Experimental Study on the Sidewalk Plate of Resin Quartz Sand Based on the Mechanical Property Test

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Abstract. This paper uses the prototype loading test of resin and quartz sand footpath boardto research the various mechanical properties of it.Through the study and analysis of the experiment,which indicated that under design load and overload effect,theresin and quartz sand footpath board's top board and bottom board stress are small, the resin and quartz sand footpath board is sufficient to undertake the design load.The deflection can meet the requirements under the design load,,but which exceeds the regulatory requirements under the overload.Resin and quartz sand footpath board's crack is in the control range when it under the design load and overload.Therefore, the various performance of the resin and quartz sand footpath board can be used for the bridge engineering, but the main controlling factor of which is mid-span deflection.

Introduction

For the bridge footpath board, which always used reinforced concrete precast slab in the past, however, it's dead weight is heavy ,construction speed is slow, corrosion resistance is poor, and maintenance is inconvenient.According to the bridge footpath's design load is not heavy, through the rational design,which can effectively overcome the reinforced concrete precast slab's problems by using the resin and quartz sand footpath board.In recent years,resin and quartz sand material has been used in many bridge structures in Sichuan and Chongqing, the United Kingdom, the United States and other European countries began to use resin and quartz sand material in the main structure of the bridge in the 70s of last century.Resin and quartz sand footpath board is an innovative application of bridge engineering by using the new composite materials, but it is a composite which is composed of a variety of materials and it's loading process is nonlinear, there is little experimental research of it at present.

The colored resin and quartz sand footpath board's mechanical properties test, according to the actual size and using the prototype specimen,the size of the test colorful resin and quartz sand footpath board is 1260mm × 600 × 75mm, which layout form is shown in Fig.1.

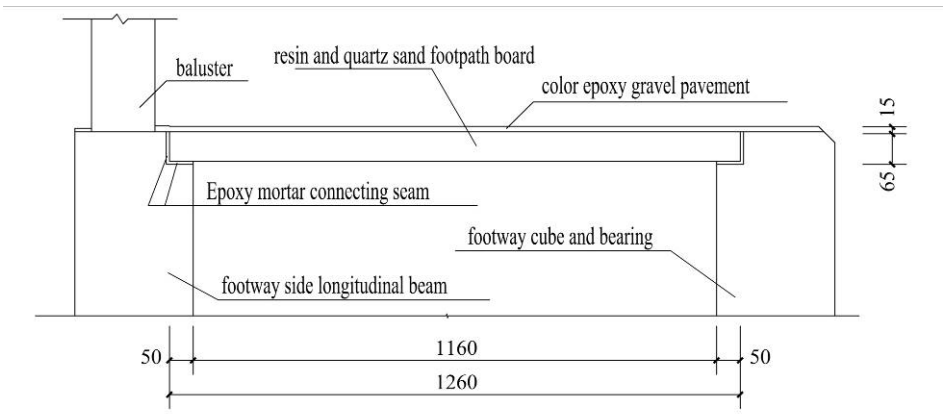

Fig.1 Resin and quartz sand footpath board layout drawing

The colored resin and quartz sand footpath board is the composite structure board which is composed of the colorful resin and quartz sand and FRP tank-shaped, the colored resin and quartz sand

footpath board base plate's thickness is 5mm, the roof's thickness is 4mm, the middle and below of waveform rib stiffener's thickness is 2mm, the above of rib stiffener's thickness is 5mm ,the colored quartz sand's thickness is 5mm, the side board's thickness is 2.5mm, it's structure form is shown in Fig.2.After finishing the erection of structural panel,putting the colored resin and quartz sand paving layer on the top of it.

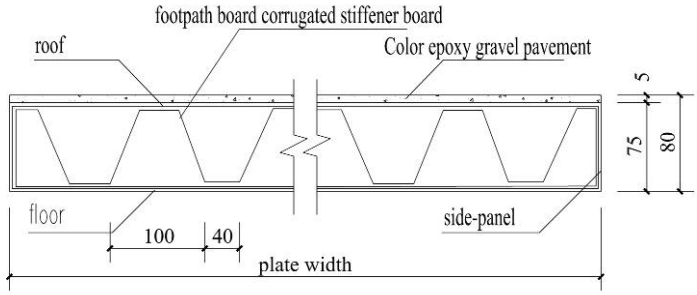

Fig.2 the structure of the resin and quartz sand footpath board

Although the resin and quartz sand has high strength , the elastic modulus is small.Therefore, there is a very important engineering significance to have a study on the resin and quartz sand footpath board which relation of stress, deflection and load have affect on the using.In this paper, using the prototype loading test method, and having a study on the stress and deflection of the colored resin and quartz sand footpath board when it under the design load and overload.The test showed that the colored resin and quartz sand footpath board's stress under panel bottom is small.While under the design load, the mid-span deflection under panel bottom meets the requirements of engineering application.

Experimental Design

Before the test, making a careful overall observation of the resin and quartz sand footpath board , the board is required no cracks, warping or other irregularities, or it can't be used in the experiment.

Loading Device Design. When it is used in the footway structure of the bridge, which should be designed according to the load standard of "General Specifications for Design of Highway Bridges and Culverts" (JTG D60-2015), it's design load is 4.5kN / m2.The loading method is the direct weight loading, the clearance between the weight drop block is 50mm in order to ensure there is no lapping between the weight drop and prevent forming the effect of arch.

The Design of Loading and Loading Program. Whether the test could reflect the actual situation, the test loading and loading program are the key.

Loading Arrangement. The size of weight test cube is 200×200×200mm, each weight is 7.5kg, each layer's load is first order. Load arrangement is shown in Fig.3.

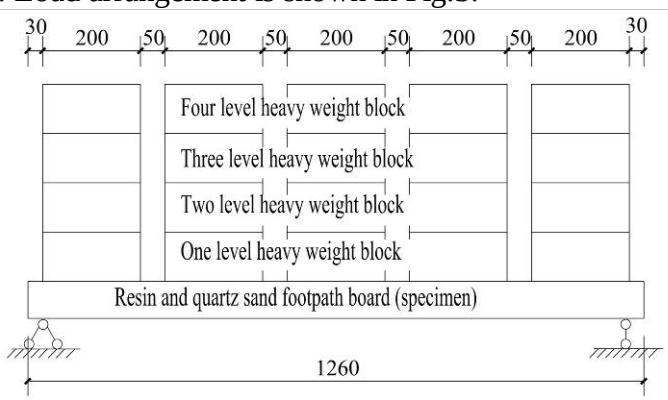

Fig.3 Loading arrangement and loading scheme

Loading Program. Through the design and calculation of the weight drop block, each block will be weighted and rechecked, and control each weight at 7.5kg.Through the calculation, each level load is 1.5kN / m^2 and three level load comes to the design value, in order to test the plastic when footpath board is destroyed, and then increasing a level load, making it to 6kN / m^2. Loading program is shown in Fig.3.

Measurement Content and Instrumentation Arrangement. Under the load levels, the main measurement content are the stress distribution across, mid-span deflection and crack craze status of the footpath board. The strain gauge is put on the upper, middle and lower side of the mid-span board to determining the stress , then calculating the stress. Arranging a mechanical dial indicator which measurement range is 30mm at the bottom of mid-span to measure the beam's deflection under the load levels; then using crack reading microscope to measure the width of crack. Strain gauge and dial indicator arrangement is shown in Fig.3.There is 3-4 minutes between each load level, until the footpath board's deformation is stable ,then collecting the strain and displacement value , and observing the cracking phenomenon.

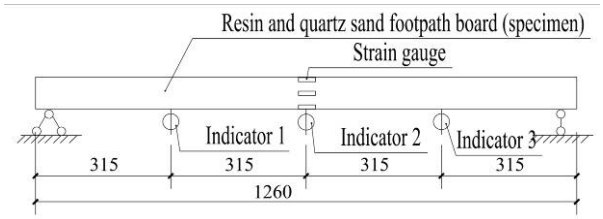

Fig.4 Strain gauge and dial indicator arrangement

Test Results and Analysis

Stress Analysis of Resin and Quartz Sand Footpath Board. According to the experimental data and calculation analysis, the slab top's maximum stress of the three specimens under the design load 4.5KN/M2 is 2.225MPa, and the maximum stress of the three specimens under the action of overload 6KN/M2 is 4.245MPa.When panel bottom under the design load 4.5KN/M2, the maximum stress value of three specimens is 3.110MPa. Under the action of overloaded 6KN/M2, three specimens of the largest stress value is 4.228MPa ,which is much smaller than the ultimate strength of resin and quartz sand footpath board.The experimental data stress value and the average value of the slab top and panel bottom are shown in Table 1, which can be seen from the experimental data, the load and the stress value are basically in linear relationship, consistent with the theoretical formula of the mechanics of materials.

Table 1 the stress value and the average value of the top and bottom of the resin and quartz sand footpath board(MPa)

position	Load (KN/M2)	1#board stress	2#board stress	3#board tress	Average stress
slab top	1.5	-1.021	-1.125	-1.057	-1.068
	3	-2.225	-2.051	-2.004	-2.093
	4.5	-3.125	-2.958	-3.012	-3.032
	6	-4.245	-3.976	-4.072	-4.098
panel bottom	1.5	1.154	1.025	0.994	1.058
	3	2.220	2.145	2.017	2.127
	4.5	3.110	3.012	2.984	3.035
	6	4.228	4.125	3.994	4.116

Deflection Analysis of Resin and Quartz Sand Footpath Board. The experimental data show that under the action of design loads 4.5KN/M2, mid-span measured displacement maximum is 1.90mm. The experimental resin and quartz sand footpath board calculated span is 1200m. 1.90/1200=1/631, less than 1 / 600th and meet the deflection limit value of the specification requirement.Under the action of overload 6KN/M2, the maximum value of the mid-span measured displacement is 3.19mm, The experimental resin and quartz sand footpath board calculated span is 1200m, 3.1/1200=1/376, which is more than 1/600, it is not satisfied. The mid-span deflection of the resin and quartz sand footpath board is shown in Table 2.

Table 2 the mid-span deflection of the resin and quartz sand footpath board (mm)

Position	Load (KN/M2)	1#board deflection	2#board deflection	3#board deflection	Average deflection
Mid-span	1.5	0.67	0.61	0.69	0.66
	3	1.25	1.20	1.31	1.25
	4.5	1.80	1.78	1.90	1.83
	6	3.19	2.99	2.90	3.03

Through the experimental data analysis, the load in less than 4.5KN/M^2, cross deflection increases with the increase of the load on the upper part, and nearly a straight line; but more than 4.5KN/M^2, deflection and load is no longer a linear relationship between the deflection is obvious. The relationship between load and the degree of cross winding is shown in Fig.5.

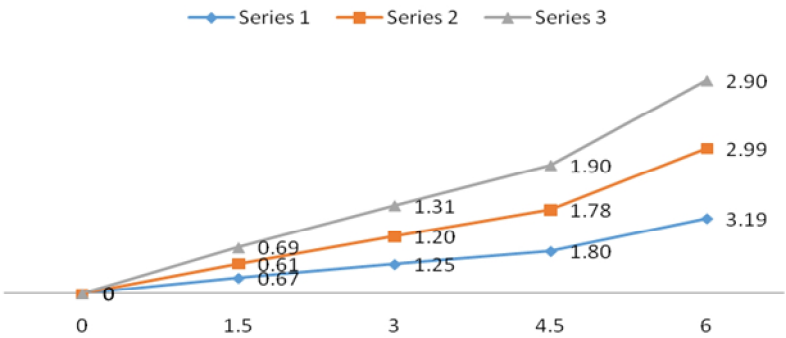

Fig.5 Relationship between load and deflection

Analysis the crack of the resin and quartz sand footpath board. Through the crack reading microscope to observe, there isn't any crack under the action of the design load 4.5KN/M^2 and the overload 6KN/M^2,so,it meets the specification requirements of the crack controlled.

Conclusions

Through the prototype loading test, some conclusions were obtained for the colleagues to reference by research and analysis its stress, deflection and crack.

(1)Resin and quartz sand footpath board in the design load 4.5KN/M^2 and overload 6KN/M^2, the slab top and the panel bottom stress are small, resin and quartz sand footpath board is enough to bear the design load.

(2) The deflection can meet the requirement under the action of design load 4.5KN/M^2.

(3)Under the action of the design load 4.5KN/M^2 and the overload 6KN/M^2, the crack of the resin and quartz sand footpath board is in the control range.

In summary, through the experimental study of mechanical properties, the properties of the resin quartz sand footpath board can be used in bridge engineering, but its deflection is the main control parameter.

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