Academic Journal of Science and Technology
ISSN: 2771-3032 | Vol. 5, No. 2, 2023

Principle and Application Prospects of Buckling Restrained Brace

Zihao Wei, Xiaosheng Song, Ruixiang Guo

School of North China University of Science and Technology, Hebei, 063000, China

Abstract: Buckling restrained brace, as a new type of support, has the dual characteristics of support and energy consumption, first explains its composition and working principle, and then briefly describes the current status and application and prospects of domestic and foreign research.

Keywords: Buckling restrained brace, Energy consumption, Principle, Engineering Applications.

1. Introduction

A new type of energy-consuming shock absorption device ----buckling restrained brace is gradually entering the public's field of vision and is continuously improved. The excellent ductility of steel is used as a core material to consume earthquake energy. Make it flexed but does not yield, repeated flexion and deformation of the earthquake medium -sized material in the pull pressure, so as to consume the earthquake energy.

2. Constitute and Principles of Buckling Restrained Brace

2.1. Constitute of buckling restrained brace

The prototype supported by the buckling restrained brace was first proposed by Japanese scholar Yoshino [1] that he proposed the idea of embedded steel plates in the steel concrete shear wall, using steel concrete walls to limit the flexion of steel plates. After continuous in -depth research, Wakabayashi [2] proposed to bury a font steel plate in the concrete, verify that the intensity of outsourcing concrete has an important impact on the stagnation performance of support, and proposed the concept of anti -flexion support.

Ordinary BRB is shown in Figure 1. The anti-flexion support consists of kernel, peripheral constraint components, and non-adhesive expansion materials. At present, there are many design forms of anti-flexion support on the market, but the basic principles are the same.

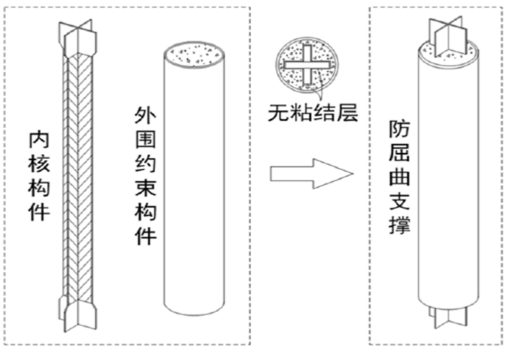

Figure 1. General anti -flexion support composition diagram

The kernel components are welded components, and the kernel units can be divided into three parts: restrained yield segment (core section), constraint non-yield segment (transition section), and non-restrained non-yield segment (connected section), as shown in Figure 2. The constraint and surrender section requires to yield under the action of repeated loads, and adopts steel with low yield points, good toughness, and high extension performance. The constraint non -yield segment is the extension of the core material. It is the key to the elastic work of the connection section and it will not break. Generally, it is guaranteed by increasing the section size and cross -section width. Non -restrained non -yield segments are walls and anti -flexion -supported connections, which can be used. The peripheral constraint component mainly limits the core segment deformation, so that the component has the effect of yielding but not flexing. It is characterized by preventing components from reducing the bearing capacity due to loss of stability.

No adhesive expansion materials are generally fitted on the kernel component, and silicone, polyethylene, rubber, latex, etc. are generally used. It can effectively reduce or eliminate the shear between the core material and filling mortar, while avoiding corrosion of the mortar. Outsourcing constraints generally use steel pipes, but with the promotion and application of fiber enhancement composite materials, fibrous materials are more and more widely used in outsourcing constraints. In addition, a certain gap needs to be left between filling the mortar and the core material. If the contact with the core material and the mortar will greatly increase the compressive bearing capacity of the core material, but the gap will reduce the low -cycle fatigue life of the yield segment.

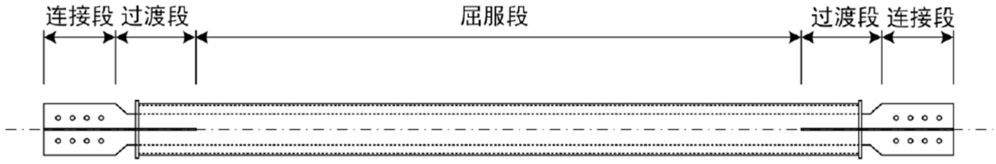

Figure 2. Ordinary anti -flexion support vertical composition diagram

2.2. Principles of buckling restrained brace

BRB does not cause flexion when the load is loaded, and it can provide a stable side stiffness to prevent overall excessive deformation. In addition, in the role of earthquakes, anti-flexion support will take the lead in entering the yield state, yielding but not flexing, consume the energy of the earthquake while reducing the impact of the earthquake on the overall structure, as shown in Figure 3.

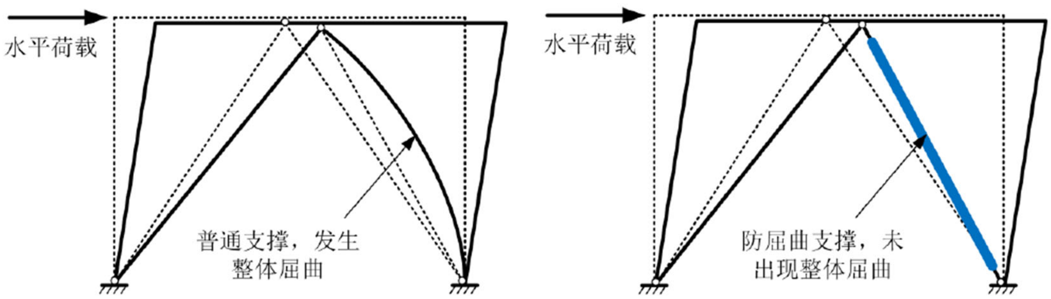

Figure 3. General support and anti -flexion support

BRB is a device that can be succumbed to all section under pressure and pulling. This feature allows it to effectively consume seismic energy while improving the anti -side stiffness. As shown in Figure 4 below, after a reasonable design anti-flexion support, a certain horizontal deformation will be generated in across when the axis force is applied to show a first-order mode. As the axial force continues to increase, the cross -medium protruding part of the core material first contacts the inner wall of the peripheral constraint component, and then the contact point is expanded to the face. Due to the constraints of the exterior opposite side displacement, the contact point is over a little to two points. The axial force continues to increase, the contact area continues to increase, and the contact point continues to increase. The flexion modulus has changed to a higher -order modal. Finally, it reaches full cross -section yield to form multiple waves of flexion.

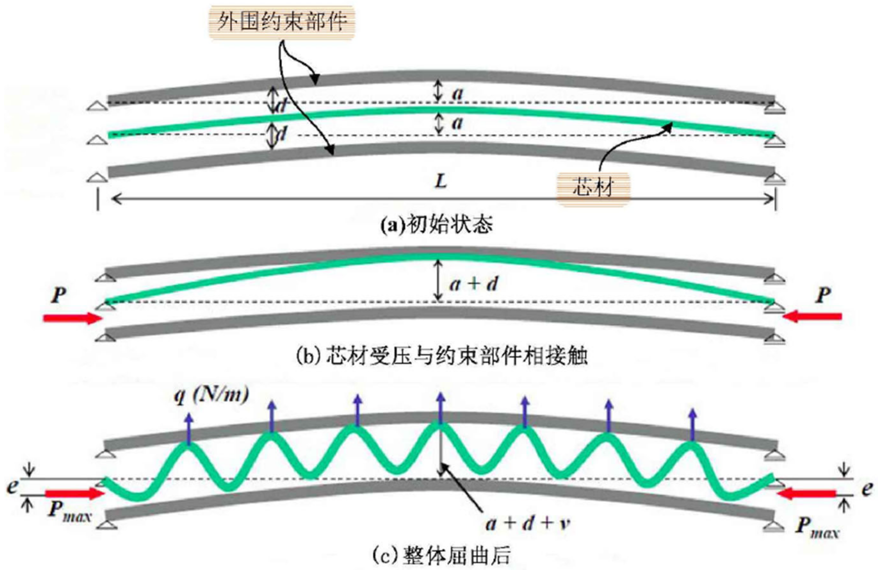

Figure 4. Principles of buckling restrained brace

2. Status of research at home and abroad

In 2011, Mille [3] proposed a BRB, which was composed of pre -pulled hyper elastic memory alloy sticks and ordinary BRB, and improved the numerical model of this support through experiments.

In 2012, Mao Yukun [4] studied the specifications of BRB connection nodes in the design specifications of many countries, and analyzed the related parameters of the anti -flexion support bearing capacity.

In the same year, Lin [5] analyzed the anti -seismic resistance of BRB in the frame structure. Test verification of BRB not only had good seismic resistance, but also had good energy consumption performance.

In 2013, Lu Binbin [6] supported the outer parcel of Xuanwan fiber cloth in the prefabricated BRB Through four groups of experiments, the anti -flexion support in the four groups of experiments can meet the requirements of the carrying capacity, energy consumption, and delay. Multi -wave flexion occurs, and the test has achieved good results.

In 2016, BAI [7] designed a set of performance -based plastic design methods, and verified its correctness by configuring the BRB on the 5th and 10 -layer framework.

In the same year, Fu Zhengping [8] experimented with the combination of carbon fiber reinforcement and steel combination as a BRB inner core. Experiments showed that when the peripheral constraints were strongly constrained, the inner core showed good shock resistance.

In 2017, Ozcelik [9] introduced the test of the new BRB, with new types of end -end constraints and outsourcing constraints. In the test of ten new BRB support, some of the restricted BRB have good energy consumption performance.

In the same year, Chunlin Wang [10] developed a new type of bamboo -style BRB. This support has good energy consumption capabilities, but there are many technical problems to be resolved.

In 2019, Zhou Peng [11] proposed two BRBs, rigid truss and cable truss constraint BRB. Both new BRBs can effectively restrain kernel flexion deformation to improve their carrying capacity and stagnation performance.

In 2020, Sun Hongpeng [12] Designed a BRB with the GFRP tube as outsourcing, and designed the steel pipe concrete framework-anti-flexion support structure system. The experimental results show that the GFRP tube anti-flexion support can effectively reduce the earthquake response, and the structure system can obviously obviously obviously Reduce the vertex displacement of the base shear and the large boiler tower.

In the same year, QU [13] has a conclusion that BRB has a greater conclusion on the impact of BRB dynamic loading research on the stagnation performance of BRB.

In 2022, Xie Mingmei et al. [14] proposed a kind of anti -flexion support for classification. Use the finite element software to establish a hierarchical yield anti -flexion support and ordinary anti -flexion support for analysis and comparison. The hierarchical yield -type anti -flexion supports the stagnation curve is fuller and can better consume earthquake energy.

In the same year, yang [15] promoted the energy requirements of anti -flexion support at different layers and different positions, and proposed new quantitative factors to verify on the prototype model supported by the 5th layer of anti -flexion support. The result shows that the method is reasonable. Accurately estimate the demand for BRB.

3. Application and Prospect

BRB was first proposed by Japanese scholars. After continuous development of Japan, the United States, Taiwan, and mainland China, it has been widely used in the actual architectural structure.

Since Japan has been experimenting and commercial research on BRB. Since the 1994 North Ridge earthquake, the United States has increased the experiments and research on BRB, and at the same time, the building has also increased the use of BRB.

Taiwan's research and application of BRB are at a high level. Taichung Guotai International Building, Taipei Guandu Tzu Chi Ai TV Station, etc. In the reinforcement or new buildings, there are a lot of BRB applications.

BRB in mainland China is gradually applied to buildings. The main tower of Beijing Intime Center and an office building in Gubei in Shanghai have increased a large number of buildings with anti -flexion support design in recent years. The design and construction skills of BRB have been greatly improved.

In terms of energy consumption, there is a lot of demand for ordinary residents' housing, and the large -scale structure and a large number of high -rise buildings have a lot of demand for structural earthquake resistance. Increasing traditional support, increasing earthquake resistance not only affects the beauty of the building, but isted a large number of manpower. Propaganda, BRB is not only high in spatial utilization, but also better shock resistance than traditional support.

4. Disadvantages and Insurance

1. There is still a lot of space for buckling restrained brace engineering applications. At this stage, the buckling restrained brace scientific research progress has gradually deepened. Pay attention to the integration of academic research and practical applications.

2. At this stage, the buckling restrained brace of commercialization is majority, limiting problems such as venue and service life, and a new type of new type of light -quality high -strength anti -flexion should be developed.

References

[1] Yoshino T K Y E A. Experimental Study on Shear Wall with Braces (Part2) [C] Summaries of Technical Papers of Annual Meeting, Architectural Institute of Japan,1971.403-404.

[2] Wakabayashi M, Nakamura T. Experimental study of elasto-plastic properties of precast concrete wall panels with built-in insulating braces [C] Summaries of Technical Papers of Annual Meeting. Architectural Institute of Japan 1973; 1041-1044.

[3] Miller D J, Fahnestock L A, Eatherton M R. Self-Centering Buckling-Restrained Braces for Advanced Seismic Performance[C]. Proceedings of the 2011 Structures Congress, 2011: 960-970.

[4] Maoyukun, Super strength coefficient of buckling restrained braces[J] shanxi architecture, 2014, 40 (13): 49-50

[5] Lin P C， Tsai K， Wang K J， et al. Seismic Design and Hybrid Tests of a Full-scale Three-story Buckling-Restrained Braced Frame Using Welded End Connections and Thin Profile[J]. Earthquake Engineering and Structural Dynamics, 2012 (41) :1001-1020 .

[6] Lubinbin, Study on the performance of buckling-restrained brace wrapped with carbon fiber and basalt fiber[D] harbin polytechnic institute, 2013.

[7] Bai J L, Ou J P. Earthquake-resistant Design of Buckling-restrained Braced RC Moment Frames Using Performance-based Plastic Design Method[J]. Engineering Structures, 2016 (107): 66-79.

[8] Fuzhengping, Study on the performance of new FRP-steel composite core buckling-restrained brace[D], Southeast University, 2016.

[9] Ozcelik R, Dikiciasik Y, Erdil E, et al. The development of the buckling restrained braceswith new end restrains [J]. Constructional Steel Research，2017(138) : 208-220.

[10] WANG C. L., ZHOU L., et al. Developing A New Bamboo-Shape Buckling-Restrained Brace [C]// 16th World Conference on Earthquake (16WCEE 2017), Santiago, Chile, January 2017, Paper No. 4018.

[11] Liwufeng, Study on the stability of FRP wrapped concrete filled circular steel tube buckling restrained brace[D], Harbin Institute of Technology, 2018.

[12] Zhoupeng, Design theory and experimental study of truss restrained buckling restrained braces[D], Harbin Institute of Technology, 2018.

[13] Qu Z, Xie J Z, Cao Y T, et al. Effects of Strain Rate on the Hysteretic Behavior of Buckling-Restrained Braces[J]. Structure Eng., ASCE, 2020, 146(1): 06019003.

[14] Xiemingmei, Seismic performance of graded yielding buckling-restrained brace frame structure[J], chinese sciential and technical theses, 2022,17(08):879-886.

[15] Yang T.Y. et al. Quantification of energy dissipation demand for buckling-restrained braces[J]. Soil Dynamics and Earthquake Engineering 2022, 155.