Study on Frame Testing by Stress Correlation

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Abstract— With market competition is growing day by day reduction in product development time is a major concern in vehicle industry. This study was done on Motorcycle Frame to correlate stress level generated in actual road condition with respect to Lab testing & seeks to identify a suitable accelerated approach to durability analysis for motorcycle frame. This study involves field data acquisition, laboratory stress correlation & accelerated durability testing. To perform this study basic principle of strain gauge data acquisition system, strain gauge data analysis and hydraulic actuators with load cell were used.

Keywords: Motorcycle Frame, Stress, Strain Gauge, Data Analysis, Load Cell, Actuators

I. INTRODUCTION

Nowadays market competition is growing day by day. To sustain in market upgradation of models and new models as per current market demand is required time to time. To design models on frequently basis new accelerated method of testing is need of time. With use of Accelerated durability testing methods we can minimize testing time and cost. In this paper, study was done for durability testing of Motorcycle frame testing by correlating stress values accumulated from actual road condition to the lab testing. After correlation was achieved test was continued for full durability cycle of frame. [2] .This correlation study consists data acquisition, data analysis and test conduction in labs to correlate same condition.

II. STUDY METHOD

Method of motorcycle frame correlation consist basically three major parts field data acquisition, laboratory stress correlation & accelerated durability testing. Fig. 1 shows the outline of procedure for correlation.

A. Test Requirement

For the conduction of test the instruments required are strain gauge, data logger with bridge and connectors, jig to hold motorcycle frame, hydraulic actuators with load cell etc. Gauge which was used for the study was kyowa KFLB series Low-temperature Foil Strain Gauges uniaxial direction with the EDX-200A high-end Universal Recorder data logger. Close loop Servo hydraulic Actuators were used for cyclic loading.

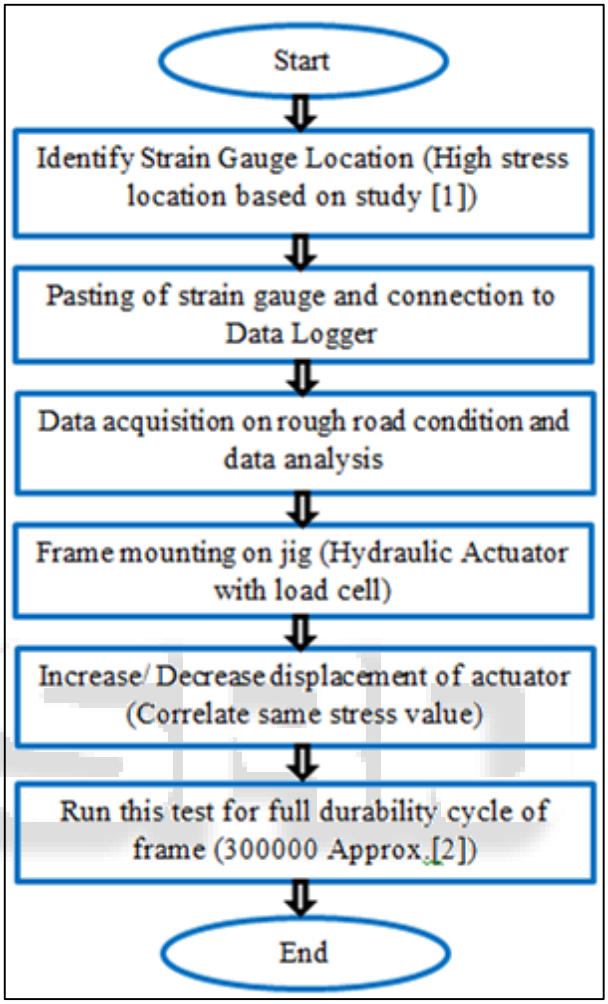


Fig. 1: Procedure for correlation

B. Test Procedure

To start the test first we need to identify high stress location in a motorcycle frame based on failures history on motorcycle frame, market research data, customer complains, virtual data simulation, reference models & stress concentration points. After high stress location is identified we need to study the load working condition which a location can have like vertical load, horizontal load or both types. For location in tension or compression gauge is mounted parallel to the axis of the loading. Now Strain gauges are pasted on high stress locations with the help of adhesives. Gauge locations are shown in fig. 2 on study vehicle. These strain gauges are connected with data logger with the help of a bridge box shown in Fig. 3.

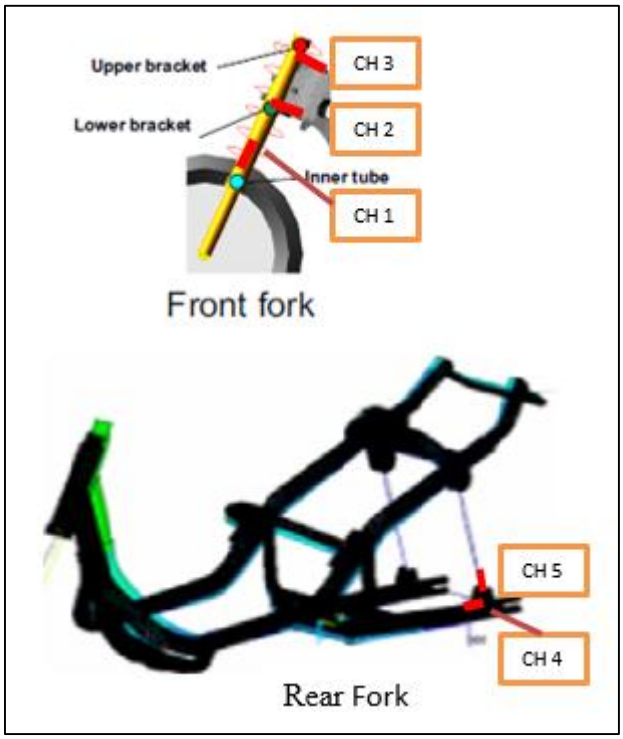


Fig.2 High Stress location

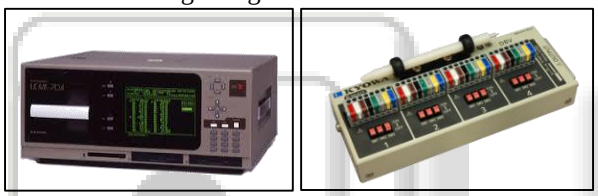
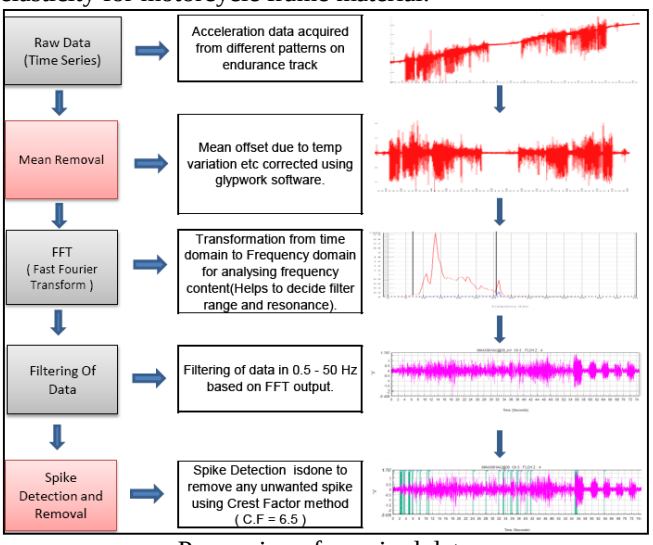
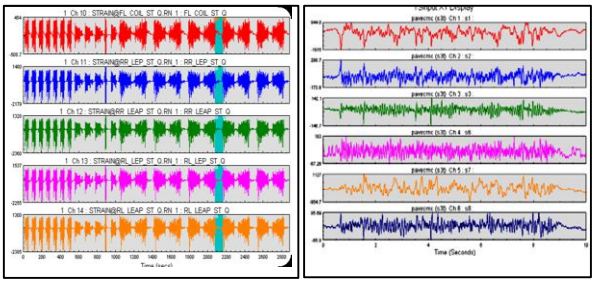


Fig. 3: Data logger and bridge box

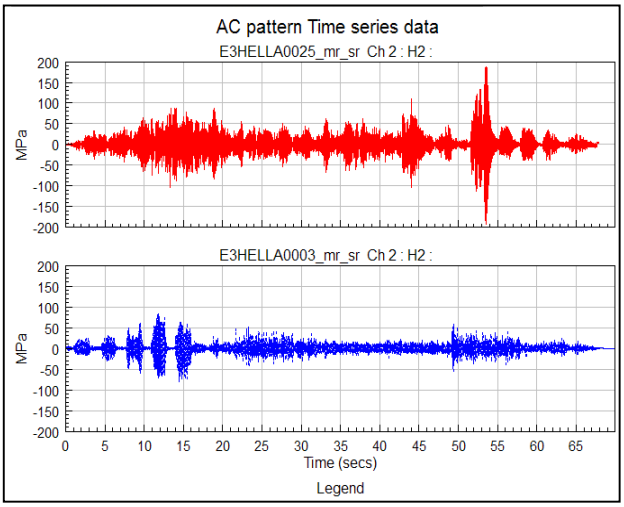
Now field data is acquired. For field data acquisition road which was selected was rough road and speeds on which data was taken were 40 km/h & 60 km/h with single rider and pillion condition. Sampling rate which was selected was 512 Hz. Filters for spikes, noise were used to ensure good data quality. After data acquisition analysis of data (Fig. 4) is done to obtain stress values by providing factor modulus of elasticity for motorcycle frame material.



Processing of acquired data



Strain Data



Stress Data

S.No.	Name of Gauge	Stress Value
1	CH1	± 150 Mpa
2	CH2	± 98 Mpa
3	CH3	± 85 Mpa
4	CH4	± 102 Mpa
5	CH5	± 125 Mpa

Fig. 4: Analysis of strain data

For analyzing the rough road data we used glypwork software. After getting the data from rough road we need to remove mean as it gets shifted due to temperature variation. Next step in data analysis is FFT analysis to deduce filter range and resonance. IN FFT analysis frequency contents are analyzed by transforming time domain data to frequency domain data. Next step in analysis is to filtering of data based on FFT output. Next step in data analysis is to remove any wanted spike in data. After analysis of data now we need to correlate the same value in the lab testing. First we will select two highest stress concentration points. In this study we found two highest stress concentrations (CH1, CH5). CH1 is selected for front fork and CH5 for rear fork. Now we mount the frame to the test rig Fig. 5 and after that loading condition are simulated fig.5 for front fork and fig.6 for rear fork. Load is provided on frame body for the rider and pillion (Front fork testing). Standard weight taken for testing was 75kg for rider and pillion each. With the help of Actuator by increasing/decreasing displacement we will achieve the same stress level. Results can be verified by monitoring the screen of data logger for CH1. After achieving same stress values we will continue the same test to full durability cycle (300000 times) [2] for the frame.

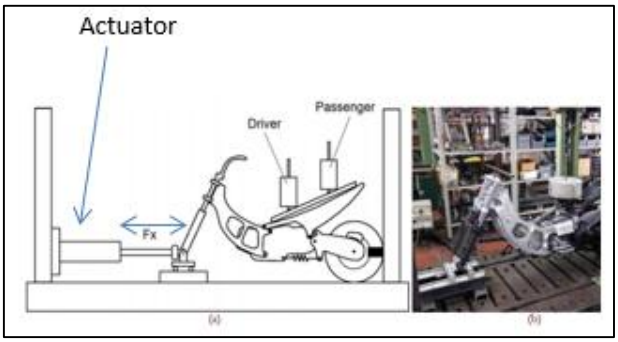


Fig. 5: Front fork stress simulation for durability testing

For the rear fork stress correlation we will adopt the same process. Fig. 6 shows Rear fork stress simulation for durability testing and for stress correlation we will monitor the screen of data logger for CH5.After the correlation we will get the load (W) by which we are getting same stress level. Now we will apply 3*W condition to conduct the test as no weight for the rider and pillion is provided in rear fork testing. After getting the loading condition we will continue the same test to full durability cycle (300000 times) [2] for the frame. Front and rear fork test is done simultaneously.

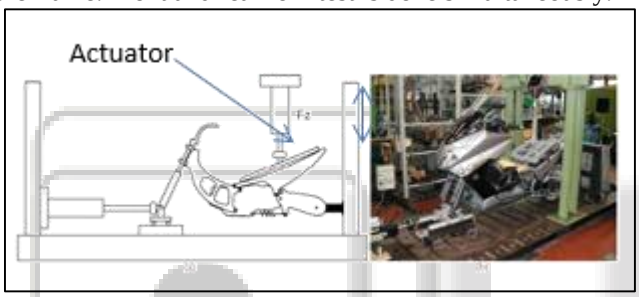


Fig. 6: Rear fork stress simulation for durability testing

III. CONCLUSION

This study concludes that in order to develop models on frequent basis accelerated full durability test are requirement of time. With this method of testing we will get test results at fast speed and implementation of test results can be done easily within the time frame of model development cycle time. Main conclusions obtained from this study are described here.

1) Stress data is acquired on rough road condition and same data is replicated in lab thus we can say that severe condition which a vehicle can have is already simulated.
2) Test is very effective in this method because of qualitatively good correlation and short time of computation.

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