The investigation and study of the damages of simple supported beam bridge in the Wenchuan earthquake

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Abstract. Wenchuan earthquake causes a lot of d bridges damaged, and brings a lot of difficulties to the rescue work. In all of the damaged bridges, the simply supported beam bridge accounts for a large part. At the same time, all these years, earthquake disaster frequently occurs. Through investigating the damage of the simply supported beam bridge in the Wenchuan earthquake, it can get its aseismic measures for the design and construction.

Keywords: Simple supported Beam Bridge; damages; aseismic measures; Wenchuan earthquake.

1. Introduction

With the continuous development of Chinese transportation, bridge has made great progress, such as cable-stayed bridge, continuous rigid frame bridge, suspension bridge and so on. However, whether it is the Highway Bridge or Railway Bridge, among the medium and small span bridge, the simple supported beam bridge occupies a dominant position. With its simple structure, clear force, convenient construction, the quality and other advantages, it is widely used in the construction of highway and railway. And it becomes the first choice of small and medium span bridge type. After the Wenchuan earthquake in 2008, the Ministry of transport organized some design institutes to investigate and detect the damage of bridges in the heavy disaster area. In this survey, there are 1657 bridges which has been checked in the Sichuan area. Among them, the simple supported beam bridge accounts for 80.68%; In Gansu Province, the simple supported beam bridge accounts for 62.28%, and its number is 71; in Shanxi Province, there are 149 bridges which has been investigated, and 59.06% is the simple supported beam bridge. In the construction of bridge, the simple supported beam bridge is the maximum number among various bridge types in our country. So, it is the kind of bridge type with the most damage in the earthquake. Therefore, it is very important to s the simple supported beam bridge.

2. The structure characteristics of simply supported beam bridge

According to the construction technology, the simply supported beam bridge is divided into the overall style and assembly style. The overall style has the advantages that its lateral stiffness is large and its stability is good. Due to the constraint of device lifting capacity, the overall style is generally applicable to cast-in-situ. The precast beam is widely used at present. According to its cross section forms, it can be divided into the Slab Bridge, ribbed beam bridge and box Girder Bridge. The common form is that: put rubber plinths on the bent cap for supporting the superstructure which is composed of the pre-stressed concrete T beam (or plate, H-shaped etc.) and bridge deck. The foundation is the spread foundation or pile foundation.

In the structure, the simply supported beam bridge is the bridge that consists of a beam which respectively are supported on a movable support and a hinged support beam, which belongs to the static structure. The beam is directly put on the rubber plinths, without any fixed measures. Normally, the bridge does not have rigid body displacement, and in the condition of internal force, the deformation is free. Therefore, it doesn't has additional internal force. The internal force of this kind of bridge will not change with the foundation deformation or the temperature change.

3. The earthquake damage of simply supported beam bridge in the Wenchuan earthquake

When the Wenchuan earthquake happens, the superstructure of simply supported beam bridge is mainly affected by the earthquake force from the bridge pier and bridge abutment. And, through the rubber plinths, the force of superstructure returns to the bridge pier and bridge abutment. In this process, the main girder of superstructure emerges displacement and deflection. When the displacement is too large, it may lead to the collision between the adjacent girders. Thus, it will have a strong impact on the link stopper, bridge pier and bridge abutment. Finally, it brings the various forms of damage of bridge. In the Wenchuan earthquake, the damage of simply supported beam bridge mainly concentrates in the follows.

Fig 1. The damage of lowering of girder

Fig 2. The damage of bridge pier

Fig 3. The damage of bridge abutment

Fig 4. The damage of rubber plinth

4. The aseismic measures of simply supported beam bridge

Ductility design of bridge piers should be fully considered, and it should use diameter greater than 12 mm as the stirrups with HRB400 reinforced bar. The stirrup is encrypted, so as to ensure the sufficient rate of stirrup. And it ensures that there is sufficient constraint on the core concrete. In addition to the stirrups, there also must be enough lacing wires between the main reinforcements in order to strengthen the constraint effect on concrete.

The joint of reinforcing steel bar is relatively weak for the bridge pier. And this part is easy to break when the earthquake occurs. The lap joint of main reinforcements should be of sufficient length to avoid emerging the weak form.

Bent pier beam should be set to prevent the strong beam weak column effect, and ensure that the first plastic hinge in beam instead of pier.

Bridge bearing bears the superstructure and piers, and column plays an important role in connecting and transferring the stress and deformation, and it is the weak link of the bridge seismic damage examples. In the past, bearing damage is relatively common, and the collision of adjacent girders and beams, longitudinal and transverse displacement, most are based on the bearing failure the preamble. In general, the cause of bearing damage which supports in the earthquake effect of stress is complex, and the design does not fully consider the seismic requirements. The retaining structure measures are inadequate, and the support material defects and the form are also the cause of bearing failure. For the earthquake zone bridge, the bearing quality will effectively reduce the lower ductility demand, and improve the safety of the bridge.

Increase the width of the pier cap beam to increase the support length of beam, which increases the support length of beam, and it can effectively avoid the upper structure in the earthquake ended beam. At the same time, falling device can avoid falling bridge design and construction of waterproofing good, such as adding restrainer, additional beam shear blocks on both sides and strengthening the anti-earthquake block.

Seismic block should be avoided for seismic design, the design and construction of randomness, and in the main beam and block set pieces of wood, rubber cushion block buffer device should be between blocks, in order to reduce the impact of main girder.

5. Summary

With the highway and construction of high-speed railway, the simply supported beam as the main bridge. Although the structure is simple, its seismic capacity is weak, and the safety reserve is low. Once the larger earthquake occurs, it easily lead to a large area of the traffic disruption. At the same time, in recent years, the earthquakes disasters often happen in the whole world. Therefore, the research about the seismic of simply supported beam bridge has a very good practical significance.

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