Tentative Ideas on Application of Prefabricated Environmentally-friendly Canals in Canal System of Farmland Irrigation District

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Abstract. This paper analyses the shortcomings of the reconstruction method of the current farmland irrigation canal and proposes a new type of environment-friendly prefabricated canal which is made of the new high-strength anti-seepage material produced by recycled construction waste. The new type of canal has the advantages of convenient transportation, low cost, high strength, short construction period, etc.

1. Introduction
The promotion of water saving supporting reconstruction project in the main agricultural production areas, especially the medium-sized irrigation areas in the main grain production areas, plays an important supporting role in strengthening agricultural infrastructure and ecological construction. The original farmland irrigation canal reconstruction project can only use traditional concrete irrigation canals due to long canal systems, small cross-sections, and limited transportation conditions. However, site-mixed concrete has problems such as high unit price and poor pouring quality. According to the survey, there are often three ways to improve existing irrigation canals: mortar masonry canals, concrete canals, and U-shaped concrete precast canals. However, the three irrigation canal improvements also have many shortcomings. The U-shaped concrete precast canals require special formwork, and the weight of a single concrete member is relatively large, which makes transportation difficult. Therefore, the cost of component production and transportation is higher than other types of canals. The mortar masonry canals have good water permeability, but its low bearing capacity easily results in deformation, and the construction period is long. Although the construction technology of concrete canals is mature, there are many procedures and the material need to be frequently manually-transferred. When commercial concrete is used for pouring, the tanker cannot reach the construction site and often needs to be transferred, which makes it difficult to ensure the quality of concrete pouring. The unit price of reinforced concrete and the construction costs are higher.

2. Processing and installation of prefabricated environmentally-friendly canals
Aiming at the problems of high unit price, low strength, and difficult transportation of the original irrigation canal, we decided to use high-strength anti-seepage materials recycled from construction waste to make precast components to solve the above problems.

2.1. Component production method
① Sorting: Sort out masonry, steel bars, concrete blocks, wood, waste plastics, waste paper and other sundries in waste building materials and implement classified management and storage.

② Smashing: For large bricks and concrete blocks, crush them into coarse aggregates and pulverize again to obtain recycled aggregates of a certain size.

③ Screening: The crushed recycled aggregate is sieved through a rolling sieve and sieved out 5mm～20mm, 0.15mm～4.75mm and 0～0.15mm, i.e. 3 kinds of aggregates of different sizes, and store them separately. For aggregates exceeding the above size are returned to the hammer crusher and crushed again.

④ Compacting: Put the aggregates that meet the specifications into the hydraulic press to compact them to the strength required by the irrigation canal components;

⑤ Forming: The compacted material board is processed into the finished components according to the actually required shape.

2.2. Component installation method

① Leveling: The site where the irrigation canal needs to be constructed is trimmed according to the actual construction size;

② Assembling: Splice the prefabricated irrigation canal components on site according to the design drawings;

③ Filling: Fill the joints with water swelling glue and conduct anti-seepage treatment on the joints;

④ Compressing: After filling, the irrigation canal is fixed and compressed to enhance the integrity of the assembled structure.

3. Advantages of prefabricated environmentally-friendly canals

3.1. Structural advantage

Compared with the existing mortar-masonry canal, the prefabricated environmentally-friendly canal is expected to increase the bearing capacity of the components and ensure a stable foundation. And the use of prefabricated components shortens the construction period. Compared with the existing concrete canal, the construction process is reduced and the problem that the quality of concrete pouring is difficult to be guaranteed due to the time consumed by manual transportation is solved. Compared with the current irrigation canal, which is mainly U-shaped section, this paper proposes a variety of structural forms (Fig. 1) to meet different functions and site requirements. And it also provides a variety of assembly methods, such as the use of bottom and side panels which not only effectively saves the occupation of transportation space and construction space, but also greatly reduces the weight of individual components, facilitating shipment and on-site construction. Under the condition that the size of the side plates remains unchanged, the effect of changing the flow of the irrigation canal can be easily achieved only by adjusting the spacing between the side plates. Compared with the mainly existing irrigation canal with U-shaped cross section, this technology provides a reliable connection method. The mainly used irrigation canal with U-shaped cross-section adopts the through seam connection method, which is very prone to dislocation and damage to cause leakage. The prefabricated environmentally-friendly irrigation canal adopts the staggered connection method of socket connection (Fig. 2a) and bolt connection (Fig. 2b), supplemented by top pressure when necessary, which not only effectively enhances the overall stability of the irrigation canal, but also eliminates the leakage problem of the connection part. It is found that the effect of water stopping is obvious and later maintenance is very convenient and simple as long as the bolt is loosened or the damaged part is directly taken out of the socket for replacement.
3.2. Economic advantage

As far as the second phase of the water-saving supporting transformation project for the medium-sized irrigation district in Haining City, Zhejiang Province is concerned, the total length of the channel is nearly 26 km. According to preliminary estimates: the factory cost of assembly channel components (50*54) produced by recycled construction waste is about 13 yuan/piece. The average canal material cost per meter is 13*(4+2)*1.5=117 yuan. According to the existing design data and the budget price of water conservancy projects in Zhejiang Province, the material cost of using traditional U-shaped channels is 182 yuan per meter, and the material cost of site-mixed concrete canals is 260 yuan per meter. Hence, the economic benefits can be estimated as follows:

| Canal type                                   | Unit price (yuan/m) |
|----------------------------------------------|---------------------|
| Traditional U-shaped canal                   | 182                 |
| site-mixed concrete canal                    | 260                 |
| Prefabricated canal produced by recycled construction waste | 117                 |

Figure 1. Various structural forms.
(a) Socket connection method (model)  (b) bolt connection method

Figure 2. The assembly connection method provided by this work.
If the cast-in-place concrete construction technology is used, it will take at least 10 days to complete the 100-meter irrigation canal. However, through the assembly process, the construction of the 100-meter irrigation canal can be completed in one day. According to the water conservancy labor budget unit price of 69.60 yuan/man-day in Zhejiang Province, the use of prefabricated canals produced by recycled construction waste compared with cast-in-place concrete canals saves labor costs about: 9*69.60/100=6.26 yuan/m.

4. Conclusion
Aiming at the shortcomings of the existing farmland irrigation canal reconstruction methods, this paper proposes the use of recycled construction waste to make prefabricated modern farmland irrigation canals. By rationally applying the construction waste reuse technology and modern prefabricated technology in farmland irrigation canals, the biggest advantages of the two technologies can be brought into full play, which perfectly solves the construction problems in the reconstruction of existing irrigation area.

If the prefabricated environmentally-friendly canals can be promoted and applied, it can bring out both social and economic benefits and open up a new solution to the problem of construction waste.

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