

Original research article

Reinforced concrete protective layer in construction

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Abstract: Reinforced concrete structure is widely used in housing construction. In the daily work of our construction project, the control of the physical quality of reinforced concrete structural engineering is a key point. Due to the large amount of reinforced concrete works, we often find that the construction workers have not paid enough attention to the thickness control of the reinforced concrete layer in the concrete structure, resulting in different thickness of the steel protective layer and the displacement of the steel. Coupled with the template size deviation and other factors caused by the protective layer of steel does not meet the requirements, and after pouring concrete, and cannot intuitively see its internal structure, and thus bring the hidden quality of the project. In addition to the raw material quality factors, the deflection of the reinforced protective layer of the reinforced concrete structural members directly affects the mechanical properties and durability of the reinforced concrete members, and the direct relationship between the mechanical properties and the durability of the reinforced concrete structures is directly related to the mechanical properties and the durability of the reinforced concrete structures, safety and service life of buildings. Therefore, the parties involved in the construction and the construction should pay enough attention and concern the protective layer of reinforced concrete structures. Here on the author involved in the construction work since the accumulation of experience and experience, the thickness of reinforced concrete structure protective layer of the views of some views for everyone to explore.

Keywords: steel bar; concrete; protective layer; control; construction

Received: 5 March 2018; Accepted: 10 April 2018; Available online: 2 June 2018

1. Introduction

1.1. Key words of reinforced protective layer and its significance

Iron and steel industry started earlier, and the real application of the construction time is not long, the application of concrete in the construction project is about 100 years. Since the human to find this new building cement raw materials, construction technology has been rapid development. Especially in 50 years ago, since the common application of reinforced concrete structures and prestressed reinforced concrete structure in engineering, also makes the building has undergone enormous changes in the field. A block of high-rise buildings where they stand, a few hundred meters' span bridge construction from the past cannot be achieved into reality. This is the middle of both steel and concrete materials of these two credit.

So how does steel and concrete work in the end? What is the relationship between them? From the physical and mechanical properties of the material, the reinforcement has a strong tensile and compressive strength, while the concrete has only a high compressive strength, tensile strength is very low, but the elastic

modulus of the two closer Have a good cohesive force, so that both play their own performance, but also a good coordination of work together to bear the structural components of the external load.

Because there is sufficient cohesive force between the steel bar and the concrete, the reinforced concrete component is subjected to external force in the calculation of the structure; Because the tensile strength of the concrete is very low, for the simplified calculation, the concrete is only considered to bear the pressure stress, and tensile stress are all borne by the steel. In terms of the cross-section design of the stressed member, the greater the tension of the tensioned steel bar, the greater the external bending moment per unit area of the steel bar, and the higher the efficiency of the reinforcement. In general, whether it is beam or plate, pull the bar should be as close as possible to the edge of the concrete side of the pull side. Such as the beam of the tendons should be in the upper part of the component tension zone. If the wrong place or reinforced protective layer is too large, ranging from reduced beam carrying capacity, while a major accident will occur.

So, is the pull of the steel bar closer to the better? The answer is negative. Because the main ingredient is iron bars, iron is easily oxidized at room temperature, much less in hot or humid environments. Reinforcing steel is wrapped in concrete components to form a passivation protective film, not relatively contact with the outside is relatively safe, but if the thickness of the protective layer is too small, is too close to the tension side of the steel side, on the one hand is likely to cause steel bars or the surface of the concrete will be gradually carbonized, it will not take long, as a reinforced protective layer of concrete will lose the protective effect, resulting in corrosion of steel, reduced cross-section, strength reduce the loss of bond between the steel and concrete, the overall damage to the component, serious will lead to the destruction of the entire structural system. Usually in addition to the base of the outer beam of the protective layer thickness is generally 2.5 cm.

In practice, due to reinforcement protection layer thickness does not meet the requirements because of quality problems too numerous to list. More prominent, such as the current residential building in the construction of the floor of the negative bending moment of the protective layer of large and in situ structure of the main beam at the junction of the main beam of the upper part of the negative bending moment of the protective layer of the problem. To residential buildings, for example, today's residential area is growing, the floor span is also growing, especially the living room floor. According the statistics, the current residential floor cracking causes 70% or so is caused by the improper location of the protective layer of steel.

It is true that the thickness of the protective layer of the steel does not play a decisive role in the quality of the individual works, but if it does not pay attention to it, the harm cannot be ignored. We should correctly understand the stress mechanism of reinforced concrete and concrete under the premise of fully aware of the reasonable thickness of the protective layer of steel on the importance of the structure of the project. Only prevent the slightest, to make our construction technology level to a higher level.

1.2. Research on the control and quality of reinforced protective layer

Reinforced concrete and concrete in the construction has become an inseparable twin brothers, from the physical and mechanical properties of the material to analyze the steel has a strong tensile strength, compressive strength, and concrete only has a high compressive strength, tensile the intensity is very low. But the elastic modulus of the two closer, there is a better cohesive force, so that both play their own performance, but also a good coordination of work together to bear the structural components of the external load.

So, how to control the steel protective layer? I think the focus should be from two aspects, one is to

grasp the construction technology before the end; Second, grasp the elements of control process. Before the construction, should be for different engineering parts, according the design drawings and construction acceptance specifications, to determine the correct steel protective layer. The thickness of the protective layer is not uniform, in general, the thickness of the protective layer of cast-in-place floor is 1.5 cm, and the thickness of the protective layer is usually 5 cm, and sometimes even 10 cm. Therefore, in the operator's technical background must be clear this thickness, otherwise it is likely to cause rework. In the construction process, the focus should be to standardize the operation, especially in the concrete pouring pits in the process need to take attention. Often barbed when the location is very correct, but one to the case of pouring changed the case, not the people step on the equipment is pressure on the top, result is to support the reinforced pound pierced, concrete upper steel Bending deformation, the thickness of the protective layer is not guaranteed. Therefore, in the construction process, should be standardized operation, is strictly prohibited operators on the steel free walking; on the upper steel, should be effective fixed; pouring should also be often checked and found that the problem in a timely manner.

1.3. The shortcomings of the existing research and the content of this study

This article from the construction of all aspects of a comprehensive analysis of reinforced concrete protective layer, so that the construction staff to better understand the importance of protective layer and operating essentials.

2. On the thickness control of protective layer of reinforced concrete structure

2.1. From the mechanical point of view

Reinforced concrete structural components are composed of reinforced concrete and concrete. From the mechanical properties of raw materials, the steel has a strong tensile strength; concrete has a high compressive strength, and its tensile strength is very low. This combination takes advantage of their respective advantages and takes on the external loads that the structural components bear. Therefore, we generally consider the stress conditions of reinforced concrete, the focus is to consider the stress of concrete and reinforced tensile stress. And whether the actual tensile stress of the reinforced concrete structural members can be consistent with the calculated stress depends on whether the position of the reinforcement in the structure is correct. This is what we call the main reason to control the thickness of the protective layer of steel.

In general, both the beam and the plate, the tensioned bar always should be as close as possible to the edge of the side of the concrete component. If the reinforcement beam of the beam should be located the upper part of the component tension zone, if the thickness of the protective layer of steel is too large, ranging from the steel cannot effectively play its due tensile effect, leaving the concrete tensile stress exceeded cracks (H0) of the tension of the upper part of the cantilever structure is reduced, and the tensile stress of the steel bar is exceeded. Such accidents are not uncommon in the history of construction. Another example is a large area of cast-in-place floor, the lower row of bars if the pad is too high, the protective layer is too large, under the external load, the concrete under the tensile stress exceeded, will produce bottom cracks.

2.2. Analysis of bond strength between steel and concrete

Reinforcement and concrete to work together, because the concrete hardened and reached a certain strength, the two between the establishment of a sufficient bond strength, this interaction known as the grip force. Reinforcement in the concrete in the protective layer must have a certain thickness, to ensure the

adhesion between concrete and steel force. If the thickness of the protective layer of steel bars is too small, the steel bars are too close to the edges of the structural members, which tend to cause the surface concrete to peel off when the reinforcing bars are exposed or the tendons. In addition, the protective layer of steel is too small, the surface concrete will gradually carbonize over time, the edge of the steel will lose the role of corrosion caused by corrosion of steel, reinforced concrete will lose the adhesion between the components, so that the bearing capacity decreases, serious will lead to the destruction of the entire structural system.

2.3. Durability analysis of components

The role of the protective layer in addition to the above, as the name suggests also plays a role in protecting the steel bar is not corroded to ensure the durability of reinforced concrete structures. There are many factors that affect the durability of reinforced concrete structures, in addition to special external factors, under the general conditions of use, mainly consider the erosion of the atmosphere and make the steel oxidation rust. The concrete is not dense, cracks, reinforced protective layer is too small, coupled with the carbonization of concrete and steel electrochemical reaction and other factors will accelerate this erosion process. Corrosion of steel bars will lead to volume expansion, resulting in cracking of the concrete layer caused by a vicious cycle, more accelerated steel corrosion process, thus greatly reducing the life of the building. Therefore, to ensure that the thickness of the protective layer in the design and specification within the scope of the provisions, will be able to maximize the protection of steel from corrosion, delay the depth of concrete to reach the steel surface of the time to ensure that the structure of the service life.

For some special circumstances of the building, such as in the corrosive gas environment of the building structure, the design of the concrete structure of the reinforced protective layer also made some special provisions to ensure the durability of the building structure.

2.4. Analysis of fire protection requirements from concrete

The protective layer also has a certain fire protection function for the concrete inside the concrete.

When the building structure of the fire, the ambient temperature sharply increased, reinforced concrete and thermal expansion coefficient is different. When the expansion value of the steel is gradually larger than the expansion value of the concrete, it will damage and destroy the bond between the concrete and the reinforcement. In addition, when the steel bar temperature rises to 700 °C, the yield strength of the steel is greatly reduced, concrete co-working conditions, which lead to structural damage. However, the concrete is a bad thermal conductor, it can protect the steel will not be immediately affected by high temperature, thereby delaying the structure of the loss of carrying capacity of the time for fire rescue time.

As the result of the above reasons, the national norms on the thickness of reinforced concrete protective layer of the mandatory requirements:

GB50010-2010 ‘concrete structure design code’ in the mandatory provisions of the provisions of the provisions: vertical force of ordinary steel and prestressed steel, the minimum thickness of the concrete protective layer (steel outside the edge of the concrete to the surface distance) should not be less than the nominal steel Diameter, and shall comply with the requirements of **Table 1**.

GB50204-2011 ‘concrete structure construction quality acceptance of local amendments to the provisions of the provision’ of the thickness of the protective layer of steel bars, the inspection of the structural parts and the number of components and acceptance methods, have made a clear description of the allowable deviation range is specified: the thickness of the protective layer thickness of the longitudinal reinforcement layer, the allowable deviation of the thickness of the protective layer of the longitudinal

reinforcement, +10mm, -7mm for the beam members and +8mm and -5mm for the board members.

Table 1. Acceptance forms for concrete structure design specifications.

Environmental		Panel, Wall			Beam			Column		
A class		$\leq C20$	C20~C45	$\geq C50$	$\leq C20$	C20~C45	$\geq C50$	$\leq C20$	C20~C45	$\geq C50$
Second class	A	20	15	15	30	25	25	30	30	30
	B	-	25	20	-	35	30	-	35	30
Third class		-	30	25	-	40	35	-	40	35

Note: The foundation of the longitudinal reinforcement of the concrete protective layer thickness should not be less than 40 mm; when no cushion should not be less than 70 mm.

In our construction, paying attention to ensure that the thickness of reinforced protective layer. In the daily construction of, mainly taken the following measures to ensure that the thickness of the concrete cover:

1) Clear the thickness of the various parts of the protective layer of concrete. Conscientiously do a good job drawing review, technology to the end, especially the construction unit of the construction team to pay the end. In some design drawings, the thickness of the protective layer will have different requirements depending on the situation. Such as cast-in-place slab and beam thickness of the protective layer, when the concrete strength is different, the required thickness is not the same. The base of the surface protection layer thickness is usually 5 cm, and sometimes even required to reach 10 cm.

2) Control the size of steel skeleton. Pay attention to the reformation of steel bars. The sampling unit of the construction unit should be familiar with the drawings and specifications. The size of the stirrups should be correct. For some steel-intensive, complex beam, column junction, the main beam and the secondary beam of the junction must be put in the same way, the rational arrangement of the direction of the main bar and the deputy tendons position. At the same time to ensure that the steel bar in the production of the correct size, to the construction site reinforcement installation, banding nodes to create conditions. To avoid the junction, point due to the installation of steel cannot be installed due to the formation of reinforced concrete layer of the protective layer, resulting in the case of exposed bars. Attention to the banding of steel forming process. When binding, according the drawings, standard operation. To ensure that the steel skeleton of the various parts of the size and accuracy, to ensure that the location of the main tendon is accurate, is to avoid the premise of the deviation of the protective layer of steel. For some complex beam and plate structure, as well as crisscross the beam and column junction point should be carefully settled based on reasonable placement of primary and secondary beam structure of the main reinforcement position, and pay attention to the construction sequence, to avoid the occurrence of steel reinforced protective layer of the situation.

3) The template size of the production will lead to excessive protection layer, so we should pay attention to the production and installation of the template project. Production should be standardized, the size to be accurate, especially the phenomenon of shrinkage can easily lead to steel protective layer is too small or even exposed phenomenon.

4) Do the bar limit measures.

In the actual construction, the steel, the template limit to do the following measures:

Wall control: After the release line, after the tie bar, in the steel skeleton according the control wire welding positioning of steel, and in the steel skeleton on the cement sticks, spacing 0.6 m and tied with the steel skeleton together to prevent the template support and concrete pouring caused by cement sticks slide.

Beam board control:

The lower part of the beam and the lower layer of the lower layer of the same thickness of the protective layer with the concrete strength equal to or higher than the strength of the concrete pad, most of the marble pad, the density of 0.8–1 m spacing.

Beam side also set up the pad to prevent beam steel displacement;

Reinforced bar with reinforced bar stool pad, to ensure that the upper steel bar position to meet the requirements of steel skeleton.

On the plate with the same thickness of the protective layer of concrete layer of PVC pipe, pouring concrete into the PVC pipe when a flat, in the second bar to find the usual PVC pipe out, leveling can guarantee the thickness of the protective layer.

1) In the concrete pouring process to promote civilized construction, pay attention to finished product protection. Construction of pouring concrete, unified command and supervision. In the band, has been formed and the acceptance of the reinforcement of the laying of a special construction of the steel road, the construction staff shall not random step on the tread, but not the equipment and equipment on the pressure, resulting in support stool and pad was flattened or trampled, and concrete Internal steel bending deformation or displacement. In the concrete pouring process in an orderly vibrating, to avoid the local vibrator or vibration rods hit the steel skeleton. In the concrete pouring process, there should be steel at any time on the offset of the steel should be effectively fixed, to further ensure the quality of pouring.

3. Construction quality control measures for reinforced concrete protective layer

3.1. Seriously do a good job drawing review, technology to the end

Conscientiously do a good job drawing review, technology to the end, especially the construction unit of the construction team to pay the end. In some design drawings, the thickness of the protective layer will have different requirements depending on the situation. Such as cast-in-place slab and beam thickness of the protective layer, when the concrete strength is different, the required thickness is not the same. And the basis of the surface protection layer thickness is usually 5 cm, and sometimes even required to reach 10 cm, which should be based on the requirements of the drawings to banding reinforcement. But we in the actual work, often found that the bar operator does not look at the structure of the general description of the drawings and only experience through the operation. Do not use the corresponding standard pad, sometimes for the sake of making trouble with the pad or less pad with the protective layer caused by deviation. These phenomena are related to the construction unit does not attach importance to technical exchanges, construction management is not relevant. These are human factors, should be completely blocked. Before the construction, should be for different engineering parts, according the design drawings and construction acceptance specifications, to determine the correct thickness of the protective layer of steel. For different components, can take different thickness of the protective layer of the pad; pad strength requirements and the main body of the same label, and the use of stereotypes plum-shaped products can be used mold processing or outsourcing; to ensure that the protective layer thickness control in the specified range (within the deviation of not more than 2 mm).

Before the end of the operation, not only for the steel group made a request, but also on the template group, concrete group and other related team requirements, stressed that the protective layer of steel the importance of improving the ideological awareness of the passive operation for the active operation, the passive management for the active management.

3.2. Reinforcement of the re-work

Pay attention to the reformation of steel bars. The sampling unit of the construction unit should be familiar with the drawings and specifications. The size of the stirrups should be correct. For some steel-intensive, complex beam, column junction, the main beam and secondary beam of the junction must be put in the same way, the rational arrangement of the direction of the main tendons and vice-bar position. At the same time to ensure that the steel bar in the production of the correct size, to the construction site reinforcement installation, banding nodes to create conditions. To avoid the junction, point due to the installation of steel cannot be installed due to the formation of reinforced concrete layer of the protective layer, resulting in the case of exposed bars.

3.3. Template production and installation

Template production to be standardized to ensure that the template flatness, strength and stiffness to meet the requirements, to avoid the deformation of the local protective layer components;

Template installation location is accurate;

Template fixed and limit measures in place to avoid the template in the concrete pouring process appeared up the mold, shift phenomenon;

The size of the template production will lead to excessive deformation of the protective layer, so we should pay attention to the template production and installation. Production should be standardized, the size to be accurate, especially the phenomenon of shrinkage can easily lead to steel protective layer is too small or even exposed phenomenon.

3.4. Attention to the banding of steel forming process

Attention to the banding of steel forming process. When binding, according the drawings, standard operation. To ensure that the steel skeleton of the various parts of the size and accuracy, to ensure that the location of the main tendon is accurate, is to avoid the premise of the deviation of the protective layer of steel.

For some complex beam and plate structure, as well as crisscross the beam and column junction point should be carefully settled based on reasonable placement of the main beam structure of the main beam position, and pay attention to the construction sequence, to avoid the phenomenon of reinforced concrete layering concrete should try to reduce the impact of steel. Any person may not arbitrarily stamp on the installed steel bars. Pouring concrete operators should take construction measures to avoid trampling steel.

In the pouring of concrete, to send full-time steel bar for reinforcement, found that steel was trampled when the shift, the timely dressing.

Eliminate the vibrations in the concrete pouring process disorderly, local vibrations or vibrating rods touch the steel skeleton.

For easy to offset the steel bar should be effectively fixed.

3.5. Installation, banding fixed steel protective layer pad

Placement, banding fixed steel protective layer pad should be used as an important part of steel construction. The state has been a few years ago to promote the use of plastic pads or stapled positioning parts as a measure to ensure that the protective layer of steel, and now in the construction of the application has been more extensive, but still found that many construction units do not attach importance to this problem. One is the number of pad set is not enough, resulting in steel sink or pad is crushed, deformation of

the situation has occurred. We generally require 0.8~1 m should be set up a pad, if the diameter of the bar is small, it should be appropriate to encrypt the pad spacing. Second, the pad should be reasonable and accurately tied to the force on the reinforcement (the main bar), and should not be placed in the non-stressed tendons, fixed to be strong, to prevent the displacement occurred in the pouring process and fall. And then a more common problem is the mix of pad, indiscriminate use, beam, plate concrete reinforced protective layer, even the same label, the protective layer requirements are not the same, but at the construction site, some workers will beam the pad used as a plate of the plate, and the plate of the plate with the beam of the pad, the concrete before the full inspection of the pad is missing or damaged.

In the general test is often found in the problem is the floor of the negative bending bar or double-layer double-bar reinforced ribs on the protective layer is too large, and the upper part of the cantilever beam bending moment of the protective layer is too large and other issues, should be concerned about the formation of steel banding of the focus of the pad to be used plum concrete pad, the label is not less than the main body of concrete, the number of pads must meet the requirements of the protective layer of the pass rate, placement, banding fixed steel protective layer pad should be used as steel construction an important part. Channel, culverts of the wall concrete blocks should be layered, staggered arrangement, the distance between the upper and lower spacing of not more than 30 cm, horizontal spacing of not more than 40cm, between the skeleton should be increased frame reinforcement, fixed two layers of skeleton spacing, location, to ensure that concrete construction It is not easy to deformation, shift.

Control of reinforced engineering is a hidden project, is the focus of concrete construction engineering construction quality control. Construction units and supervision units should do a good job of the concealed acceptance of steel works.

3.6. To promote civilized construction, pay attention to product protection

In the concrete pouring process to promote civilized construction, pay attention to finished product protection. Some construction units are often in the pouring of concrete, no one unified command and supervision. Has been tied to the formation and acceptance of the rebar online construction workers have no taboo to chaos step on the tread, and even equipment and equipment on the pressure, cause the support piers and the pad to be squashed or stepped on, and concrete bending deformation or displacement. This will make the reinforcement position and the thickness of the protective layer cannot be guaranteed. As well as in the process of pouring concrete pound disorder, local vibrator or vibration rods touch the steel skeleton, will make the steel skeleton deformation, dislocation, so that the thickness of the protective layer is uneven. Therefore, in the construction of concrete pouring, should be standardized operation, in addition to easy to offset the steel should be effective for the fixed, there should be someone command and supervision, is strictly prohibited personnel walking freely on the steel, vibrating according operational requirements serious and orderly operation, vibration cannot easily hit the steel skeleton.

3.7. Steel skeleton installation requirements

- 1) Steel surface without corrosion and welding slag, the main tendons should be straight, the surface shall not have cracks and other damage;
- 2) Double or multi-layer steel should be sufficient between the support, the skeleton shall not be deformed, loose welding and welding, with sufficient rigidity;
- 3) Steel processing, production must be in strict accordance with the design and specification requirements;

4) To ensure the stability of steel skeleton, in the production process, to ensure that the quality of steel banding and welding;

5) The skeleton installation process to be reasonable, scientific, skeleton installation is complete, to the skeleton position size to carefully check to ensure that the location is accurate, does not meet the requirements, to be corrective treatment; the complex structure of the structure, reasonable placement of primary and secondary Position, and pay attention to the construction sequence, to avoid the emergence of steel reinforced protective layer of the situation.

6) The skeleton in the transport process should also prevent the deformation of the skeleton, if necessary, to strengthen the stirrups to encrypt.

3.8. Implementation of the three inspection and acceptance system

Combined with the specific characteristics of the project, the road after the completion of the process, the first is the work class self-test, signature, qualified after reporting the project department of professional engineers, qualified by the professional engineers before the inspection engineer supervision and acceptance.

Strict implementation of the first engineering approval system:

According to the unit number, the process will be refined, each individual component construction should be reported before the first piece of construction program, after approval in the first piece of construction in the implementation of the first piece of the project should be completed after the completion of the need to be completed of the process, pay attention to matters such as discussion, to the end, clear, to ensure that follow-up construction quality of the project is not less than the first.

Strengthen the management, the development of appropriate incentive measures:

The project manager department shall set up the quality control group of the reinforced protective layer, formulate the control measures of the protective layer in detail, and hold the meeting research countermeasures on a regular basis. The development of appropriate incentive measures, signed letters of responsibility, linked with the economic effects. To meet the requirements of the team recommended to give appropriate incentives, the problem of the team should be given appropriate economic penalties to fully mobilize the enthusiasm of most workers.

3.9. Strict testing procedures

According the project self-inspection, supervision and sampling, laboratory sampling and quality supervision and inspection procedures, all exposed reinforced concrete protective layer pass rate of not less than 90%.

4. Conclusion

Reinforcement is a very easy to overlook, but very important problem. The thickness of the protective layer will cause the surface of the exposed surface or the effective height of the cross-section reduction, which directly affects the bearing capacity and durability, it must be from the design and construction of two aspects of the strict control of the thickness of the protective layer: Considering the durability, the effective height of the section and other factors, in strict accordance with the design life, environmental category, component type, concrete strength to determine the thickness of the concrete protective layer design values; and in the construction of a solid template, reinforced size; Stool and other materials properly, layout is reasonable, is strictly prohibited staggered, leakage; the types of interspersed with the orderly, strict conceal acceptance, to ensure the accuracy of the protective layer thickness.

Conflict of interest

The authors declare no conflict of interest.

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