DYNAMIC STRESS EXPERIMENTAL STUDY ON ASYMMETRIC BEAM TO COLUMN CONNECTION STRUCTURE

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Summary The port structure consisting of spur pile, vertical pile and beam is subjected to impact loads, so its internal stress state of each point will rapidly change over time. Dynamic photoelastic method is used to study the dynamic stress and stress wave propagation. With epoxy resin and other materials, a photoelastic model of beam to column connection structure is processed and product. The dynamic response of the model under the impact load by the free fall is researched by the dynamic photoelastic method, and recorded by the new digital dynamic photoelastic system with a laser source and high-speed photography system. The internal dynamic stress propagation and distribution, the maximum shear stress and the dynamic stress concentration problems can be obtained by analyzing the dynamic response. Researching on the key part under impact load using dynamic photoelastic method can furnish the experimental evidence of transient stress phenomenon for theoretical research and engineering applications.

INTRODUCTION

Ports in the process of using bear both static loading and dynamic loading, so stress distribution is very complex, particularly dynamic load effect, the stress distribution and stress concentration changes as time changes [1]. Asymmetric beam to column connection structures consisting of straight column, oblique column and beam mainly is subjected to impact loads [2].

Dynamic photoelastic method is one effective method to analysis structures under impact loads and dynamic stress. In 1920s, Frocht from the USA and Tuzi.Z from Japan begin to study on dynamic photoelastic method, because of the shooting conditions, they captured only component photoelastic fringes in slow loading process. Subsequently, Senior [3],Dally, and Link [4][5][6] and Riely, as well as Fang Ruhua, Zhang Linchun [7], Song Jinliang [8][9], Lu Yusheng, and Lian Zhiying contribute to dynamic photoelastic experiment and other significant contribution to the development and improvement of the instruments and equipment.

As high-speed photography and image processing software development, the new-type dynamic photoelastic system was successful developed. It was composed of the improved traditional dynamic photoelastic test device, high-speed photography system and digital image processing system, and overcome the deficiencies of multiple-spark so that the stress wave can be observed continuously and real-time [10][11][12].

DYNAMIC PHOTOELASTIC TEST PRINCIPLE

The stress rapidly deliverys on the object under impact load, and its extension is an important indicator of dynamic features. The theoretical base of dynamic photoelastic is the use of temporary birefringence phenomenon of photoelastic material, and the stress-optical law to provide the information of stress waves though the polarized optical-field.

The dynamic stress-optical law is expressed as

$$\sigma_1(t) - \sigma_2(t) = \frac{N(t) f_{\sigma d}}{d} \qquad (1)$$

N is the fringe series at one moment; d is the thickness of the model; $f_{\sigma d}$ is the material dynamic stress fringe value; σ_1, σ_2 , N are function of time. The isochromatic fringes can be obtained in circular polarized optical-field when the model is under the impact load.

DYNAMIC PHOTOELASTIC EXPERIMENT AND RESULTANALYSIS

In the plane polarized optical-field (shown in figure 1) of the dynamic photoelastic experiment, it is circular polarized optical-field (shown in figure 2) out of the two venetian blinds. Based on the test principle, the dynamic photoelastic experiment under the impact load is taken place on the circular polarized optical-field.

By analysis of a port structure sectional drawing (Figure 3), the model structure can be simplified and photoelastic experiment model will be product .After uniformly distributed impact load in the middle of the model, dynamic photoelastic isochromatic fringes are (Figure 4) collected and dynamic stress changes (Figure 5) of four connections, also stress concentration points, can be get by analyzing the dynamic photoelastic isochromatic fringes and applying the formula (1).

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In Figure 5, dynamic stress changes can be analyzed visually.

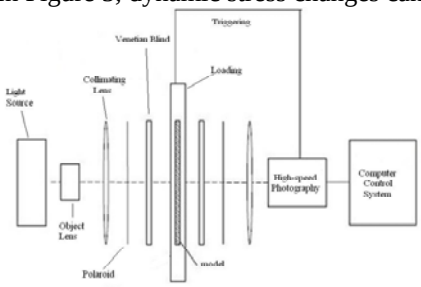

Fig.1 optical path

Fig.2 new-type dynamic photoelastic system

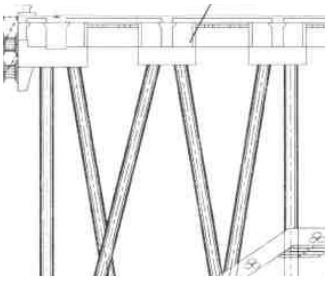

Fig.3 Port structures section sketch

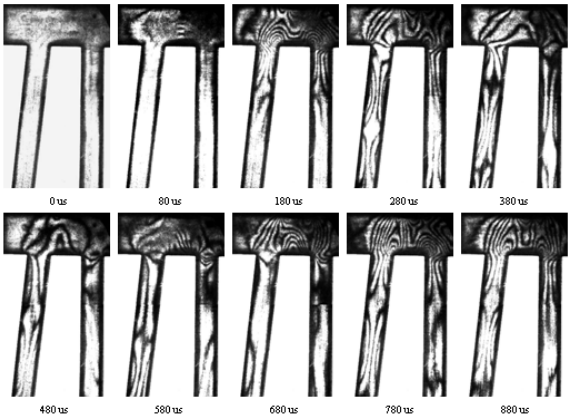

Fig.4 Dynamic photoelastic isochromatic fringes

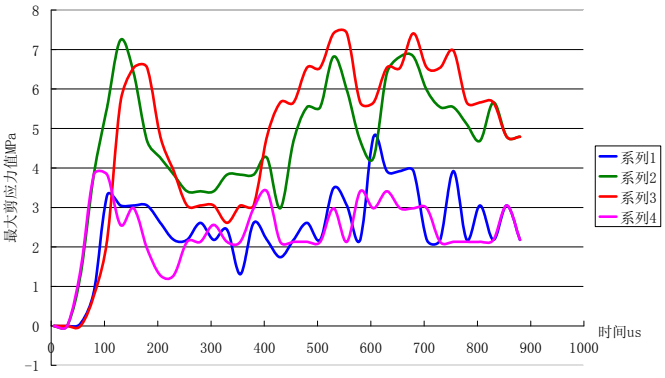

Fig.5 Dynamic stress changes of stress concentration site

CONCLUSIONS

With epoxy resin and other materials, a photoelastic model of beam to column connection structure is processed and product. The dynamic response of the model under the impact load by the free fall is researched by the dynamic photoelastic method, and recorded by the new digital dynamic photoelastic system with a laser source and high-speed photography system. The internal dynamic stress propagation and distribution, the maximum shear stress and the dynamic stress concentration problems can be obtained by analyzing the dynamic response.

Further, dynamic stress situations of different tilt angles and symmetry structure can be analyzed, so reasonable proposals can be made for structural design.

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