The Experimental Analysis and Numerical Simulation of a Car Frame Coating Thickness - Element in a Legal Cause Settlement of an Insurance Proof

Laurentiu Claudiu Manea[1], Adriana Teodora Manea[1], and Dragos Sorin Dima[2]

[1]University „Ovidius" of Constanta, Romania, [2]Transilvania University of Brasov, Romania

profmanea@yahoo.com

Abstract. This paper deals with an issue that car owners are facing increasingly more (*after the coatings of car bodies increasingly thinner in the manufacturer's process - for economic and financial reasons*) in the conditions in which warranty complaints relating to the ability of the coating to preserve the aesthetic qualities of the car exterior surface, grow. The theme paper highlights a set of measurements of the car's body element „left rear wing "directly correlated with the reference of an one year earlier similar production car, and draw conclusions through the simulation in a virtual environment, related to the uniformity coating thickness and framing of the car body element / within the limits assumed by the manufacturer - thus identifying potential areas with lower resistance to the aggressive factors of the environment.

Keywords: automotive body frame, coating, virtual environment, forensic expertise.

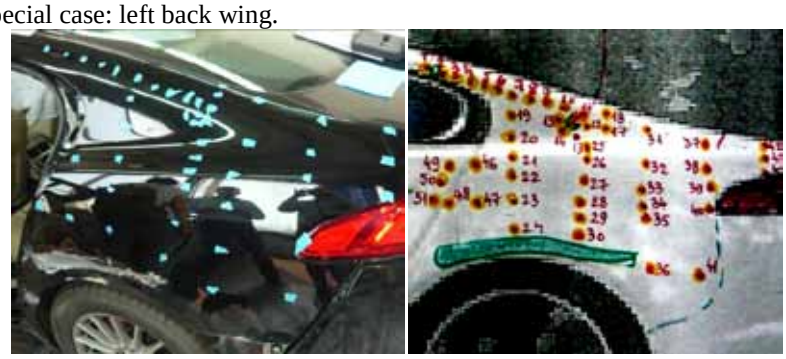
1 Introduction

This research is the subject of court contesting aesthetics outer cover body part "Left rear wing" of a premium range car, in a warranty case changing request, due to alleged cases generated by the production process of the manufacturer with the vehicle replacement demand. Technical judicial investigation was to determine whether there were prerequisites of the destructions due to manufacturer process and if the measured thickness of the coating of automotive body parts were within the limits specified by the manufacturer as technological extremes agreed. The research was conducted under conditions wherein the ferrous body left found in research has been investigated in comparison with symmetric body right part, (whose history in mining show that had been applied additional coverage after a previous repair) and with reference to an element of identical body frame of the same model, - latest 2016 manufacturing aluminum body version.

International Congress of Automotive and Transport Engineering, CONAT 2016
Transilvania University of Brasov, 2016
ISSN 2069-0401

2 Experimental determination and analysis of results

Examinations and measurements were performed with metrologies equipment in multiple series of measurements to the same point and data statistically processed in order to digitize and import them into a computing environment virtually creating corresponding areas to identify thickness variation of the coating destruction especially claimed to be in the area denoted B (Figure 2). Environment software used was MatLab and form surface results could be analyzed so as to be able to indirectly extract a conclusion on the uniformity of the underbody frame protection coating in the manufacturing plant and the dispersion coating thickness on body elements investigated in this special case: left back wing.



a. left rear wing 2015 carframe - in case

b. right wing 2015 carframe - in case

c. similar left rear wing 2016 carframe –dealer reference

Fig. 1. Measuring experimental car body preparation

In Figure 1 we can see the correspondence measurement points relative to the positioning of the measured values (statistically mediation) taken by the team formed by six experts (three technical experts, investigators and three specialists from the brand manufacturer) in connection with the coating thickness of body every measuring point (pre-treatment, undercoating layer of primer + insulator (sealing body) (primmer) + paint (base coat chromatic coverage -) + protective varnish) which is modeled virtual (after chromatic tones) by extreme values measured for each component in the three cases in Figure 2: a. left rear wing -car in the case; b . right rear wing- car in the case (1800 rotated to front in Figure 1, b) c. similar car left rear wing 2016production model reference.

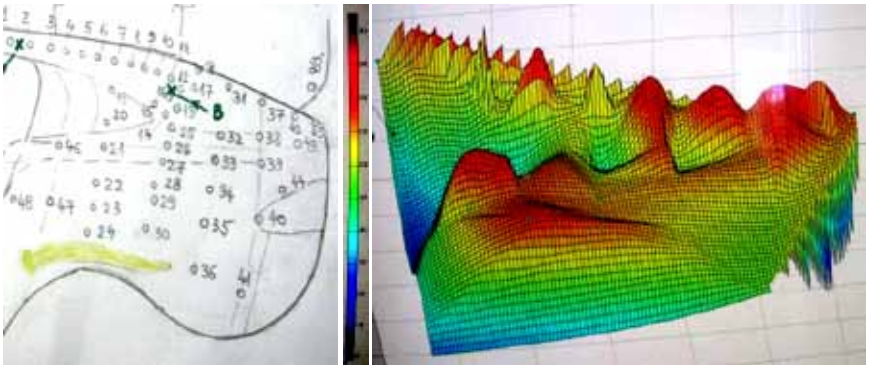
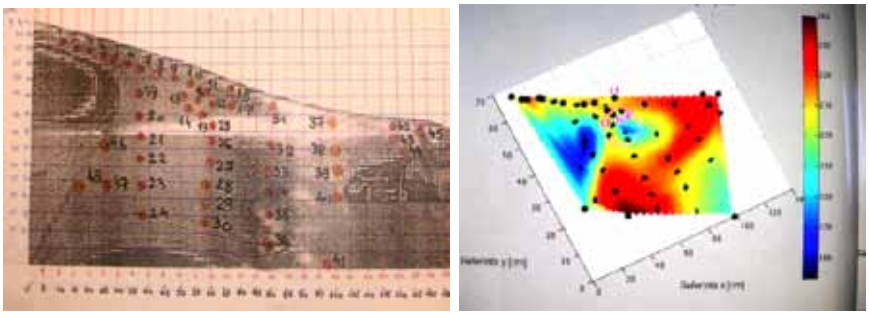


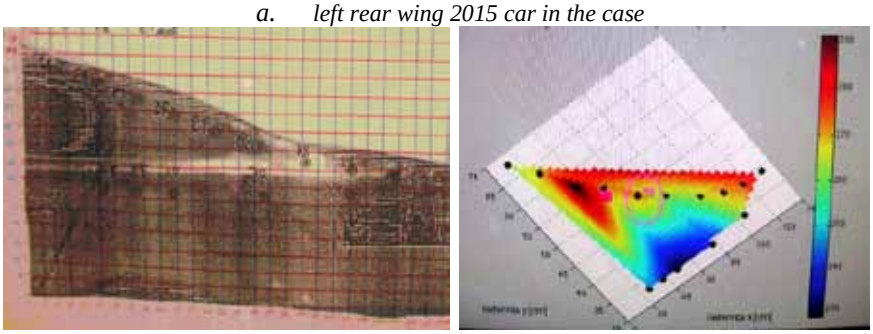
Fig. 2. Digitization of framework surface coatings *left rear wing* element of the bodyframe - according to the experimental measurements

Virtual color processing gives us (up-dark red coating thickness of heavy-valued maximum-dark blue heavy-minimum coating thickness values-down on the scale) for the destruction area of interest B fig.2, a particularly important technical feature: „in this area the coating is thinner than adjacent areas" (comparison made in Figure 3 between point a and c-between elements of the body had not suffered subsequent coatings on the manufacturing line -up crossing the final quality control). This shows that it is possible, even due to the design configuration of the shape of the body frame element „rear wing", or because of the brand's technology coatings (paint drop granulation, coating robot head tilt, instant pressure design particle paint / varnish, value of the electrostatic field created between body and "ground") thickness of the coverage remain more consistent towards the upper edge of the body "rear wing" and less in B zone, -the present research focus measurement. Perhaps this is an argument that less consistent coating B Zone may be less resistant to external destructive factor attack. Variant analysis of coating thickness by adding an additional layer of color paint and clear coat shown in Figure 3 (bright rear wing of the car in case - rotated 1800) confirms this argument : in the terms of additional coverage "settlement coating on the rear wing support" behavior determine coating thickness decrease in the same area studied symmetric versus B zone of the left back wing;

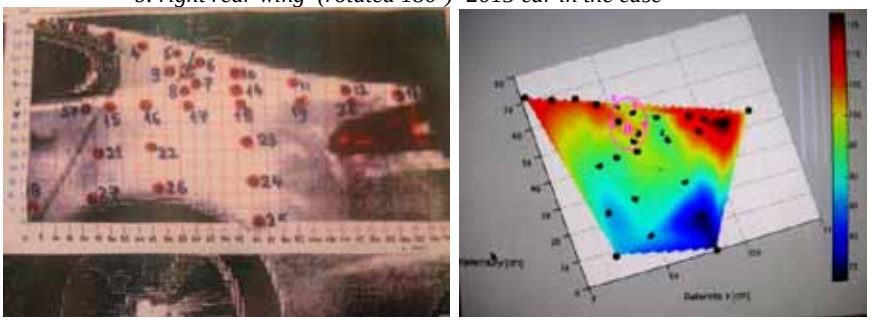
However, this observation should be added that the coating in the cases studied and modeled in 2 and 3 are a and b (when the coating thickness was not influenced by - repair coatings, paints, and subsequent clear coatings-) represented paint thickness values for the relevant passenger car-production in 2015, falls within the general engineering supported documentary producer that set the margins, between 79 microns and 526 microns.



a. left rear wing 2015 car in the case



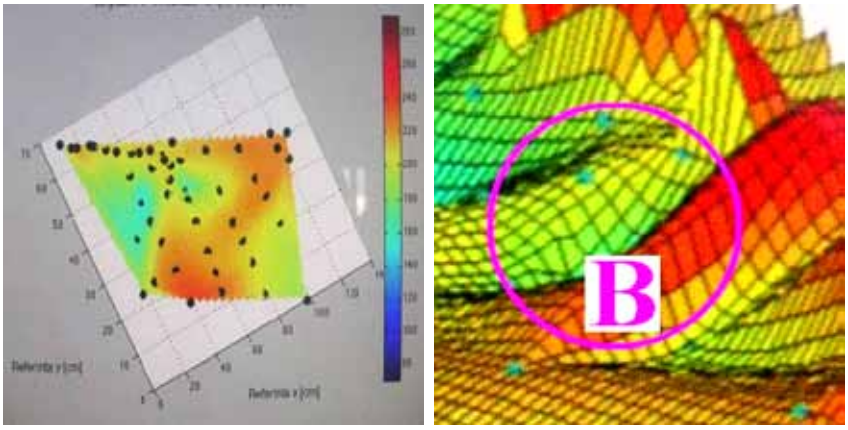
b. right rear wing (rotated 180^0) -2015 car in the case-



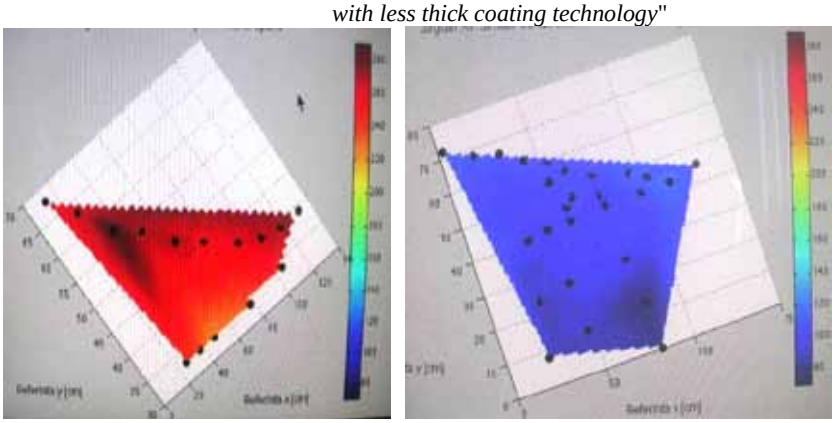
c. left rear wing –reference 2016 production car-

Fig. 3. Coordinative reference tracing (origin toward front of the car) measurements in obtaining experimental results, in terms of coating thickness Bodyframe Data Collection *on mathematical virtual environment MatLab software simulation of the distribution coating thickness between maximum and minimum measurement - element of interest:rear wing body frame (Source: MatLab software by MathWorks USA)*

An interesting observation it appears when we find, experimentally that the non-ferrous (aluminum base) body frame car technology coating can reduce drastically in terms of thickness values and depth of cover, with primarily financial and economic implications, for the manufacturing company. But it is possible that the type of paint, its viscosity, texture and pigment-based combination, setting technological parameters of robotic paint line for painting non-metallic version (as in our research case) Figure 1, a, b and Figure 3 a, b, or metal coatings (as in the case of the car having as a reference –Figure 1.c and Figure 3,c) determine the possibility of one year later covering body parts "left wing back" below the limit of 79 micron, declared by the manufacturer.



a. Left rear wing *car in the case* – 2015 plant coating bodyframe surface layer "*for zone B with less thick coating technology*"



b. right wing car -rotated front with 180^0) - extra layer of coverage (repair)
c Left rear wing car reference 2016thinner layer on the (Al) support deposited on the 2016 production line, in the plant

Fig. 4. Distribution of the coating thickness between maximum and minimum measurements on the frame element *rear wing* get through virtual simulation in MatLab mathematical software *in order and compare coating thickness with manufacture's technical limits: 79-526μm*

To get a clear picture of the destruction scale of the car frame part "left rear wing Area B (Figure 4) " of the 2015 production car – in case -, was imposed, in virtual environment, the same level of scale representation (of course with MAXImum thickness coating recorded for the analysis of the right rear wing (-documented repainted after the damages suffered in an accident), and the MINimum recorded in the measurements of body car reference / 2016 -left rear wing- (car provided by the manufacturer's representative - see Figure 1,c, and Figure 2,c), virtual data experimental results (in Figure 4,a,2) confirming the results already iterated above.

Program Code. Source: MatLab software by MathWorks USA

Part of Program listings and commands in the MatLab software are given:

```
  load('jaguar.mat'); [X Y Z]=suprafata3DXLS(x1,y1,z1,step);
  fig=figure(1); %%  aripa stanga spate
  surf(X,Y,Z,'EdgeColor','none','LineStyle','none','FaceLighting',
'phong';
  hold on
  scatter3(x1,y1,z1,80,'filled','MarkerFaceColor','k');
  xlabel('Referinta x [cm]','FontSize',12,'Color','k');
  ylabel('Referinta y [cm]','FontSize',12,'Color','k');
  zlabel('Grosime strat acoperire element caroserie
[\mum]','FontSize',12,'Color','k');
  title('Jaguar XF in cauza- aripa stanga
spate','FontSize',14,'Color','k');
  caxis([70 290]); colorbar
  function [X Y Z]=suprafata3DXLS(x,y,z,1)
       rangeX=floor(min(x)):step:ceil(max(x));
       rangeY=floor(min(y)):step:ceil(max(y));
       [X,Y]=meshgrid(rangeX,rangeY);
       Z=griddata(x,y,z,X,Y,'cubic');
  end
```

3 Conclusion

Because the B-zone fig.2 is the research area in which has been claimed an aesthetic destruction appeared to the body coating turned out, the experimental measurements made here revealed lower paint coating than in adjacent areas, partly because of the design surface configuration and layout of body parts, partly probably due to plant manufacturer technology coverage, but with the final thickness of the entire protective coatings of the car frame was found within the limits declared by the manufacturer. The result of the forensic research was that the complaint made during the warranty period on these issues was unfounded and therefore rejected.

Acknowledgements. The authors want to thanks to Mr. Barbes I from the Petromidia Petrochemical Refinery Plant, Technical measurements Laboratory that putted to our disposal the measuring gauge, and also to Mrs. Cristina Manea, who use hers knowledge in MatLab programming software to define the coating surface of the vehicle's body frame.

References

1. Streitberger, H. J., & Dossel, K. F. *Automotive paints and coatings*. John Wiley & Sons (2008)
2. Williams, D., The Telegraph, http://www.nissan-global.com// Researches of Auto Glym, 10 May 2011
3. Dave, K. G., Machine polishing by rotary polisher, www.Detailingword.co.uk
4. Ryland, S. G.; Kopec, R. J., The Evidential Value of Automobile Paint Chips. Journal of Forensic Sciences 1978, 24, (1), 140-147.
5. DuPont World Market Color Books, DuPont, Wilmington, DE (http://pc.dupont.com).