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Application and Optimization of Culverts in Rain and Shunt Diversion

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Abstract: In order to fully consider the influence of the existing facilities and the society on the design of the urban drainage and drainage pipe network, it is necessary to analyze the technical aspects of the drainage structure, elevation, structure, construction technology and other functions and cost influence, through the analysis and calculation of the listed of a number of alternatives to optimize. In the actual transformation of the application, especially for the natural flow through the gravity of the rainwater system, the vault relative to the circular pipe is more appropriate, can be used as the first choice, and according to different circumstances, the parameters of the culvert can be optimized through the calculation has been determined for cost-effective of the program and parameters.

Key words: rain and shunt diversion transformation, vault, application, optimization

The diversion system of the urban drainage network can effectively reduce the pressure of the sewage treatment plant and reduce the environmental risk of the sewage discharged directly into the river channel and then optimize the management of the urban drainage facilities, to create landscape wetlands, for the water systems to have a positive meaning to the construction of the Sponge City.

However, the construction of urban drainage pipe network at the beginning, due to planning, standards, technology, capital and other factors, most cities have the problem of rain and sewage mixed. As the city develop to the present transformation, it is a very big constraints and difficulties. In order to make full use of the existing facilities, it is necessary to avoid the transformation of the existing facilities and the community have a great impact, but also from the technical level analysis of drainage cross-section form, elevation, structure, construction technology and other functions and cost. Through the calculation of the listed a number of alternatives to optimize the program to achieve a higher efficiency of the discharge efficiency and social benefits.

1. the choice of the culvert section

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Take the pipeline as an example, according to the flow formula: Q = AV

Q is the flow, A is the cross-sectional area, and V is the flow rate

The relationship between flow rate, flow and pressure in pipelines

Flow rate: $V = C\sqrt{(RJ)} = C\sqrt{[PR / (\rho gL)]}$

Flow : $Q = CA\sqrt{(RJ)} = \sqrt{[P / (\rho gSL)]}$

Where : C - Pipeline Xie Cai coefficient;

L - Length of pipe;

P - The pressure difference between the ends of the pipe;

R - Hydraulic radius of pipe:

P - Liquid density;

G – Gravity force plus acceleration;

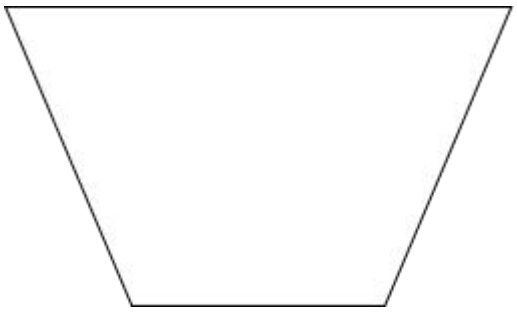
S - The friction of the pipe.

From the formula can be seen, the flow and the flow rate increases with the increase in pressure, for the time being regardless of the design specifications on the flow rate limit, and water pressure increases with the increase in flow rate of the impact of increased. In practice, in order to achieve the same flow and flow rate in the same circumstances, it is necessary to raise the bottom elevation of the initial section in the design of rainwater pipelines, especially in the case of rainwater pipelines, especially those which rely mainly on gravity as natural flow. But because the rainwater pipes are mostly under the road, in order to ensure that the pressure to withstand the vehicle, which is subject to the depth of the pipeline casing constraints, so the choice of the culvert becomes inevitable, regardless of whether the use of cover drainage or box culvert, generally only need to ensure that the pavement structure is thick, and guarantee for a better bearing capacity.

Although the hydraulic calculation of the culverts is different from that of the circular pipe, the flow and the flow rate increase with the increase of the pressure difference.

2. the optimization of the culvert section

The form of the cross-section of the culverts can be trapezoidal or rectangular, depending on the circumstances. In fact, when the transformation is made, the original road is broken and the trapezoidal section is used, and the excavation section is fully utilized to achieve the maximum cross-sectional area. Considering the construction and quality assurance factors, the trapezoidal section cost is relatively higher.



$S = (B + B_1) * h / 2$ B_1 upper width, B bottom width, h depth of the culverts

$B_1 = B + 2hm$ m is the groove grading factor, and S is the sectional area

$S = (B + B_1) * h / 2 = (2B + 2hm) * h / 2 = B h + mh^2$

$B = (S-mh^2) / h$

(1)

The cross-sectional area of the culverts is determined according to the flow. After determining the area, the area is known as the fixed value, and the maximum depth of the depth of the culvert (combined with the thickness of the pavement structure) is limited by the elevation. The slope coefficient, m can be determined according to the condition of the original structural data of the site. After the determination, the value of B can be determined by calculation according to the established constant and the above formula, and then can determine B_1. In order to better verify the value of B and h under what circumstances the largest cross-sectional area, or in the cross-sectional area is the flow of the case to determine the circumference of the circumference of the smallest, so not only the impact of the destruction of the road the smallest and most economical. We can get by formula:

Circumference: $W = B + B_1 + 2\sqrt{}(h^2m^2 + h^2) = 2B + 2hm + 2\sqrt{}(m^2h^2 + h^2)$

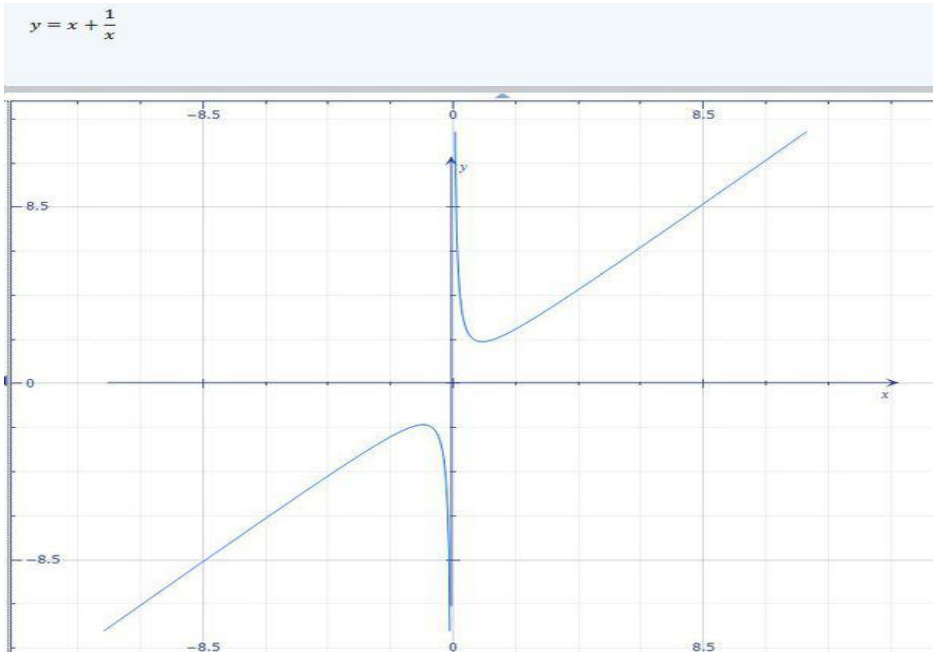
$W = 2B + 2h [\sqrt{}(m^2 + 1) + m]$

Substitute (1)

$W = 2S / h + 2h\sqrt{}(m^2 + 1)$

(2)

W is a hyperbolic function of h, such as the equation $y = f(x) = ax + b / x$ (a, b> 0) is a hyperbolic function, often called the hook function.



Can be a variety of ways to find the most value, x> 0 f (x) have the minimum:

$f[min] = f(\sqrt{}(b / a)) = 2\sqrt{}(ab)$

$W_{min} = 4\sqrt{}S\sqrt{}(m^2 + 1)$

(3)

Let $S = 1$, $\sqrt{}\sqrt{}(m^2 + 1)$ = constant n, substitute (2)

$n^2h^2-2nh + 1 = 0$

Solution equation: $h = 1 / n = 1 / \sqrt{}\sqrt{}(m^2 + 1)$

(4)

Substitutes (1): $B = [1-m\sqrt{}(m^2 + 1)]\sqrt{}\sqrt{}(m^2 + 1)$

(5)

Since S is proportional to h, that is, h satisfies the elevation requirement, the trapezoidal section $h = 1 / \sqrt{}\sqrt{}(m^2 + 1) S$, $B = [1-m\sqrt{}(m^2 + 1)]\sqrt{}\sqrt{}(m^2 + 1) S$, it can be economically optimal, the impact of the destruction of the road to minimize the maximum displacement effect. S is determined by the design flow that is, according to the flow needs to determine the parameters of the culvert section.

3. the need to explain the problem

For the application of the preferred culvert in the rain and shunt diversion, it is generally limited to the case of natural discharge through the gravity flow. For the case where the relay pump station is set up, the height difference can be adjusted by the pumping station, the culverts are aligned with the circular pipe in a clear slightly. For the optimization of the end parameters, mainly from the circumference of the culvert and the area of the two aspects of the function of the impact of the price as a basis for judging the program optimization, the actual application, structure, material and some hydraulic factors may also affect the optimization effect, so, more need to proceed from reality, according to different circumstances to make a different comparison program, and then to optimize.

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