Moving Load Study Of Steel Concrete Composite Bridge and Concrete Bridge.

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KEYWORDS

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ABSTRACT

Bridges are very important in our day to day life Composite bridges is the new type of bridges constructed. In composite bridge the girders part are made of steel and they are covered with the concrete deck. Different types of loading are applied on the bridge. Depending on the magnitude and intensity and many other adverse effects the structural system and performance may compromise and that may lead to a reduction of the expected bridge life. A composite (steel concrete) bridge having dimensions of 40 m span was investigated in this paper. The model was developed for the composite bridge dynamic analysis and was implemented in the MIDAS-CIVIL program which has finite element method simulations. Comparasion of the concrete and composite bridge was made

1 Introduction

In this developing modern world bridges are very important structures. The design of bridge must have all the different important requirements to form a design which satisfies the needs to form a safe construction. While the safe designing of the bridge or any structural element the influence of surrounding factors must be taken in which the structure is to be built. The economical and environmental point of view of the structure may affect because of these factors. In bridge design, other factors, like the process in which construction is carried out or the structural reuse and destruction strategies, must be also being considered. For this one must have the proper knowledge of behaviour of the materials used in construction which undergo wear and tear throughout their life time. The purpose of steel connector is to transfer the longitudinal shear stress from the deck to the steel beam. It helps the separation of steel side part girder and concrete part. The mixed action behaviour in both materials is obtained upon beam. Other types of shear connector are block, hoop and channel connectors. These types of connectors are used when large amount of shear is to be transferred. The above image shows the variety of the connectors used on beams for construction process. The flexible type shear connector is used widely as compared to the other types. Anchorage type of shear connector is mostly used when the precast girder is used. The strength of the shear connector relies on steel type, compression force of the concrete and dimension of connector. The design of the shear connector should be carried out according to IRC 22-2015. Cambering is the process of developing the reverse parabola curve to the girder on its opposite direction. Cambering to steel girder is done by two methods i.e. hot bending and cold bending. In hot bending method heat is applied to the girder which is wedged at certain points and in cold bending method cambering machine is used to put force on girder. Cambering is done to recompense the dead load deflection. Because of variety of vehicles passing on bridges different dynamic action is occurring on structure. Depending upon weight and power and many other disadvantageous conditions the structure and performance may compromise and because of this reason bridge life will be reduced from the expected. Cambering should be done according to IRC 24-2010. It says that cambering for beams with span less than 35 m is not necessary. Cambering to the main girders shall be such that when the girders are completely loaded with dead load including the 75 percent of live load attending to its maximum bending moment, the structure shall take the original geometric shape as per the design.

General Objectives

1. To study overall behaviour of composite bridge under dynamic loading.

2. Analyze the difference in structural behaviour between conventional and composite bridge.

3. To design structurally safe composite model bridge using concrete material and steel material.

4. Extending knowledge in application and selection of composites in consideration of properties and characteristics.

Fig Steel Beam

This present paper will give the structure response over time period and after applying various loads. It will be helpful in understanding the behavior of structure over time period with applied load. The designing of bridge is done by using working stress method by taking in account various loads and their factors of safety

A dynamic analysis of steel concrete composite bridges is the principle attention of this project. From this analysis, the dynamic response of steel-concrete composite bridge and conventional bridge was compared, and delivered the facts on whether or not a composite bridge is structurally and economically feasible. Measurement of different set of parameters for the composite bridge deck is carried out. A layout for a steel-concrete composite bridge is done. This part contains cost effective preliminary design for composite bridge. MIDAS CIVIL software was used to model the bridge and carry the finite element analysis of the model as per Indian standard codes.

2 Loading as per IRC

Dead Loads for elements like Slab, Steel I Girder, Diaphragms, Pier and Pier Cap are considered as per IRC6:2017

Also the loads like super imposed dead load, wearing coat, crash barrier etc. are considered as per IRC6:2017

Moving loads due to standard IRC vehicle i.e. Class A and 70R and their combination and braking load as per IRC6:2017. E.g. 3 Class a vehicles, Class A+ 70R vehicle near and Class A+ 70R vehicle at the edge.

Forces due to shrinkage and creep of concrete are also considered.

3 Influence Line Analysis .

The An influence line diagram is the representation of the moving force on the member at a specified point. It graphically shows the bending moment, force because of shear or the displacement in member at the specific point or any of point on the member. The influence line diagram shows the effect of the loads acting on the span of members. After plotting the influence lie diagram we can find the maximum impact point on the span because of the placement of the moving loads on that span. By this influence line analysis we can find the maximum shear force and also max moment force position of the structure or the span.

The magnitude of live load or impact load caused because of the moving vehicles on the highway bridges can cause various reactions depending on the position of the vehicles. The influence line diagram helps us to study these values based on the position very easily. With the help of influence line diagram we can get the position at which the maximum shear force and maximum bending moment is caused because of the moving vehicles and its impact force on span of the bridge.

Influence line diagrams are useful in the structure which is subjected to live loads because of different types of vehicles. After the plotting of the line diagram we can find the placement of the moving load vehicles which gives the maximum value of shear force deflection of the span or the maximum value of the moment from bending force on length. For the formation of influence line diagram first the uniformly distributed load caused because of the vehicles is converted to simple point load. Finding the values with help of point load is quite easy compared to that of distributed load.

Then that unit load is placed on the span and related to it the maximum values of shear force or bending moment can be found out. Depending on the various end conditions like simply supported or cantilever or the combination of both conditions the values of shear force and bending moment can differ. For a single point load many formulas to get the direct value of maximum shear force and maximum bending moment are also been derived to save the time from calculations.

The value of maximum shear force for the cantilever shaped beam will be occurring at the point which is next to the fixed position. For the simply supported structure the position of the max value of shear force will be at the point near to the reaction. However the position of the maximum value of bending moment is not yet constant the position changes from condition to condition. With the help of trial and error method the roughly position can be determined the shape of the diagram for the bending moment is generally curved shaped.

Following are the uses of the influence line diagram and analysis on any member of the structural element which has to be designed.

1. They are mainly used to study the impact of the live loads or variable loads due to different types of moving vehicles.

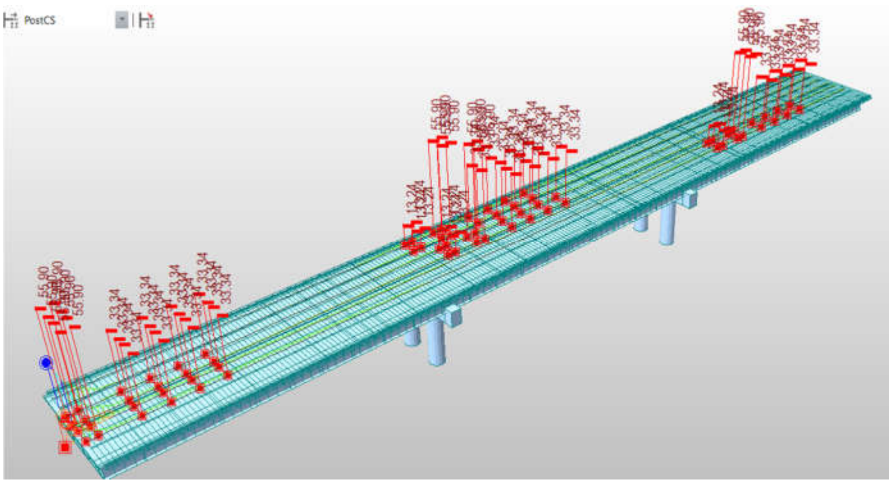
2. To find the reaction at end support, deflection, shear force and bending moment because of the any force applied on the beam or the span of the highway or any type of bridge.

3. To find the effect of the moving load at the specific point at the any member of the structural element.

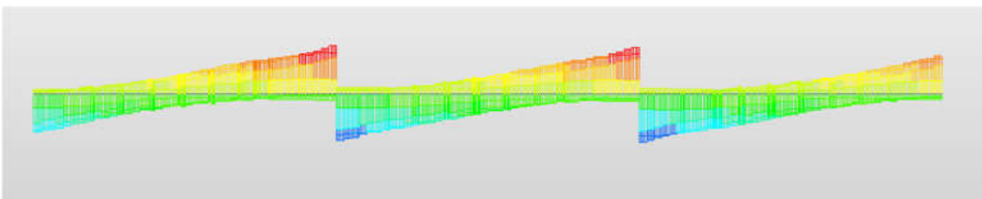
4. Shear force and bending moment diagrams shows the effect of loads at all points along the members.

5. They can be used even if the load is not unit load and also can be used when multiple loads are applied.

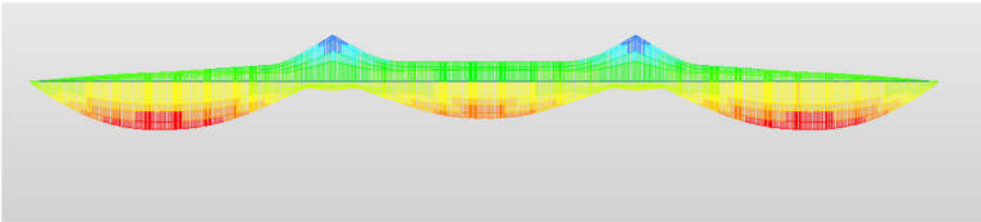
6. With the help of influence line diagram a structural designer can find the accurate position of the load which cause the maximum value on the complete structure



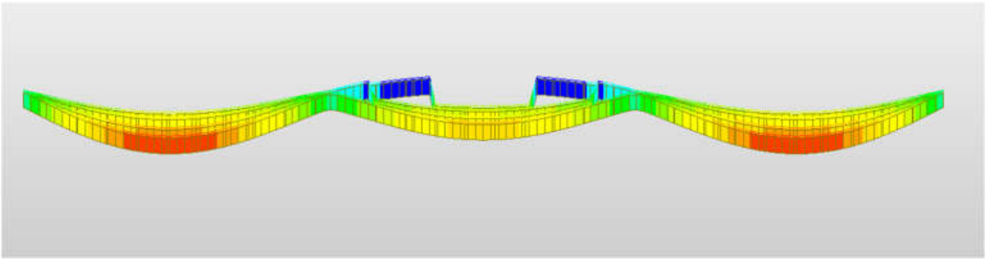
Class A Moving Load Condition



Shear Force IDL Diagram



Bending Moment IDL shape

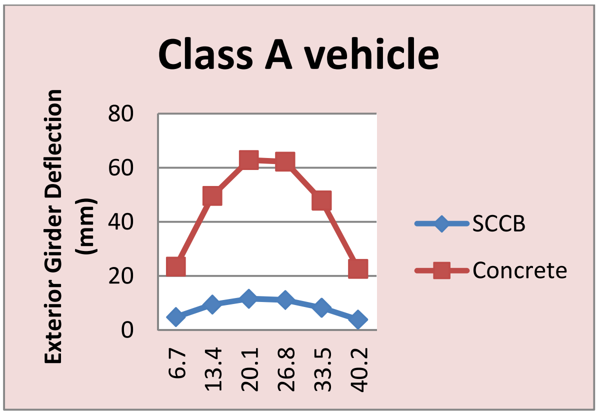


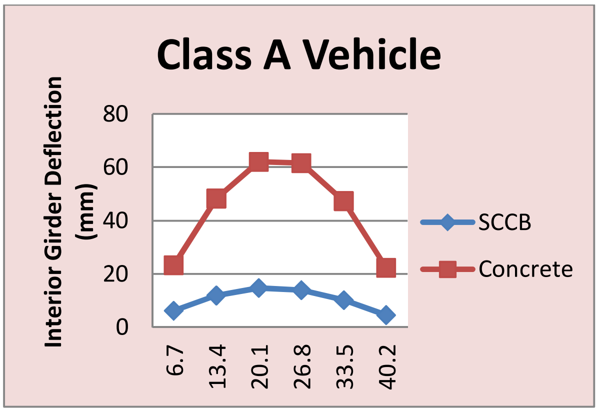
Deflected shape

4 Results:

After applying the loads as per IRC load combinations following results were observed

1. Deflection in Bridge

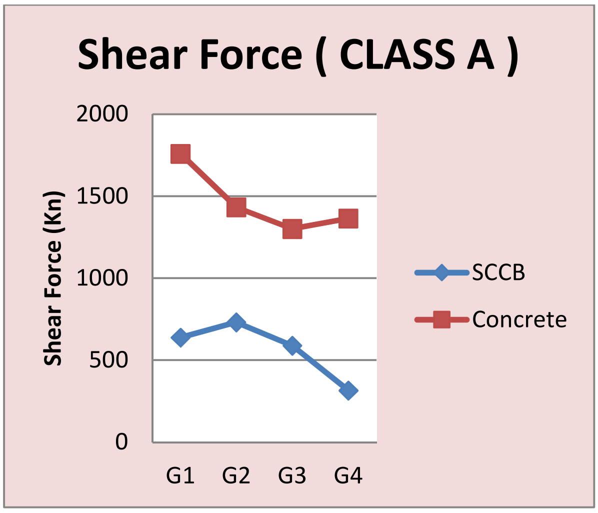




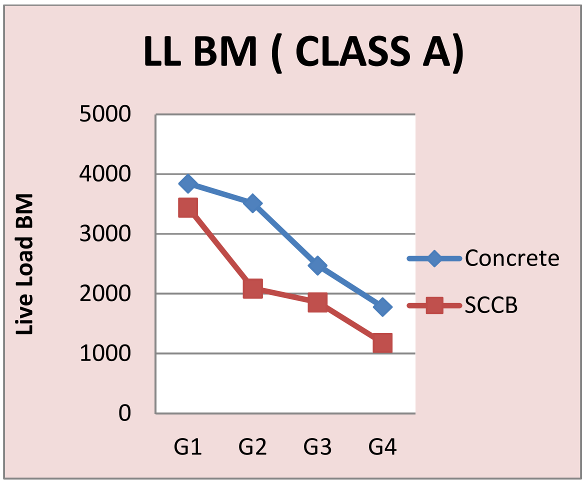
The graphs result were based on the moving load condition of Class A. As the graph shows the deflection at the exterior girder i.e. girder 4 for steel composite girder bridge was seen as 11.64 m and the deflection for normal concrete bridge was observed as 62.04 m. Similarly the result for interior girder i.e. girder 3 was also observed. The maximum deflection in steel concrete composite bridge was observed as 14.65 m and the deflection for normal concrete bridge was observed as 62.83 m. Hence the deflection at the normal concrete bridge was more than that of steel concrete composite bridge. It was observed that the deflection in the composite bridge were large as compared to to the concrete bridge. Hence the composite bridge is preferable as compared to that of the normal concrete bridge.

2. Shear force

Shear force is the axial force acting on the surface of the bridge. It is very important force to be considered. Class A moving vehicles placed at the equal distance from each other are considered for the calculation of result of the Shear force in girder of both the models. The graph represents the comparative results of shear force calculation acting on both the bridge models. For steel concrete composite girder bridge the maximum value for shear was observed in girder 2 that is internal girder. Max shear force value was 729.77 KN. And for the concrete girder bridge the max shear force was observed in girder no 1 that is exterior girder. Max shear force value was 1757.76 KN.It was observed that the max value of shear force was observed in the condition 1 i.e. Class A+ 70R vehicles near condition. The result was compared with the max allowable force from shear of the structure. Results seen were way below the permissible value hence the structure was safe for shear force.



3. Live Load Bending Moment

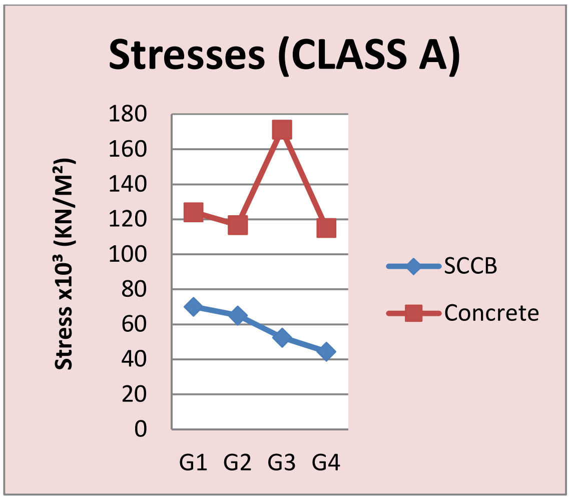


The maximum values for live load bending moments for both steel concrete composite girder and concrete girder was observed and plotted graphically for the 3 Class A vehicle condition placed at equal distance from each other. Max value of live load bending moment for steel concrete composite bridge was observed to be 3442.27 KNm and maximum value of live load bending moment for concrete girder was 3843.06 KNm. It was observed that live load bending moment value of second model concrete girder was greater compared to first composite model girder bridge. It was also observed that the values of moment for girder 1 are more compared to that of other girders. The reason for max bending moment in girder no 1 is because the load acting on girder 1 because of the live load condition is greater than the other girders.

The values of moment observed for all three conditions were compared with the analytical calculations and it was seen that they were below the allowable values of maximum bending moment. Hence the model can be said to be structurally safe and can be construct.

4. Stresses in girders.

The maximum values for stress for both steel concrete composite girder and concrete girder was observed and plotted graphically for the 3 Class A vehicle condition placed at equal distance from each other. The combination of dead load and live load according to IRC code was applied to the models and stresses values were obtained. Same load combinations were applied to both the models and the results were calculated. The stress peak value was developed in the steel concrete composite bridge was 70.18 x 10^3 KN/m² and the maximum value observed for concrete girder was 171.34 x 10^3 KN/m². The stresses value developed in the composite form bridge are far less than of the normal concrete bridge. The loads acting on the steel girders are less as compared to that of concrete girder hence the stresses developed in steel concrete composite girder bridge are very less compared to that of concrete girder bridge. The values for maximum stress in girders for both the models were observed for all three conditions and were compared with the analytical calculations and they were below the allowable values of maximum bending moment.



No	Material	Composite	Concrete
1.	Concrete	20,90,900 INR	3,96,000 INR
2.	Steel	-	43,60,000 INR
3.	Reinforcement	18,90,000 INR	-
4.	Pre stressed steel	75,500 INR	-
5.	Shuttering	2,67,750INR	-
	Total	4324150 INR	47,56,000 INR

5 Conclusion

From the design and analysis of both the bridges following conclusions were made:

1. The Deflection of the concrete bridge is very large as compared to that of the composite bridge because the self weight of the concrete bridge is large as compared to that of the composite bridge. Hence the deflected shape of the composite is less.

2. The shear force of the composite bridge is low as compared to that of the concrete bridge because the Forces acting of the concrete bridge is large as compared to that of the composite bridge. Hence the composite girder bridge is safer.

3. The Bending moment values and also the stresses of the concrete bridge is very large as compared to that of the composite bridge because the weight of the concrete bridge is large as compared to that of the composite bridge.

The steel components last longer and the maintenance required is also less. Steel components are less likely to damage during the worst environmental conditions like earthquake and hurricane. Generally when there is railway line passing below the bridge or a bridge is built over a river or sea, steel girders are preferred over concrete as it doesn't corrode easily and also can absorb the impact of vibrations because of the railways. Only the initial cost of constructing steel girder is high

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