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MECHANICS OF STRAIN PROPAGATION IN MEMBERS OF A PLATFORM STRUCTURE DEVISED FOR INTENSE PAYLOAD

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ABSTRACT

This research paper deals with the mechanics of mechanical strain and its propagation in a steel structure through experimental analysis of a distinctive platform integrated with vehicle chassis. Dynamic values of strain components are evaluated on all constituents of the platform structure at various critical locations. Strain gauge classification for experimentation of the platform structure is described. Different nature of stresses at significant locations is evaluated with the aid of linear and rosette gauges.

Present-day data acquisition systems are utilized for acquiring the strain values. Static and dynamic strain values are evaluated for constant speeds on cross-country track.The experimentation reveals exact strain values, as there are no assumptions for measurement. Cross-country road characteristics are exactly simulated for this measurement process.

The optimum vehicle speed is maintained for the entire measurement process. Tri-axial values of strains are calculated using rosette reduction technique. Linear strain values are evaluated on longitudinal members of the platform structure. Values of strain acquired different locations reveal the critical areas of the structure for possible design modifications.

KEYWORDS: Platform Structure, Strain Signal, Data Acquisition Systems, Tri-Axial Stresses, Dynamic Strain

INTRODUCTION

Experimentation in present-days has acquired a vital significance as alomost all mechanical systems can be computer simulated. Present vehemence on product accountability, new anticipated designs must be lighter and stronger, and more conscientiously tested.

This places pioneering importance on the experimental strain measurement techniques. Mechanical strain is a term that relates to the dimensional transformation in component under contemplation. Category of freight is the key factor, which decides the nature of strain induced in the structure on chassis.

The economic and industrial progress of a nation depends on transportation and unswerving use of a road vehicle. The continual adjustment of vehicle speed and distance in response to change in traffic conditions generates various forces which remain unbalanced, causing a great impact on transportation system.

A transportation vehicle is subjected to innumerable types of static and dynamic loads during its travel. The structure under consideration is especially designed for various intense loads acting at the same instant. The structure is made of structural steel light weight channel sections. These members are expressed as longitudinal and cross components of the platform. All these are welded to each other using oxy-acetylene welding method. A steel structure is shown in figure 1 below.

Figure 1: Steel Platform Strucutre

EXPERIMENTAL STRAIN ANALYSIS

The experimentation process for strain measurement at various locations leads off with the gauge selection. The gauge selection process passes through various phases as assessment of exact strain sensing alloys, to decide the operating characteristics for gauge, assistance materials, gauge series, gauge length and gauge pattern. The most decisive parameter is heat indulgence and this is accounted during gage length and gage pattern assortment. In the present experimentation, the strain measurement locations are selected at longitudinal and cross-members. Strain rosettes have been utilized to acquire tri-axial strain values at several locations on cross members. Linear strain gauges are employed at locations on longitudinal members to acquire longitudinal strain values. Actual loading conditions are followed while placing the dummy load on the platform. Dynamic strain measurement has been carried out while driving the vehicle on cross-country tracks at constant speed. The portions of tracks have been selected such that they exhibit approximately uniform characteristics. Dynamic measurement has been made with zero stationary orientation. The acquired signals have been investigated and the dynamic components have been obtained.

Installation and Experimentation

Premising to gauge installation, surface preparation is of enormous significance. The phases of surface preparation are degreasing, abrading of the structure surfaces, marking of gauge location layout lines at the selected locations on the structure and surface conditioning. Degreasing process eliminates oil, grease, unprocessed contaminations. For this experiment isopropyl alcohol is employed as degreaser. Surface abrading confiscates scale, paints and builds a surface for suitable gauge bonding. For surface grazing, a silicon carbide paper of fine girt is utilized. Further gauge location layout lines are constructed at right angles to each other. Here one line leans in the direction of strain measurement. Surface conditioning is employed for removal of remains during burnishing operation.

The concluding step is neutralizing which brings the surface to an alkalinity of 7 to 7.5 pH, appropriate for micro-measurements. M-Prep 5A is neutralizer. Further in this research strain gauges are bonded to the structure using M-bond 200 catalyst and further soldered. Intense care is taken during soldering operation as this would agitate all the above mentioned operations.

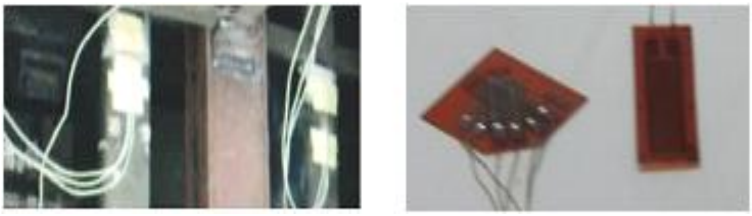

Figure 2: Installed Strain Gauges on the Structure and Individual Rosette & Linear Strain Gauge

Figure 2 above shows the installed strain gauges and sample rosettes & linear gauges. Static strain measurement has been worked out for various load conditions. Dynamic strain measurement has been carried out while driving the vehicle on cross-country track at a constant speed of 30 km/hr. The trail fragments signifying approximately regular characteristics are opt for measurement. Dynamic measurement has been made with zero stationary reference. The acquired signals have been evaluated and the dynamic components of strain have been acquired. The strain gauge locations and positions are enlisted in table 1 below

Table 1: Locations of Different Strain Gauges

Strain Rosettes	Linear Strain Gauges
Cross-member 2: (RCM-2)	Longitudinal member Front : (LLM-F)
Cross-member Mid 5 : (RCM-5)	Longitudinal member Mid (LLM-M)
Cross-member Rear 6: (RCM-6)	Cross member 5: (LCM-5)
Rear cross-member 7: (RCM-7)	Longitudinal member Rear: (LLM-R)

STRAIN MEASUREMENT AND SIGNAL ANALYSIS

The amount of load acting on the structure is of vital implication during the vehicle in action especially when the vehicle travels on a rough road land. The panorama to damage the elegant cargo present in the shelter/container mounted on the structure is significantly increased due to arbitrary nature of load on cross-country tracks. Strain signals on the new structure for abovementioned dynamic load conditions are acquired for a truck travelling a speed of 30kmph. The strain-acceleration signals are acquired in time sphere of influence. These strain-acceleration signals are further analyzed using a DOS mode operating software. Root mean square (RMS) values of the signals are contrived in micro-strain (με). The rms values of signals measured at various locations on the structure are given in table 2 below

Table 2: Strain Rms Values for Strain Signals on Cross-Country Track at 30 Km/Hr

Gauge Location	RMS (με) Strain Value	Gauge Location	RMS (με) Strain Value
RCM2-A	(+)37.95	RCM5-A	(+) 89.17
RCM2-B	(+)86.16	RCM5-B	(+) 254.25
RCM2-C	(+)37.46	RCM5-C	(+) 80.16
LLLF	(-)64.110	LCM5	(-) 24.57
RCM7-A	(-)8.59	RCM6-A	(+) 153.419
RCM7-B	(-)22.01	RCM6-B	(+) 131.07
RCM7-C	(-)7.35	RCM6-C	(-) 65.588
LLLR	(-)25.911	LLLM	(+) 77.254

Using the succeeding reduction technique for linear and rosette strain gauges, the dynamic values of strain are worked out. The stress values calculated based on Von-Mises criteria are tabulated below in table 3.

Table 3: Stress Values after Analysis of Experimental Strain Signals

Sr. No	Gauge Location	Stress Magnitude (MPa)
01	RCM: 2	1.76
02	LLL:F	-1.34
03	RCM: 7	0.872
04	LLL:R	-0.544
05	RCM: 5	5.38
06	LCM: 5	-0.516
07	RCM: 6	4.13
08	LLL:M	1.62

CONCLUSIONS

The strain measurement at significant locations is carried out for the evaluation of stress to which the individual longitudinal and cross-members are subjected, to describe the behavior of the structure due to the load applied on platform and for the design validation. The cross-members of the platform structure are subjected to bending stress due to application of the load. The inner portion where a rectangular rosette is placed on second cross-member is subjected to a stress value of 1.7 MPa for full load. The maximum stress values occurred for half and full loads on the exterior portion of the mid cross-member of the platform are 2.78 MPa and 4.28 MPa. The stress experienced on the rear of the platform on outer longitudinal member is 23% more than that of the stress experienced on the mid portion on outer longitudinal member of the platform. The stress experienced on the rear of the platform on outer longitudinal member is 14% more than that of the stress on the front of the platform on same longitudinal member.

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