Study on Resilience Model for Seismic Wall of New Assembly

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Abstract: In the situation of an earthquake disaster, ordinary wall will be difficult to withstand a wide range of shaking, prone to collapse, and its resilience is very poor. For this purpose, the study on resilience model for seismic wall of new assembly is carried out. According to the initial theoretical stiffness expression and the different arrangement of bars and the vertical connection method, the initial stiffness is modified. On the basis of the theory of elasticity, the summit load of seismic wall and the bending load capacity of the wall are analyzed so as to build the resilience model. And the seismic wall and the unloading rules are studied, that the situation of an earthquake can be carried out by plastoplastic analysis with the use of resilience model for seismic wall of new assembly.

Keywords: New assembly; Seismic wall; Resilience; Model

1. Introduction

The structure of shear wall has the advantages of good quality, fast construction speed, skillful emission reduction and so on, which is widely used in the residential industry, the promotion of such structure can provide some technical support to the construction. With the continuous enhancement of the technology, the ecological composite structure can be combined with the shear wall, so that the resistance of the wall increased [1]. In the situation of an earthquake disaster, ordinary wall will be difficult to withstand a wide range of shaking, prone to collapse, and its resilience is very poor, which is difficult to meet people's demand for strong seismic resistance. For this purpose, the study on resilience model for seismic wall of new assembly is carried out. According to the initial theoretical stiffness expression and the different arrangement of bars and the vertical connection method, the initial stiffness is modified. On the basis of the theory of elasticity, the summit load of seismic wall and the bending load capacity of the wall are analyzed so as to build the resilience model. The resilience model can be used to analyze the earthquake situation and ensure the safety of people. It provides a powerful supporting means for the future plastoplastic analysis of the wall.

2. Resilience Model for Seismic Wall of New Assembly

The seismic wall of new assembly is greatly different from the ordinary wall on both the force strength and the broken form. In the situation of an earthquake disaster, ordinary wall will be difficult to withstand a wide range of shaking [2], prone to collapse [3], and its resilience is very poor. The seismic wall of new assembly is often used in the most vulnerable bottom of the frame structure; this set can improve the firmness of the bottom, so the resilience model is carried out.

2.1. Calculation of stiffness of seismic wall

2.1.1. Initial stiffness correction

The seismic wall of new assembly is mainly for the suspension-type interface, according to the principle of material mechanics, the initial theoretical stiffness of seismic wall in the vertex horizontal direction can be expressed as:

$$f = \frac{1}{\frac{h}{2Em} + \frac{kh}{PS}} \tag{1}$$

In the formula (1): f is the initial theoretical stiffness; h is the height of the seismic wall; m is the section inertia of the seismic wall; S is the area of the section; E is the elastic modulus of the wall material; P is the shear modulus of wall material which is 0.3E; k is the unbalance coefficient of the section shear, which is 1.5.

The seismic wall of new assembly improves the stiffness of ordinary walls in the structure, so in the wall stiffness calculation, the formula (1) should be amended. By analyzing the influence of different steel bars arrangement and vertical connection on the resistance of seismic wall, and studying the important parameters such as axial compression ratio, shear span ratio and reinforcement ratio, and so on [4], the amended formula can be obtained as follows:

$$f' = \frac{ab}{c\left(\frac{h^2}{2Em} + \frac{kh}{PS}\right)} \tag{2}$$

In the formula (2): a is the coefficient of axial compression ratio, shear span ratio, reinforcement ratio and other important parameters influence the resistance stiffness. b is the coefficient of the influence of the vertical connection on the resistance of the seismic wall. If the welding work is carried out with the welding plate, b is a constant 1; if it is connected with the slurry, b is 0.85. c is the coefficient of the influence of the different steel bars arrangement on the resistance of the seismic wall. If it is well-distributed, c is a constant 1; if the distribution is intersecting parallels, then c is 1.25; if the distribution enclosure of a shape, then c is 1.3.

2.1.2. Determine the stiffness at different stages

Determining the stiffness at different stages of the seismic wall with the secant stiffness, of which value depends on the ratio of the average value of the push-pull load to the average of the displacement in both directions, as shown in equation (3)

$$f_n = \frac{|+F_n| + |-F_n|}{|+G_n| + |-G_n|} \tag{3}$$

In the formula: $+F_n$ is the maximum value of the load bearing in the n-th positive direction, $+G_n$ is the corresponding displacement; $-F_n$ is the maximum value of the load bearing in the n-th negative direction, and $-G_n$ is the corresponding displacement. The stiffness at different stages can be calculated, the results are shown in Table 1.

Table 1. Determination Results of Stiffness at Different Stages

Stage Number	Initial Stiffness	Reduced Stiffness	Pre-yield Stiffness	Post-yield Stiffness	Descent Stiffness
1	102.29	89.36	50.69	20.81	-19.12
2	101.14	80.59	48.72	19.35	-11.39
3	99.87	76.38	43.25	13.86	-20.15
4	92.85	70.23	30.19	8.15	-22.58

2.2. Peak load analysis of seismic wall

According to the skeleton of seismic wall, it can be seen that the wall is basically elastic when it is cracked, so the peak load of seismic wall can be analyzed by elasticity theory. Although the overall connection performance between the vertical edge structure and the wallboard is good, welding with welding plate can make the vertical stress effectively transmitted. However, there are always problems that connected with the outside world, such as for the connection with the slurry layer patchwork, and the connection with the cast-edge, etc., making the seismic wall damaged by the concrete in the seams due to the existence problem, resulting in uneven force, bearing capacity overload, and damaging the structure to a certain extent. Therefore, it is necessary to analyze the bending load capacity of the wall. The bending load capacity coefficient is up to the vertical connection mode of the wall board, and the vertical stress can be effectively transmitted by the embedded welding plate, and the shear resistance is better than that of the ordinary wall. The embedded welding plate is located at the center of the wall and the bottom of the beam, the distance between the center and the neutral axis is close, and the bending load capacity is low. If the position of the embedded welding plate is placed outside the wall panel, the distance between the outside bars and neutral axis is relatively far, the bearing capacity is strengthened, and the cooperativity built by the edge constraint is better, and the bearing capacity of the seismic wall is improved.

2.3. Loading and unloading rules of seismic wall

The loading and unloading rules of seismic wall can better reflect the wall structure and parameter degradation, but also the key part of the construction of resilience model, as shown in Figure 1.

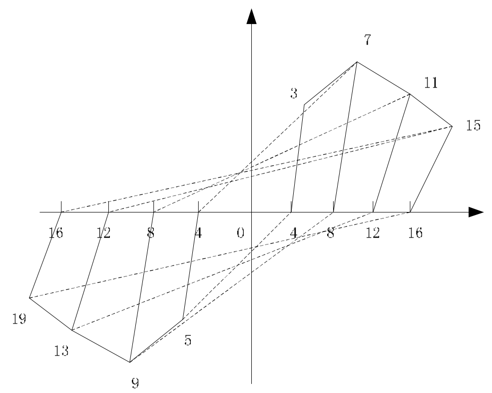

Figure 1. Resilience model

The loading and unloading rules of seismic wall include:
When the wall load is loading to the crack load 3 points, the seismic performance is in the elastic phase and the degradation stiffness is not taken into account. The stiffness value before wall cracking depends on the loading stiffness, unloading stiffness and reverse loading stiffness. When the loading load is more than 3 points but not yet reached 7 points, its stiffness depends on the pre-yield stiffness; when unloading load points to 5, the unloading stiffness value is similar to the stiffness before cracking; for reverse loading, its reverse yield point is 7, then 7 points for reverse unloading.
When the loading load is more than 7 points but not yet reached 11 points, its stiffness depends on the post-yield stiffness; when unloading load points to 9, the unloading stiffness is approximately the post-yield stiffness; for reverse loading, due to the impact of degradation parameters that the structure is changed, then the reverse yield points from 9 to 7, and reverse unloading.

When the loading load is more than 11, its stiffness depends on the stiffness after descent. When unloading load points to 9, the unloading stiffness is approximately the reduced stiffness.

When the peak of loading load exceeds 80%, the displacement resilience model will reach the ultimate limit.

3. Conclusion

According to the basic manufacturing principle of seismic wall, a resilience model for seismic wall of new assembly is put forward. According to the calculation formula of stiffness at different stages, the distribution method can be obtained, which makes the distribution of cracks more uniform and ductility stronger. The use of embedded welding plate can ensure the effective connection between the upper and lower wall panels to achieve a reasonable distribution of vertical distribution stress. The stiffness loading of the wall at different stages are analyzed so as to put forward loading and unloading rules. The seismic wall of new assembly can meet the needs of the general structure, even in the repeated horizontal and vertical load it can also play their own elastic performance, and enhance the seismic rigidity.

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