International Journal of Multidisciplinary Research and Development
Online ISSN: 2349-4182, Print ISSN: 2349-5979, Impact Factor: RJIF 5.72
www.allsubjectjournal.com
Volume 3; Issue 10; October 2016; Page No. 30-33

Survey on engineering structure reinforcing method

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Abstract
Structure reinforcing is a heavy job. Influenced by the natural environment and application environment for a long time, the functions of the desolated building are to be weakened gradually. So the structure reinforcing becomes necessary. Through reading the large amounts of data, there search reinforcing method that such as concrete masonry and steel structure etc. Shear and compressive properties and application results of the engineering were summarized the current reinforcement technology's advantages and disadvantages were analyzed the direction of future research was put forward and provide reference for related research.

Keywords: engineering structure; structure reinforcing; reinforcing method

1. Introduction
A large number of buildings, bridges and other engineering structures need strengthened and repair due to the aging of material environment erosion and other natural factors [2, 15], design error, construction error, shoddy work or poor quality *et al* for negligence, collision or fire, to improve the effects of earthquakes, war and other disasters, as well as the design specification, such reasons as to improve security reserve [4, 7].

2. Method for strengthening concrete structure
2.1 Direct reinforcement
2.1.1 Enlarging section reinforcement method
When the reinforced concrete component itself cannot meet the requirements of normal use or bearing capacity, it is necessary to strengthen the reinforced concrete members. The reinforcement method of increasing the original structure section is to enlarge the original structure section or increase the reinforcement of the original structural member. The bearing capacity of the normal section of the concrete flexural member increases with the increase of the area and the strength of the reinforcement within limits. In the case that the reinforcement ratio of the normal section of the original member is not too high, increasing the area of the main reinforcement can effectively improve the bending bearing capacity of the normal section of the original member [5].
The construction technology of simple adaptability is strong, and has a mature design and construction experience; applicable to beams, plates, columns, walls and the general structure of concrete and reinforcement; but the construction site wet operating time is long, for production and life have certain influence and after reinforcing the building clearance has certain reduction.

2.1.2 Replacement concrete reinforcement method
The advantages of the method is similar to the method of increase in section, and reinforcement does not affect the building of clearance. However, there are some disadvantages of the long construction time, which is suitable for the reinforcement of concrete bearing member, such as beams, columns and so on, which are low or seriously deficient in compressive area [12].

2.1.3 Outsourcing steel reinforcement method
Outer steel reinforcement is the steel or steel plate in the reinforcement of the outside, can be divided into two types of wet and dry. Dry outer clad steel Reinforcing method is that the steel is directly wrapped around the strengthened member and there is no connection between the steel and the component. Wet encased steel strengthening method is divided into two: one using epoxy resin chemical grouting or latex cement slurry paste and other methods, the type steel reinforced member is bonded into a whole; another is steel reinforced a certain distance is left between the components, middle pouring concrete is actually a steel encased and concrete combining the composite reinforcement method [6].
The method also known as wet encased steel strengthening method, the stress is reliable, simple construction, on-site workload is smaller, but used steel quantity larger, and should not be used where no protection is used for more than 60 for more than 60℃ place; for in use are not allowed to significantly increase the original component section size, but asked to greatly improve the bearing capacity of concrete structure reinforcement.

2.1.4 Steel reinforcement method
Reinforced concrete under flexural members of externally bonded steel strengthening method is in the component bearing capacity is insufficient section (flexural tensile zone, is the compressed region of the cross section and oblique section) surface with a special building structure glue plate, which can improve bearing capacity of strengthened component. External sticking steel reinforcement method, reinforcement steel anchoring crucial must ensure that the plate in the pull off before does not occur and degumming bond failure.
The method is simple in construction, fast, site no wet work or only plaster, etc. a few wet operation, little influence on production and life and reinforcement to the appearance of the original structure of clearance and no significant effect, but the reinforcement effect in a great extent depends on glue to craft and the operational level; applicable to bearing static load and in the normal humidity environment of bending or tension member reinforcement.

2.1.5 Reinforcing method of fiber reinforced plastics

Outside the fiber reinforcement is the fiber reinforced composite material affixed to the reinforced component of the tensile region. The fiber reinforced composite material can be used in the shear zone of the component, and is adhered to the outer surface of the strengthened member, affixed to the component of the outer surface of the reinforced and make it reinforced section to work together, to improve the structure of the bearing capacity of the objective.

The method in addition to have the similar advantages of the sticking steel plate, but also has the resistance to rot turbidity, resistant to moisture, almost does not increase the weight of the structure, durable, maintenance costs low, but need to special fire protection processing, applicable in a variety of mechanical properties of concrete structural members and the general construction.

2.1.6 Anchor bolt anchorage method

The method is suitable for the transformation and strengthening of the concrete bearing structure of the concrete strength grade C20 ~ C60, which is not suitable for severely weathered structures. The design and calculation of element concrete member and low reinforcement ratio component by using anchor bolt.

2.2 Indirect reinforcement method

2.2.1 Prestressed reinforcement method

Prestressed reinforcement method is the use of external pre-stressed steel bar and steel bar reinforcement method of components of the architecture as a whole, is characterized by by prestressing force and part of the tie rod or support force, change the original structure of the internal force distribution and to reduce stress levels of the original structure, the general reinforcement structure unique should stress strain hysteresis phenomenon can be completely eliminated [15].

The method can reduce the strengthened component of stress level, not only the good reinforcement effect, and can greatly improve the overall structure bearing capacity, but strengthened the appearance of the original structure have certain influence; suitable for large span and heavy structure reinforcement and under high stress and high strain state of concrete member reinforcement, but under the door and cannot be used for temperature in more than 60℃ environment, also should not be used for the structure of concrete shrinkage Xu Bianda.

2.2.2 Increase bearing reinforcement method

Adding the pivot reinforcement method is to reduce the load effect on the strengthened member and to improve the bearing capacity of the structure by reducing the span of the bending member, This method is simple and reliable but easy to damage the original appearance of the building and use function, and may reduce the use of space; application in reinforced concrete structure of specific conditions permit. Concrete structure reinforcement for concrete conditions permit.

3. Masonry structure reinforcement method

3.1 Method for direct reinforcement of masonry structure

3.1.1 Reinforcement method of reinforced concrete external layer

It belongs to a kind of composite section reinforcement method. The utility model has the advantages of simple construction process, strong adaptability, masonry bearing capacity of reinforced has improved greatly and has mature design and construction experience, applicable in reinforcing the cornice walls, The drawback is construction site wet operating time is long, has a certain influence on the production and the living and strengthened building clearance has certain decrease [8].

3.1.2 Reinforcement method of reinforced cement mortar

It belongs to a kind of composite section reinforcement method. The advantages of the method are similar to that of reinforced concrete reinforcement method, but the improvement of bearing capacity is not as good as that of the former. Application in reinforcement of masonry walls, and sometimes also used for the reinforced concrete external layer reinforcement with wall column wall on both sides of the wall of the stirrups closed.

3.1.3 The reinforcement method of adding wall supporting column

It belongs to a kind of reinforcement method of enlarging section. The advantages are similar to the reinforcement method of reinforced concrete, but the bearing capacity is limited, and it is difficult to meet the seismic requirements.

3.2 Method for indirect reinforcement of masonry structures

3.2.1 Non adhesive bonded steel reinforcement method

It belongs to the traditional strengthening method, its advantages are simple construction site workload and wet operation less for to not allowed to increase the original component section size, but requirements greatly improve the capacity of normal section strength of masonry column reinforcement; the disadvantage for the reinforcement cost is higher and the similar steel structure of the protective measures.

3.2.2 Prestressed bar reinforcement method

It can greatly improve the bearing capacity of masonry columns, and the reinforcement effect is better, and it is suitable for the strengthening of masonry structure with high stress and high strain state. Disadvantage is not used in high temperature environment, the bad environment temperature cannot be more than 60℃ [9].

3.3 Structural reinforcement and repair of masonry structure

3.3.1 Additional beam reinforcement

When beam settings do not meet the current design specifications, or vertical and horizontal wall junction bites rub have obvious defects, or the housing overall poor should add ring beam reinforcement.

3.3.2 Additional beam mat reinforcement

When under the crossbeam of brick masonry was partially crushed or beam wall under the partial vertical cracks, beam reinforcement pad should be added.

3.3.3 Partial masonry

When the housing partial rupture, but in identifying the cause of its rupture has not yet affect the bearing and safety, can be a

partial removal of the broken wall, and to enhance the strength of the mortar with the whole brick masonry

3.3.4 Masonry crack repair

Before the crack repair, according to the stress state of masonry members and the characteristics of the cracks and other factors, determine the causes of masonry cracks, so as to crack repair or use the corresponding reinforcement measures [14].

4. Steel structure strengthening method

4.1 Strengthening method for changing structure calculation pattern

Change the structure calculation and graphics of the reinforcement method is to change the distribution of load structure, path, node properties and boundary conditions, we use add additional members and support, prestressed construction based on space cooperation work to change the structure calculation model and the structure is reinforced [10].The main way:

4.1.1 The method of increasing the stiffness of the structure or component is used to reinforce the structure

1) To increase the support to form a spatial structure and checking according to space structure;
2) The additional support increase the stiffness of the structure, or to adjust the structure of self-vibration frequency to improve structural bearing force and improve the dynamic performance of the structure;
3) The additional support or auxiliary rod structure of the slenderness ratio decreased to improve its stability;
4) In frame structure strengthen a colonnade stiffness, which carry most of the horizontal forces, in order to reduce the load of the other column;
5) In the tower structure arranged in the rod or the tensity cable to strengthen the stiffness of the structure.

4.1.2 Reinforced by changing the section internal force of the bending member

1) To change the distribution of the load, for example, to transform a concentrated load into a plurality of concentrated loads;
2) Change the end support, for example, the variable is hinged to the rigid junction;
3) Adding the middle supporting seat or connecting the end part of the simple supporting structure into a continuous structure;
4) Adjust the position of the support for the continuous structure; The structure is changed into a rod type structure;
5) Prestressing force

4.1.3 The method of changing the internal force of the truss is strengthened.

1) Additional variable truss strut brace structure;
2) Adding prestressed tie rod

4.2 Strengthening the reinforcement of member section

After the combination of the original component and the new welding or bolt connection, the new type steel section is formed to meet the requirement of the structure function. This is a widely used steel structure strengthening method at present. It has the advantages of convenient construction, and can be used in the load condition. When this method is used for strengthening steel structures, the selected section should be in favor of strengthening technical requirements, and consider the status of existing defects and damage [11].

4.3 Reinforcement of connection mode

The joint of steel structure is the key link of the whole function of steel structure. In the process of design and construction, we should do "strong node and strong connection". For steel structure connection method, namely welds, rivets, bolts and high strength bolt connection method of selection should be according to the structures need strengthening the reason, purpose, by force, structure and construction conditions, and to consider the structure of the original connection method to determine [16].

In general, the steel structure reinforcement shall be welded with friction type high strength bolt connection, and it can also be used in the connection of the welding seam and friction type high strength bolt. When the welding connection is used, the welding process and the connection material should be adopted.

4.4 Crack repair and reinforcement

Due to repeated loading and material selection and construction of the manufacturing and construction improper installation, with expansion or brittle fracture tendency of crack damage, should try to repair before the repair, we must analysis the seriousness of the causes and effects of the crack, to adopt improved structure of actual work or reinforcement measures, are not suitable for the repair and reinforcement of the components, it should be removed and replaced.

4.5 FRP steel structure reinforcement

FRP (fiber reinforced composite material) as a new reinforcement material to its excellent mechanical properties and adapt to the demand of modern engineering structures to large span, tall, heavy load, lightweight development, are being widely used in engineering structure reinforcement in. In particular, the research and application in the field of reinforced concrete reinforcement has achieved good development. Compared with the traditional steel structure reinforcement, the use of FRP reinforced steel structure will not lead to serious stress concentration, and will not produce residual stress, and has the advantages of simple construction, low maintenance costs [13].

5. Epilogue

In the background of the country to advocate energy conservation and benefit, the structure reinforcement has become a hot topic, and its research has become particularly important. Along with the progress of science and technology, all kinds of new reinforcement materials and technologies have emerged one after another. There are also a variety of questions to be solved. Such as:

1) FRP application reinforcement is worth further exploration and research.
2) The bonding performance between the reinforcing materials and concrete needs to be further studied and solved.
3) New high strength materials used in structural reinforcement.

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