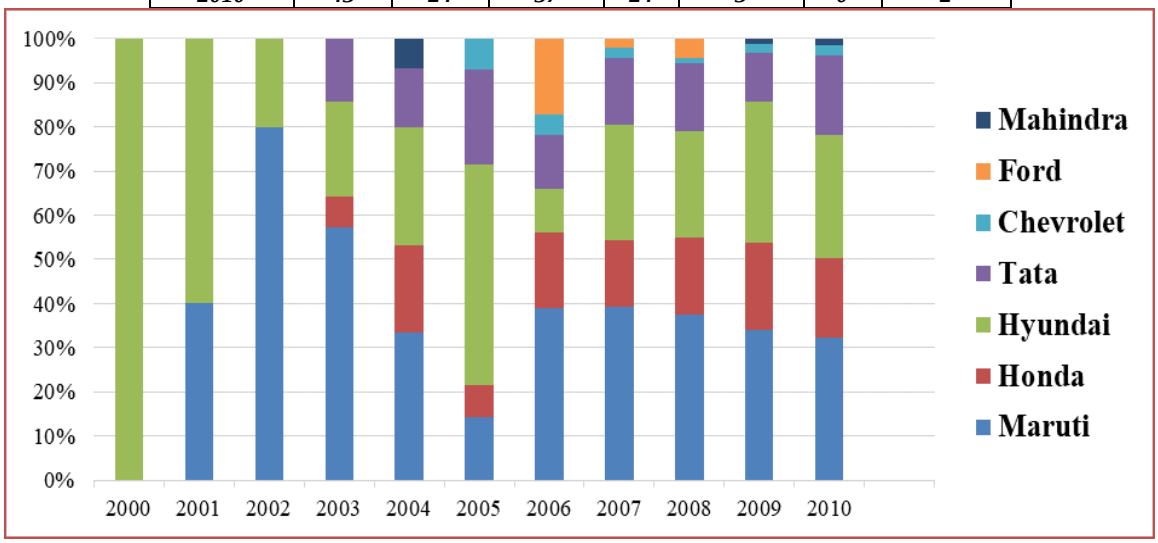

Fig. 3: Graphical Representation of the Breakdown of the Survey in Terms of Model Year and Manufacturer

Table 3 summarizes the imperfection type (blistering, surface rust, perforation and total imperfection) found on various vehicles in the survey. Figure 4 graphically illustrates the surveyed data into three imperfection types and the total number of imperfections. Since 5-9 year old vehicles had the most statistical significance, vehicles older than these have been ignored because of the small sample size.

As expected, the number of vehicles exhibiting a certain imperfection tends to increase with the increasing age of the vehicles. It is also quite evident that the number of blisters and surface rust were more predominant than perforation.

Table – 3

Survey Summary According to Model Year, Quantity and Imperfection Type

Model Year	***Approx. age of Vehicle (years)***	***Quantity of Vehicles Surveyed***	***Quantity/ Percentage of Imperfection Type***							
			Imperfection*		***Blistering***		***Surface Rust***		***Perforation***	
			No.	***%***	***No.***	***%***	***No.***	***%***	***No.***	***%***
2000	***15***	***1***	***1***	***100%***	***1***	***100%***	***1***	***100%***	***0***	***0%***
2001	***14***	***5***	***5***	***100%***	***4***	***80%***	***5***	***100%***	***4***	***80%***
2002	***13***	***5***	***5***	***100%***	***5***	***100%***	***5***	***100%***	***3***	***60%***
2003	***12***	***14***	***14***	***100%***	***14***	***100%***	***12***	***86%***	***6***	***43%***
2004	***11***	***15***	***13***	***87%***	***13***	***87%***	***15***	***100%***	***2***	***15%***
2005	***10***	***14***	***11***	***79%***	***11***	***79%***	***12***	***86%***	***2***	***18%***
2006	***9***	***41***	***36***	***88%***	***38***	***93%***	***33***	***92%***	***4***	***11%***
2007	***8***	***46***	***39***	***85%***	***37***	***80%***	***26***	***67%***	***0***	***0%***
2008	***7***	***91***	***66***	***73%***	***68***	***75%***	***56***	***85%***	***0***	***0%***
2009	***6***	***91***	***58***	***64%***	***64***	***70%***	***46***	***79%***	***1***	***2%***
2010	***5***	***133***	***86***	***65%***	***79***	***59%***	***56***	***65%***	***1***	***1%***

*Imperfections – designates others not including blisters, surface rust or perforation, but something like scratch, paint delamination etc.

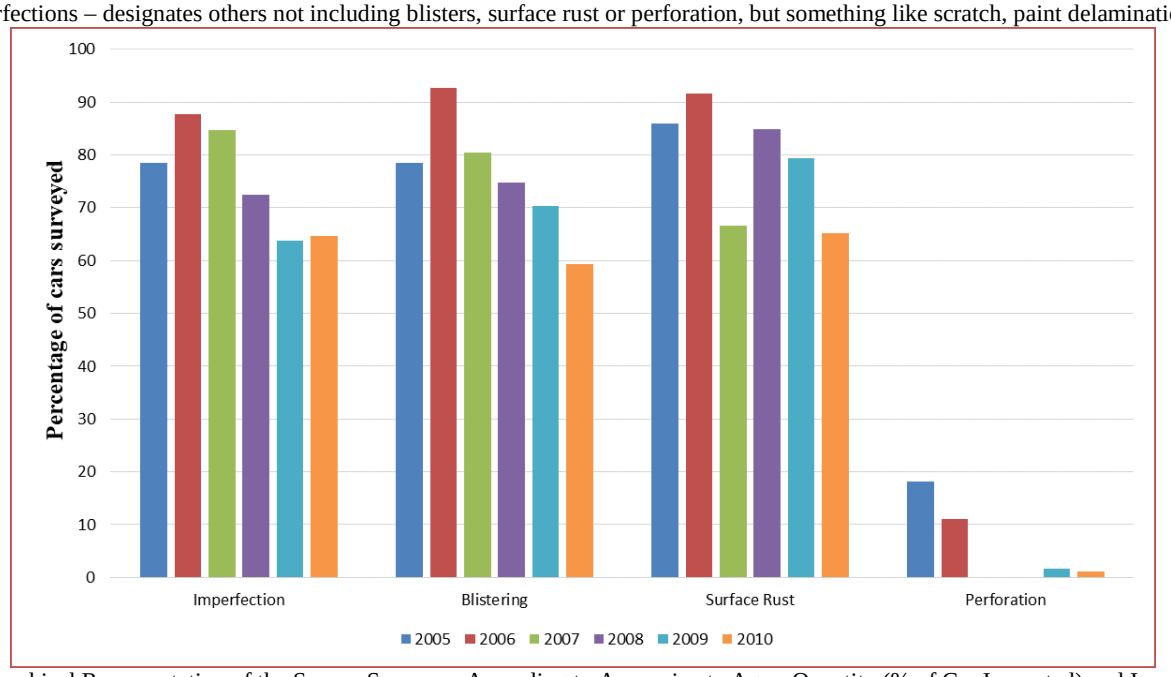

Fig. 4: Graphical Representation of the Survey Summary According to Approximate Ages, Quantity (% of Car Inspected) and Imperfection Type

In order to understand the nature of the imperfection type and its location on the vehicle, the survey data was plotted as shown in Table 4.

It is quite evident that perforation was not an issue of concern while blistering and surface rust are major detrimental features. Out of the four major parts inspected, rocker panel exhibited the highest damage in terms of number of imperfections, blistering and surface rust. This can be attributed to its closeness to the ground and hence effects of road debris, stagnant water, etc. The surveys related to three individual sites, viz., Powai, Juhu and Gorai is indicated in Fig. 5

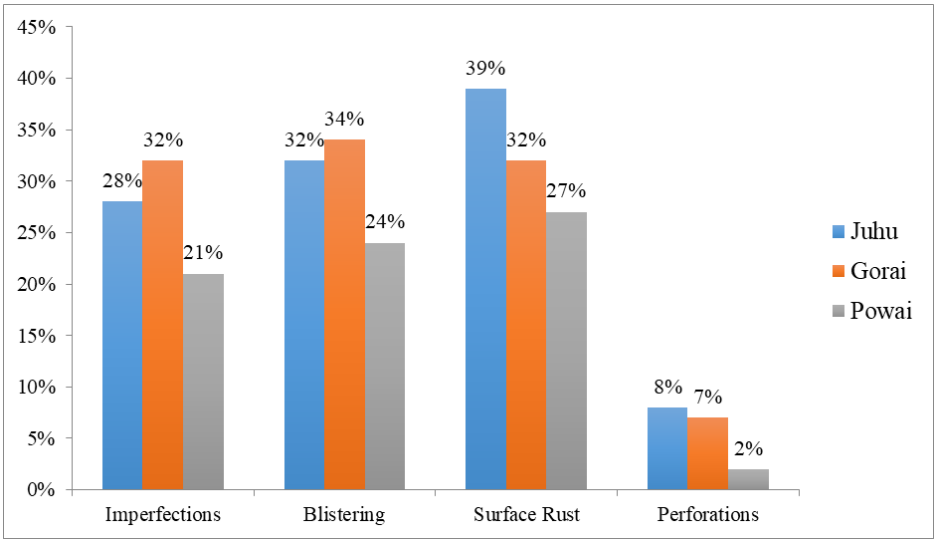

Fig. 5 Bar Chart for the damage due to various defects on three sites surveyed.

Table – 4
Quantity (No.) and Percentage (%) of Vehicles Exhibiting Imperfection for Various Parts of the Vehicle

	Imperfection		***Blistering***		***Surface Rust***		***Perforation***	
	No.	***%***	***No.***	***%***	***No.***	***%***	***No.***	***%***
Door Handles	***124***	***27%***	***134***	***29%***	***110***	***24%***	***9***	***2%***
Bonnet	***117***	***26%***	***126***	***28%***	***180***	***39%***	***4***	***1%***
Boot or Hatchback	***83***	***18%***	***92***	***20***	***129***	***28%***	***8***	***2%***
Rocker (Sill) Panel	***145***	***32%***	***159***	***35%***	***183***	***40%***	***4***	***1%***

There was another attempt to have a survey on a few high class cars which use galvanized steel as the starting material in comparison to the many Indian cars which use steel coils as starting material. The results are compared in Fig. 6
The survey shows that a car after six years shows higher corrosion on a non-galvanized steel usage while where galvanized Steel was used the corrosion damage was very low.

The use of galvanised steels in automotive not only enhances the life and durability of car, it also helps to maintain the coating facility free from pollution due to seven tank pre-cleaning of steel coil.

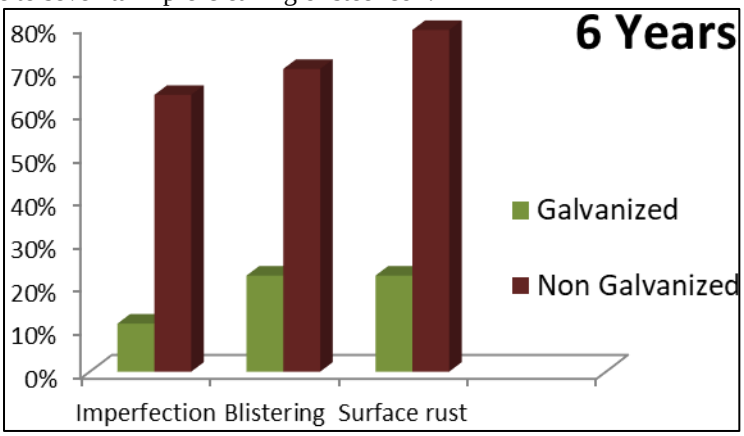

Fig. 6: Comparison of Corrosion of Two Cars, One using Galvanized Steel and the Other Ordinary Steel as the Car Body

V. SUMMARY & CONCLUSIONS

1) The results of the survey conducted on about 500 cars that are constantly under the influence of aggressive and humid conditions show a good correlation between the imperfections in automotive body and the age of the vehicle. Further, imperfections in different parts of the automotive body have been studied to show that the body parts close to the road (below the belt line) are most prone to imperfections such as blisters and surface rust.
2) The percentage of cars with imperfections noted in the India survey were remarkably similar to those measured in Michigan area of North America on vehicles around the same age. This is despite the fact that significant amounts of road de-icing salts are used on the Michigan roads during the winter months, while this is not the case on roads in the coastal areas of Mumbai.

3) A comparison of galvanised steel body cars to that of the cars where cold rolled steels were used show significant improvement in the extent of corrosion
4) Based on the above, it can be reasonably expected that the conversion of car body panels manufactured in India from painted cold rolled steel to painted galvanized steel will significantly improve the corrosion performance as was the case in North America.

REFERENCE

[1] T.C. Simpson et.al. "U.S. Automotive Corrosion Trends Over the Past Decade", SAE 1995, Paper #950375 (Detroit, MI)
[2] A.C.Tiburcio and M.J.Yergin, US Automotive Corrosion Trends : 1998 SAE (ACAP) , 2003-01-1244