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Vibration Analysis Of Existing RC Bridge – A Review

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Abstract: To obtain bridge accelerations, a dynamic analysis of a bridge is conducted to use a vehicle-bridge interaction model. The load exerted the passing vehicles is a mix of dynamic loading caused by the uneven bridge deck, which creates bridge vibration. Bridge vibration vehicular has a detrimental impact on numerous elements, notably driving safety and pedestrian comfort. As a result, an effective and precise technique to forecasting bridge vibration due to vehicle passing is required at the design stage. A reaction spectrum model is suggested in this paper to predict the bridge root-mean-square (RMS) acceleration response caused by a single-vehicle passage. A Kalman filter-based approach was used to extract the vehicle dynamic loads from a field test. The vibration based NDT, Analysis model in MIDAS, Comparetative study, VBDD methods and Numerical approach is used in these paper.

Keywords: Bridge, Vibration, Natural frequency

I. INTRODUCTION

India has the 2nd largest network of roads with 4.7 million km. It has up to 0.65 km of road for a sq. Km of land which is more than USA(0.65) and China(0.16). This network of road transport approximately is more than 60% of all goods in the country and 85% of total passenger traffic. [4]. Road activity has massively progressed over the last past years with improvement in connectivity between various major cities, towns and villages. Government of India under the "Ghatishakti yojan" has reserved 20% of the total budget investment for infrastructure to develop roads. Vehicle loads are applied to a bridges. These structures are becoming slender and, as a result, prone to large amplitude vibration as a result of demand and new construction technology. An appropriate vehicle vibration model is made to learn these cases. The vehicle motion of a bridge is self-sustaining and random in nature. The maintaining of a safe and reliable civil infrastructure is important to a national economy and the well-being of all residents.

Vibration is an oscillatory motion and the structure can be classify based on Analysis is Static and Dynamic, in bridge the Static load of vehicle impart full load of vehicle on Bridge but no induced of Force to vibrate the system until the application. in the Dynamic analysis the vehicle is on bridge it imparts a partial load on bridge and it also induce some vibration on bridge. By D'Alembertz principle moving mass generates inertia force it indicates the moving object force dependents on Vehicle load, moving acceleration, Damping of the system to cause inertia and system stiffness. the object produce dynamic force on surface of the road and in the bridge deck. Bridge should resists these loads and also vehicle also generate lateral force on surface. These dynamic excitation while cause the bridge to vibrate, Vibration will leads to the behavior of the system. if the bridge is in weak nature will give more frequency. These frequency and displacement can be solved by several ways there are 1) Classical Methods of solution 2) Duhamal Integration Solution 3) Transform Methods 4) Numerical method.

Critical damping is required to remove vibration energy in the system $C_r = 2m*W_n$ and Damping ratio is the relative value of the Critical damping of that system. Damping can be evaluated by the experiments, it is part of nonlinear of the material, The role is to removal of Kinetic energy and Forced energy from the vibrating structure and by virtue of which the amplitude of Vibration decrement steadily. The dampers will convert potential energy and kinetic energy into heat, friction and wave properly into structure. The natural frequency of the system is depends on physical property, Elasticity modulus, and length of the span majorly.

The frequency ratio is defined as ratio of forcing frequency to natural frequency. At frequency ratio is one then forcing and natural frequency are equity, then the Transmissibility of amplitude, acceleration and velocity is inseminate. It can be control by dampers in one way and other way is it's maintenance, operation and evaluation of bridge strength by implementing the regulation of the outcome. On operation of bridge the physical properties get deteriorate with time. For the old operation bridge can be evaluate on regular time after half years of the life span.

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II. VIBRATIONS

A. Vibration-Related Analytical Work On RC Bridge

The bridge of span 10, 12, 14, 16, 18, 21, and 24 was modeled, analyzed, and designed in MIDAS 2019 software and compared with the natural frequency of the bridge. [4]. The study is comparative with the working stress method IRC-21 with the limit state method IRC-112. They consider the live load to be IRC-6 Class AA and IRC 70R loading in the work. Bridges in India are constructed as per design details of standard plans, issued by the Ministry of Road Transport and Highway (MORTH) and approved by the Government of India. The design is in accordance with IRC: 5-1985, IRC: 6-1966, and IRC: 21-1987. The loads selected in the design are one lane of IRC Class 70R or two lanes of IRC Class A, on carriage. Footpath load of 5 KN/m^2. wearing coat load of 2 KN/m^2 considered. The designs are applicable for 'Moderate and Severe' exposure conditions by IS 456 , horizontal seismic co-efficient from IRC 6: 1985 considered. After static analysis, the Shear force fluctuation with span length for different IRC loading condition. As there is a dead load, the greatest shear forces are generated at the interior girder supports, but when there is a moving load, the highest shear force occurs outside at the girder supports Footpath load of 5 KN/m^2. Wearing coat load of 2 KN/m^2 considered. The designs are applicable for 'Moderate and Severe' exposure conditions by IS 456, horizontal seismic co-efficient from IRC 6: 1985 considered. After static analysis, the Shear force fluctuation with span length for different IRC loading condition. As there is a dead load, the greatest shear forces are generated at the interior girder supports, but when there is a moving load, the highest shear force occurs outside at the girder supports. The bridges are simply supported by the provision of bearings due to the variation in bending moment with span with varied IRC loading. Sagging moments are found in all of the longitudinal girders. [4]. The bending moment is increased with dead load comparatively to 70R and IRC class AA load along with the span of the bridge. The graph depicts the frequency modes that decrease with the length of the bridge, and the higher mode has a frequency in a shorter span than the lower mode. Natural frequency (W_n) is inversely proportional to the span of the bridge. [4]. The bending moment and shear force obtained from seismic force increase with the span of the bridge. The span/deflection curve with Midas and the clause of Indian standards is on the safer side. [4]. The below graphs b) In comparison to 70R and IRC class AA loads, the bending moment increases with dead load, as does the bridge span length. The graph depicts the frequency modes that decrease with bridge length, and the higher mode has a frequency in a shorter span than the lower mode. W_n is inversely proportional to the span of the bridge. d) The bending moment and shear force obtained from seismic force increase as the bridge span increases. curve with Midas and the clause of Indian standards is much on the safer side. [4]. VBDDs (Vibration Based Damage Detection Methods) is The change in modal flexibility is evaluated using a modal flexibility matrix, which is then utilized to define the region of damage. It is the sum of contributions from all possible mode shapes and associated natural frequencies, and it encompasses the affects of both mode shapes and natural frequencies.

[6]. $[F] = [\varphi] * [1/w^2] * [\varphi]^T$.[6].

[F] is Flexibility Model, $[\varphi]$ $[\varphi]^T$ Mass normalized and it transpose, $[1/w^2]$ In ascending order reciprocals of natural frequency squares. $[F^d]$ and $[F^h]$ destructive and Healthy flexibility modal. [6].

$\Delta[F] = [F^d] - [F^h]$.[6]

Structural degradation, in general, decreases stiffness while increasing flexibility. As a reason, an increase in structural flexibility can be used as a reliable predictor of potential. [6]

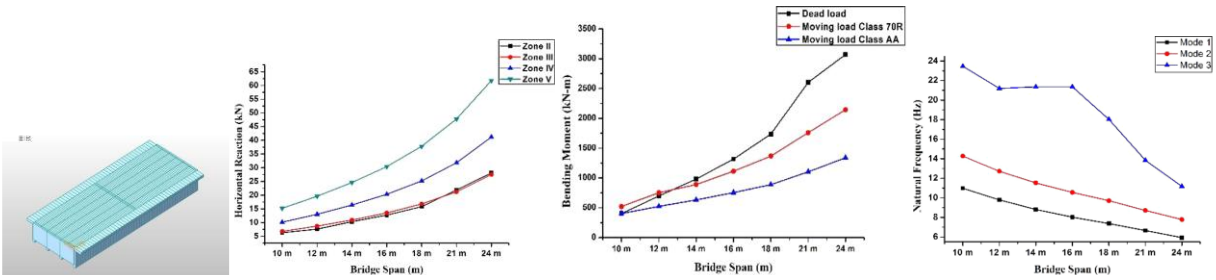

Figure a) Midas modal. b) Bending Movement c) natural frequency d) horizontal force v/s span of Bridge. [4]

Conclusion

The span of less than 12 m, the range of variation is not too much compared to a span of more due to the impact factor not varying in the range. The earthquake load is nearly the same in Zones II and III, but it is increased by 1.5 and 2.0 times the Shear force and bending moment in Zones IV and V. Flexure reinforcement is higher with design by IRC-6 as

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compared to the IRC-112 code. The W_{n1} and W_{n2} show similar variations in the span. As the length of the bridge increases, the W_n decreases. Hence, while designing a short-span bridge free vibration response of the bridge, because for spans of 21 m and 24 m, the frequency of, for example, W_{n1} is closer to 5 Hz to 6 Hz, but if it falls below 4 Hz, it may experience resonance because vehicle induced vibration is 3 Hz to 4 Hz, implying that a bridge with a small span is dynamically stronger than one with a large span. Approach to VBDD to detect damage in an innovative composite slab-girder pedestrian bridge. Under single and multiple damages scenarios, impact vibration tests were done on the undamaged and damaged composite pedestrian bridges using lumped masses to simulate damage. To determine the location and relative severity of damage, natural frequencies and the corresponding mode shapes obtained from impact vibration tests were used in combination with the modal flexibility method. ABAQUS is used to create (FE) models of the undamaged bridge and the damaged beam specimen, They validated modeling techniques were used to create FE models of the bridge under single and multiple damage scenarios.

B. Vibration-related Experimental work on RC bridge

The monitoring process is under way for one of the spans of the bridge, and the results are evaluated in vibration and displacement. These results can be directly displayed on the OLED screen, which is connected to the sensor and is placed on top of the pier. Vibration, which is created by many traffic vehicles on the bridge, is recorded by a sensor every second. These vibrations are noted in peak hour frequencies at normal intervals of time. Hansford vibration converts reading into acceleration and displacement. The bridge, which is monitored, should not exceed the limit. The max value of that bridge at peak hours is 15.8 Hz. On average, approximately 45% of trucks, 40% of four-wheeler vehicles, and 15% of two-wheelers and other light vehicles use that bridge. is 16 Hz to 2 Hz. This bridge was monitored because it had completed its half year of life time. [5]. The vehicle-bridge interaction is known by the natural frequency of the vehicle response. The feasibility has been verified in several studies by means of closed solutions. In bridge natural frequency identification using the cross spectral density function, using thecrossspectraldensityfunctionestimation.[2].A new frequency estimation method is based on using two vehicles. Speci al vehicles, on the other hand, do not need to be prepped. Bridge vibration, the prominent vibration source across severa l vehicle responses, is identified via signal processing. [2]. Bridge natural frequency identification using cross-spectral density function estimation is considered to be the most effective of the three methods for extracting bridge vibration components. Numerical experiments employing a vehicle-bridge interaction (VBI) model are used to evaluate the algorithm's performance under various scenarios. The effectiveness of such indirect frequency detection has been proved by numerical simulations. After that, experimental research involving the synchronous sensing of two vehicles is carried out. Because the vehicles are of different types, the only signal in common is the bridge frequency. [2]. The 1st Wn of the bridge has been identified with various driving speed combinations, demonstrating the proposed approach's W_n identification performance. Vehicle vibrations on a bridge are affected by two main excitation sources: bridge vibrations and road roughness. While vehicle responses to road roughness can be enormous depending on the road profile, the frequency peaks of the spectrum are not always sharp due to the irregularity of road roughness as well as vehicle damping. Bridge vibration components are often less than those associated with road roughness. Small disturbances on the bridge surface are further dampened before they reach the vehicle body. Separation of the bridge vibration components from the rest of the bridge vibration components. [2]. Bridge components are represented by a 6-DOF beam element. The bridge is represented as a simple beam with length L, uniform flexural rigidity EI, and mass per unit length m. The bridge's damping is represented by mass-stiffness proportional Rayleigh damping. While bridge parts with which vehicles physically interact are represented by so-called interaction elements. Newmark-b method can be used to solve the integrated system of vehicle and bridge in tandem to obtain the dynamic responses of the vehicles and bridge. For unconditional stability, the Newmark-b method parameters b and c are set to 0.25 and 0.5, respectively. m_v = 16600 Kg, j_v = 64598 Kgm^2, m_i = 700 Kg. truck and truck $c_i=10*10^3$Ns/m, $k_i=4*10^5$, and k_j=3.5*106N/m EI = 1.06*10^5 MNm2, m = 4406.76 Kg/m, and L = 59 m for m = 8800 Kg. time interval = 0.005 s. Two vehicles drive on a bridge, one after the other. The individual power-spectra is computed from the responses of vehicle A and vehicle B. Vehicle A has a maximum speed of 30 km/h, while vehicle B has a 5% lower maximum speed. The dashed vertical line indicates $f_{b,\,l}$ = 2.21 Hz, the bridge natural frequency calculated from FEM analysis. [2]. A strategy of suggesting the bridge's natural frequency indirectly from the vibration responses of 2 vehicles. Two vehicles move across the bridge as part of a strategy. The acceleration responses captured for each vehicle throughout the period while it is travelling on the bridge are processed to compute their unique power-spectra and cross-spectrum. [2]. Considered Example 1 is a single-axis vehicle driving over a simply supported bridge, and Example 2 is a three-axis vehicle with 5 DOF as modeled in ANSYS. Bridge parameters include the following: span length of 16m, bending stiffness of 2.05 x 1010 N/m2, vehicle parameter suspension system m_1 4.69 x 10^4 Kg, K 4.878 x 10^6 N/m spring stiffness damper C 3.14 x 10^5 Kg/s The recursive calculation was conducted to determine the interaction force between the vehicle and bridge at each node by using the allowing the vehicle to be passed to be obtained. Multiple vehicles travelling across should be performed between the vehicles and the bridge similarly. Different models are created under ANSYS and can be solved by the arithmetic method. [2].

Multiple Vehicles are that Condition I: 4 vehicles were assumed to be moving in the same direction, and have v = 90 Km/H and the head to head distance vehicles was 50 m (2lanes). Condition II: 2 vehicles were assumed to be moving in one direction, and the other 2 vehicles were moving in the opposite direction (starting from the other side of the bridge), and have v = 90 Km/H and the head to head distance vehicles was 50 m (2lanes). Special Condition I - Overtaking: 1vehicle was assumed to be moving at a speed of 80 km/h in lane 1and then 2 vehicle later moving at a speed of 120 Km/H in lane 2, in such that the overtaking maneuver is completed at the mid-span point of the bridge. Special Condition II - Changing lanes: the eccentricity of the vehicles position changes from 3 m when the vehicle drives onto the bridge, to −3 m when the vehicle drives off the bridge, thus requiring the inclusion of the torsion influence of the coupled vibration. Special Condition III - emergency braking and pulling-over: it was assumed that the vehicle was moving at a speed of 120 km/h, then slowed under the influence of an retardation of −5 m/s^2finally stopping on the bridge. The all condition initially taken as t_0, v_0, mass m_1, m_2 and using preliminary data modeled in ANSYS and results are evaluated in the parameter of span v/s deflection and Moment with condition and special condition. Effect of girder stiffness decay coupled vibration vehicle bridge system. Multiple parameters always have a coupled effect on the analysis results, study only focused on the stiffness decay that occurs at the center of the girder span. The ratios of the decay were assumed to be 10% and 30%, and the influence on the stiffness decay length and the vehicle velocity were studied. The results were displayed as 3D. the paper says that the more deflection and Moment occurs at the Condition II then the Condition I and in case of Special Condition of Moment and Deflection are more in overtaking vehicle, then the Changing lane, then the Emergency Breaking. In MATLAB they calculated the bending Moment Impact Factor. The coupled vibration mainly influence the vehicle speed. [2]. vehicle normalized dynamic load generation of vehicle normalized load from modal response formal, a sinusoidal wave is adopted to represent the mode shape of the bridge on which the proposed response spectrum is applied. [1]. F_d -zero mean dynamic load caused by the ϕ_n corresponds to the n^{th} mode shape value at the force position related to the vehicle's longitudinal position x_F and traverse position r_F. model properties know ductility properties calculate response from the kalman's filter based method. [1].

$F_{normal} = (\alpha F_d/G) * \mathrm{Sin}(x_F)$. [1]

The test bridge is a two-span box girder bridge on which the vehicle-induced load dynamic is normalized. was 40m in length and 10m in width. An ambient vibration test of the bridge was performed in advance to obtain the base dynamic parameter and mode shape of the bridge. [1]. Vehicle Normalized dynamic load extraction 3axis accelerometer at mid-span and inclination at the bridge gravitational acceleration is recorded by camera is set up at both at ends of the bridge. as the estimated vehicle properties know in bridge evaluate. the weight of vehicle is obtained through Weigh-in-motion technique and parameter α was estimated to be 0.76 the data is Root mean square of accelerometer, RMS is high sensitive to the sudden pavement of roughness representative response spectra. a representative of response spectrum of a light commercial vehicle is illustrated with its highest value at 1.5 to 2 Hz indicating dominant frequent of the vehicle dynamic load measured directly. In the field test described 191 vehicle passage is recorded. more specifically for damping ratio 0.01 of generalized SDOF system the response spectrum for each passage is calculate . final response spectrum is drawn. [1]. Factor affecting spectrum a). Pavement roughness effects, it creates the vertical excitation of vehicle system thus vehicle dynamic load is generated and it is transfer to the bridge. b) Driving speed effect it acceleration response of the bridge. c) Driving Path effect it is vehicle running from the central line it induced torsion vibration the bending vibration in bridge. with all consideration the Power spectrum density (PSD) is drawn. The Vehicle-Normalized Dynamic Load is defined and derived using such a Kalman Filter-Based method which first isolates vehicle-based method response [1]. A modeling of the human-structure interaction is needed for the serviceability analysis of these structures under human-induced vibrations. [8].

$m\ddot{u}+F=0$ [8]

m is the mass of pedestrian. F is lateral force. They measured lateral force at four walking speeds of 3.75, 4.5, 5.25, and 6.0 Km/h with a sampling rate of 200 and a recording time of 30s. [8]. F(t) is calculated by the Fourier series. Mean while the acceleration of the system can evaluated. The oscillation in the system is evaluated by a) Non linear oscillator Symmetry about a point in a lateral walking force plot prevents the use of quadratic or other even order variables in lateral walking force modeling because it destroys the required symmetry. To ensure symmetry around the point. [8]. b) Self oscillator, The energy required to sustain the motion of a self-sustaining oscillator was produced by the oscillator itself, leading to negative damping that feeds energy to the grid. It is an active system that, when disassembled or isolated, continues to oscillate in its own cycle. [8]. c) Van-der-Pol Oscillator max Velocity profile occurs in the first and third quadrants of phase space when the limit cycle is stable. The fundamental frequency and its odd upper harmonics display prominent peaks. [8].d) Rayleigh Oscillator Maximum velocity occurs in the second and fourth quadrants of phase space, when the limit cycle is stable. The fundamental frequency and the odd upper harmonics have the highest peaks. [8]. e) Proposed Oscillator To find the model parameter, the least - square identification approach is used. The pedestrian model parameters are identified using MATLAB Ls qlin function. [8]. SHM system is influence of the temperature as a stiffness is considerable changes in RC Bridge for this aspect use acceleration signals rather than

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strain sensors and so on it effects Young's Modulus(E) and Characteristic strength of Concrete (f_{ck}). the study is on span of bridge is 6m simply supported rectangular Bridge. The FEM of beam 30discretized beam elements having 4° DOF each translation and rotation at each. [11]. Analysis is done in MATLAB with IRC-Class A vehicle. The damage considered in this paper is percentage loss in Bridge stiffness. [11]. 2 type of vehicle model is used in this paper the 1st one is a system of quarter car, the 2nd is half car crossing bridge are used to assess the feasibility of acceleration-based Bridge weigh in motion(BWIM) system. Using MATLAB L/4and L/2 car vehicle acceleration, velocity and displacement Conditions. Percentage loss of stiffness gives co-relative temperature. after 500 half can vehicle are used under healthy bridge conditions. [11]. The bridge is observed for one year and response is taken compare the curves, the novel method is used detect using a statistical approach. [11]. The main objective of this paper is to look at the possibility of using finite element modal analysis of old highway bridges, along with information from the bridges' initial CAD drawings, as a qualitative tool to assist bridge observers in identifying the locations of crucial high stress/strain zones on the bridges that are related to certain frequencies caused by vibration-waveforms generated by vehicles. The findings of a finite element modal analysis are compared to experimental results from a 60-year-old highway bridge using Operational Response and Waveform Analysis (ORWA). [9]. The work describes the experimental methods used to gather operational response data for a single-span highway bridge and shows evidence of problematic structural motion induced by certain traffic loading frequencies. Actual, apparent bridge damage is determined and related to motion via waveform analysis, and the results are compared to finite element modal analysis outcomes. They want to identify, locate, and evaluate damage prior to actually correlating it with operational loads and providing a solution to the problem of structural motion. [9]. ORWA can be broken into four steps: (1) capturing operational response data experimentally; (2) visualizing structural motion across a broad frequency spectrum; (3) identifying the most significant excitation/response frequencies; and (4) correlating structural motion at considerable frequencies with structural motion caused by operational excitation. The operational vibration test measured the dynamic response of the whole superstructure and a part of the substructure to vibration induced by cars crossing a bridge. Five roaming uni-axial accelerometers or one fixed-reference accelerometer have been used. 440 response points were evaluated: 70 for every beam, 10 for every diaphragm, and 20 for every abutment. The operational vibration was traffic loading, and the measurement was initiated by the reference accelerometer at that point. A 10-car average was used, that is, after 10 cars hit the benchmark accelerometer, one average auto spectrum and cross spectra were computed and recorded for each accelerometer location. Magnets have been used to attach the accelerometer sensor to the bottom flanges of the beams and diaphragm members, and brackets were epoxy-fixed to the faces of the abutment walls to measure the vertical acceleration of the walls. Impact Test The bridge was conducted as a field impact test as a baseline approach, with the aim of expanding confidence in the ORWA test. The Waveform Analysis for every response of the baseline accelerometer out of each functional vibration data set collected was examined to identify the effect of traffic passing over the field-tested bridge. By converting the temporal history of the bridge's reaction to the frequency domain, it is possible to identify the frequency where the bridge shows large movements. A healthy bridge's numerical modal analysis using the finite element method (FEM) can help identify local areas of excessive stress or strain at natural frequencies. As the model ages, other damage areas may appear, limiting the numerical model's usefulness. However, a healthy bridge model may still provide helpful information about some high-stress areas induced by mode excitation, especially if the changes in natural frequencies are not severe. [9]. When the vehicle is on the bridge, its responses are interconnected and it can be carefully examined. The system matrices differ for every position of the vehicle on the bridge. The natural frequencies of the combined system also vary during the vehicle crossing. However, the coupled nature of the two subsystems was used in the prevailing study to identify the natural frequencies of one subsystem from the response of another. Once the acceleration of a vehicle from a known state has been obtained, the signal's spectrogram has been obtained and analyzed to determine the appearance of the bridge fundamental frequency. [7]. Peak responses are found to increase as vehicle speed increases. The peak magnitude rises, but the frequency of oscillation is not significantly affected. In this study, a spectrogram of vehicle acceleration response has been created with a sampling frequency of 200 Hz and a 50 percent overlap between signal segments. The natural frequencies of the bridge for first three modes of bending are 7.15, 28.60, and 64.35 Hz. The sections that follow describe the parametric studies that were carried out in order to determine the natural frequency of a bridge based on vehicle vertical acceleration. [7]. a) External Force b) Structural Dynamics response. c) The response result is decomposed into individual structural model response. A passing of vehicle attached with sensor to scan the Bridge, so it is indirect method due to no need to install the sensor in the bridge. Vehicle scanning method is suitable for beam/ girder like bridges and pipe that allows structural loads along the length. Bridge with Damping may not gave exact modal values by VSM method in Bridge Modal. VSM is improved by using FEM concept like Moving Internal Node Element (MINE) to know Dynamic behavior of the Bridge in more accurate manner. . [3]. Procedure for VSM : a) Input all structural and vehicular data, including road roughness. b) Calculation the dynamic response of the system using the semi-analytical or numerical modeling in this improved vehicle scanning method, and adopt the MINE method. c) Perform Fourier Transform on the dynamic response of the Contact point and obtained the Natural frequency of the bridge. d) Decompose Contact point response the test Vehicle with the modal decomposition method,

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in this improved VSM the elliptic filter is adopted. this filter is designed based on Natural frequency and signal strength. e) Calculate the analytic signal from narrow band. signal using Helbert Transform. f) From the instantaneous amplitude, construct the bridge's mode shape. g) By repeating steps (d to f). [3]. The Approach Above Method Is Used In Below Bridge Conditions And The Response Is Validated By Bridge Experiments: a) Undamped bridge with road roughness. b) Undamped bridge without road roughness. c)Damped bridge with road roughness. [3]. The related investigations were carried out in two phases: The OPC concrete, the stud connection with a height-to-diameter ratio more than 4. UHPC this composite lower self weight higher the strength by Ultra-high performance concrete (UHPC) light weight concrete with strength and young modulus is 60MPa and 40 GPa, the standard connector with ratio of height to diameter. On the other hand, usually has compressive strength and modulus of elasticity greater than 100 MPa and 40GPa, respectively. The fatigue push-out tests provided more conservative results than the beam tests, irrespective as to whether the stud connections were placed in an orthotropic steel-UHPC composite deck or a standard steel-NC composite beam. Because there are more stud connectors in the shear span than in the push-out test, shear stress redistribution of the stud connectors in the beam test can contribute to the beam results. [10].

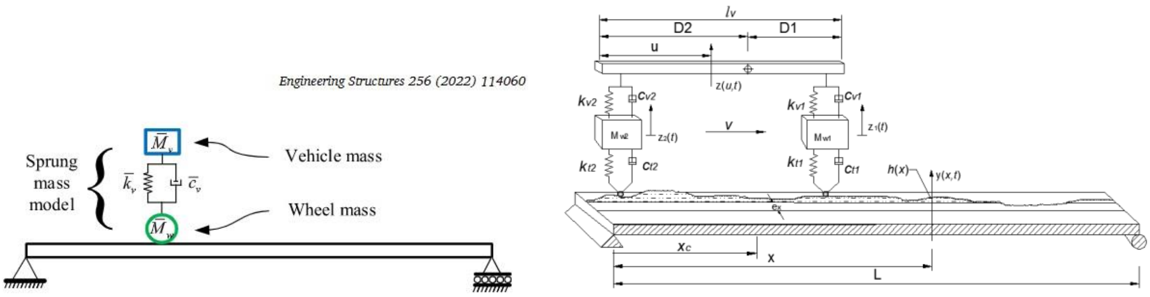
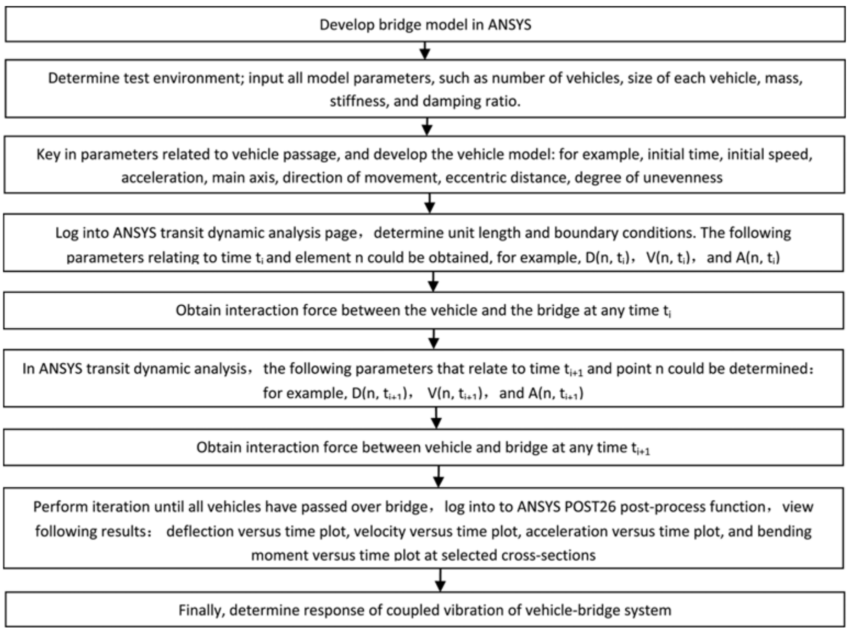


Figure: SS Beam under a moving sprung mass model [3], Bridge subjected to half car modeled. [7],



Flow chat Vehicle Based Interaction Method. [2]

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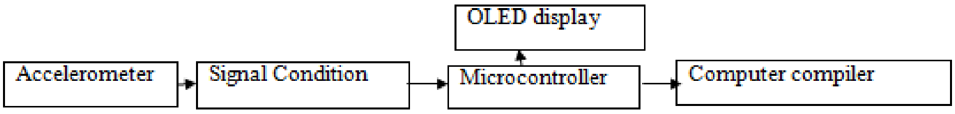
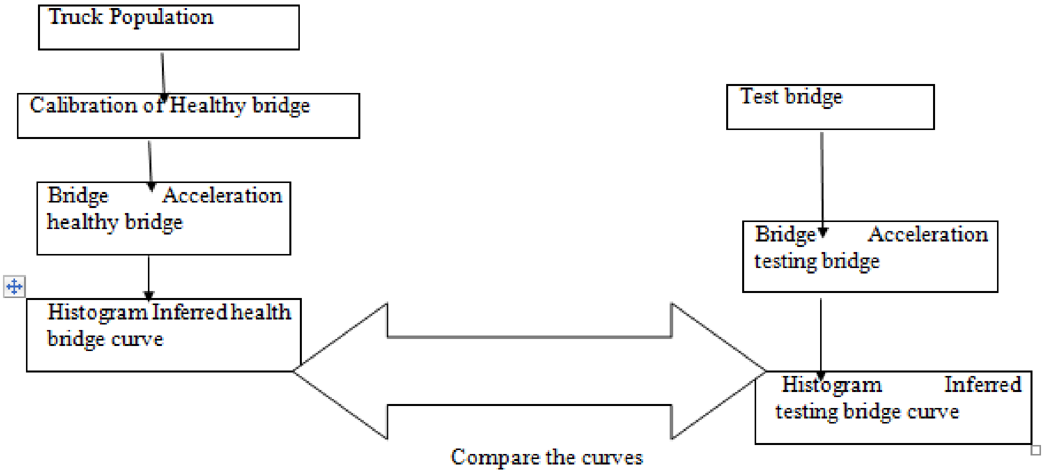


Flow chart the working procedure of Accelerometer. [5]



Flow chart of analysis of bridge . [11]

Conclusion

Vibration analysis by experiment on a bridge is a complex method due to various factors defining the dynamic response. It can be determined that the results of the experiment data are related to the bridge system. several to conduct experiments like SHM, NDT numerical analysis, and a comparative study between a standard bridge and a test bridge. To evaluate the present condition of the bridge.

III. CONCLUSION

The vibration in bridge is induced by moving vehicle it cause the material to distress when the frequency ratio is near to resonant, the Bridge transimibility of Displacement, Velocity and acceleration is indeterminate when the natural frequency matches with forcing frequency. In order to avoid this phenomena to evaluate the bridge natural frequency and implies restriction on the forcing frequency in order to prevents sudden collapse.

REFERENCES

[1] H. Wang and T. Nagayama, 'Response spectrum model of vehicle dynamic load for the prediction of bridge vibration level due to single vehicle-passage', *Eng. Struct.*, vol. 260, p. 114180, Jun. 2022, doi: 10.1016/j.engstruct.2022.114180.

[2] T. Nagayama, A. P. Reksowardojo, D. Su, and T. Mizutani, 'Bridge natural frequency estimation by extracting the common vibration component from the responses of two vehicles', vol. 150, pp. 821–829, 2017, doi: 10.1016/j.engstruct.2017.07.040.

[3] D. S. Yang and C. M. Wang, 'Modal properties identification of damped bridge using improved vehicle scanning method', *Eng. Struct.*, vol. 256, Apr. 2022, doi: 10.1016/j.engstruct.2022.114060.

[4] K. A. Shaik and C. G.P., 'Investigation of Indian standard plans issued by Ministry of Surface Transport for T-beam bridges', *Mater. Today Proc.*, vol. 52, pp. 724–730, 2022, doi: 10.1016/j.matpr.2021.10.132.

[5] K. Chilamkuri and V. Kone, 'Monitoring of varadhi road bridge using accelerometer sensor', in *Materials Today: Proceedings*, Jan. 2020, vol. 33, pp. 367–371. doi: 10.1016/j.matpr.2020.04.159.

[6] S. Ali, D. Thambiratnam, S. Fawzia, K. D. Nguyen, H. Van Den Elsen, and I. A. Fujii, 'Damage detection of an innovative composite slab-girder pedestrian bridge using vibration characteristics', *Struct. Infrastruct. Eng.*, 2021, doi: 10.1080/15732479.2021.1880447.

DOI: 10.17148/IARJSET.2022.9494

[7] R. Lalthlamuana and S. Talukdar, ‘Conditions of Visibility of Bridge Natural Frequency in Vehicle Vertical Acceleration’, *Procedia Eng.*, vol. 144, pp. 26–33, 2016, doi: 10.1016/j.proeng.2016.05.003.

[8] P. Kumar and A. Kumar, ‘Modelling of Lateral Human Walking Force by Self-Sustained Oscillator’, *Procedia Eng.*, vol. 144, pp. 945–952, 2016, doi: 10.1016/j.proeng.2016.05.121.

[9] S. Rahmatalla, K. Hudson, Y. Liu, and H. C. Eun, ‘Finite element modal analysis and vibration-waveforms in health inspection of old bridges’, *Finite Elem. Anal. Des.*, vol. 78, pp. 40–46, 2014, doi: 10.1016/j.finel.2013.09.006.

[10] Z. Shi, Q. Su, F. Kavoura, and M. Veljkovic, ‘Behavior of short-headed stud connectors in orthotropic steel-UHPC composite bridge deck under fatigue loading’, *Int. J. Fatigue*, vol. 160, Jul. 2022, doi: 10.1016/j.ijfatigue.2022.106845.

[11] E. OBrien, M. A. Khan, D. P. McCrum, and A. Žnidarič, ‘Using statistical analysis of an acceleration-based bridgeweigh-in-motion system for damage detection’, *Appl. Sci.*, vol. 10, no. 2, Jan. 2020, doi: 10.3390/app10020663.