

# COMPARE SHEET of CORRUGATED STEEL PIPE & REINFORCED CONCRETE CULVERT

Compare to reinforced concrete culvert, corrugated steel pipe is widely used in our road construction because easily install, short term, lower price, they are differences on material and technical although they all are type of culvert

1, DEMANDS OF FINAL GOODS			
Item	Reinforced Concrete Culvert		Corrugated Steel Pipe
Concrete Grade	Satisfied demands of design		/
Rebar	must not be exposed or heavily misplaced		/
Geometry	should be within the tolerance		Geometric size is within the allowable deviation range
Appearance	Surface should be straight and round, with no defects such as honeycomb surface, segregation, potholes and cracks. If the defect is less than the following, it should be used after repairing, otherwise it should be abandoned.		The surface is smooth, the weld is flat, and there are no defects such as pores, cracks, slag inclusions and splashes
	The area of each honeycomb shall not exceed 30×30mm	Cellular depth must not exceed 10mm	Area of the honeycomb shall not exceed 1% of the total area
Transportation, loading & unloading	necessary anti-collision measures should be taken		Should be prevented from colliding during transportation, loading & unloading. If the galvanized layer is damaged, it should be coated in time

# COMPARE SHEET of CORRUGATED STEEL PIPE & REINFORCED CONCRETE CULVERT

2, CONSTRUCTION REQUIREMENTS		
Item	Reinforced Concrete Culvert	Corrugated Steel Pipe
<b>Construction Technology</b>	Preparation before construction → construction stakeout → foundation excavation → laying pedestal → laying round pipe → joint treatment → inlet and outlet treatment → layered backfill compaction	Preparation before construction → construction stakeout → foundation excavation → foundation layer backfills → assembly pipe section → culvert pipe in place → stratified backfill compaction → inlet and outlet nozzle treatment
<b>Foundation</b>	The basic material of the reinforced concrete pipe culvert generally has a gravel cushion, a lime cushion or a raft foundation. Due to the high requirements on the foundation bearing capacity of the reinforced concrete pipe culvert, most of the roads in China use the raft foundation. When using the concrete foundation, pay attention to the size of the foundation and the settlement joint should meet the design requirements. The position of the settlement joint should be consistent with the joint position of the pipe joint. The settlement joint should be filled with bituminous wadding or impervious elastic material.	The metal bellows is made of metal and has strong adaptability to deformation. It is suitable for use in many unfavorable geologies. It requires relatively low basic materials, and generally uses a gravel cushion or a replacement gravel. The thickness of the foundation cushion should be determined according to the actual geological characteristics, and at the same time meet the design requirements of the foundation bearing capacity.
	Whether it is a reinforced concrete pipe culvert or a metal corrugated pipe culvert foundation, it is required to consider the basic reserved arching degree problem.	
<b>Pipe joints in place</b>	a. Before the installation, stake out the position of the axis and determine the number of pipe joints	a. Accurately stake out the tube axis position and arrange the position of each tube reasonably.

# COMPARE SHEET of CORRUGATED STEEL PIPE & REINFORCED CONCRETE CULVERT

Version 1.0

Revision Date: 2016/02/16

	b. Installation begins downstream and the joint faces upstream. Pay attention to check the adhesion between the pipe joint and the base, so that the pipe joint is evenly stressed.	b. Starting from the installation of the pipe joint on one side, the center line of the test tube section is parallel to the longitudinal axis of the foundation. After adjusting the distance between adjacent flanges of the two pipe joints to be about 2cm, all the bolts are put on, the screws are screwed, and the flat buckle can be used. In this way, the connections are installed in sections by section.
	c. During the installation process, it is necessary to check whether the faulty bottom of the adjacent pipe joints meets the allowable deviation of the specification and whether the slope of the culvert is smooth.	c. When all the pipe joints are connected, inlay the asbestos mat between the adjacent flanges, and then insert the asbestos mats firmly, and then manually tighten the screws symmetrically until the appearance of the two flanges is 2~3mm.
	d. After the pipe joint is assembled, the joint treatment shall be carried out immediately. The width of the culvert joint shall not exceed 10 mm, and the inner and outer sides of the joint shall be filled with asphalt batt or other elastic impervious material to form a flexible sealing layer. Sometimes, when the design is specified, the outer layer of the sealing layer is wrapped with two layers of 150 mm wide impregnated oil felt or a C20 hoop.	d. Use a jack to correct the axis of the entire culvert so that it is on the central axis.
	/	e. Apply asphalt to the inside and outside of the pipe wall, and the thickness of the coating should be more than 1mm.
<b>Backfill</b>	a. When the entrance and exit masonry mortar or concrete strength reaches 75% of the design strength, the fillers required by the design can be used for symmetrical layered filling on both sides.	a. In cold areas, the backfilling requirements must be the same as the base material in a certain range (usually 0.5m) on both sides and top

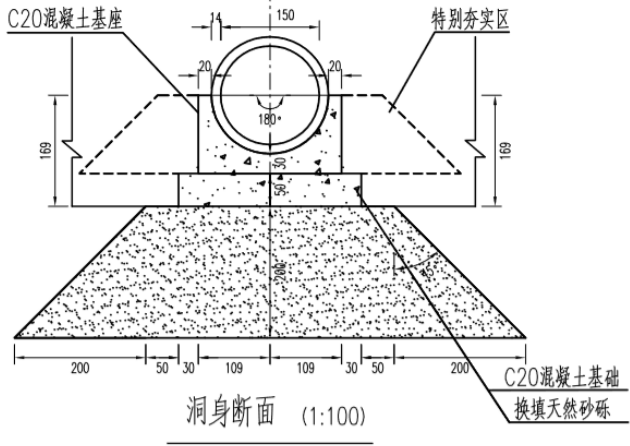
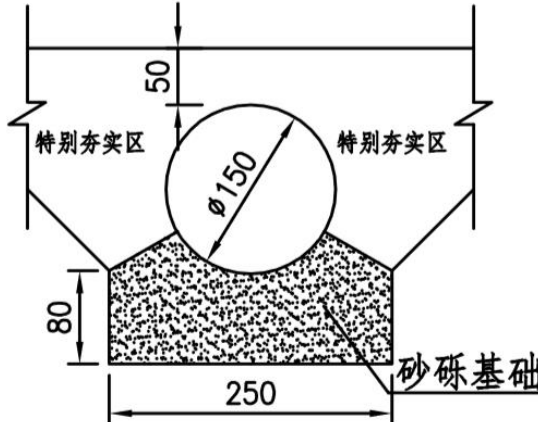
# COMPARE SHEET of CORRUGATED STEEL PIPE & REINFORCED CONCRETE CULVERT

Version 1.0

Revision Date: 2016/02/16

	b. Filling of culverts shall be carried out within a range of not less than 2 times on both sides of the hole. The filling of each layer may be controlled according to the subgrade compaction standard on the corresponding layer. pressure in real time, pay attention to protect the round tube from damage	b. In non-cold areas, both sides and top backfilling may require the same roadbed packing. During backfilling, it is necessary to ensure that both sides are layered at the same time to ensure that the hardness of each laminate meets the design and specification requirements. After the height of the top packing of the pipe exceeds 30cm, the static pressure of the roller can be used. After exceeding 60cm, the pressure of the roller can be used.
	c. Allow the machine to pass when the thickness of the fill on the top of the culvert is greater than 0.5~1.0m	

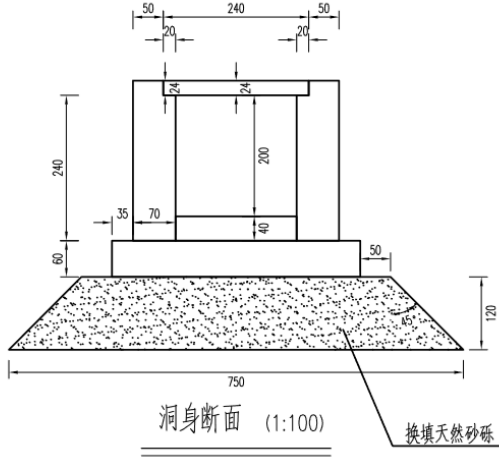
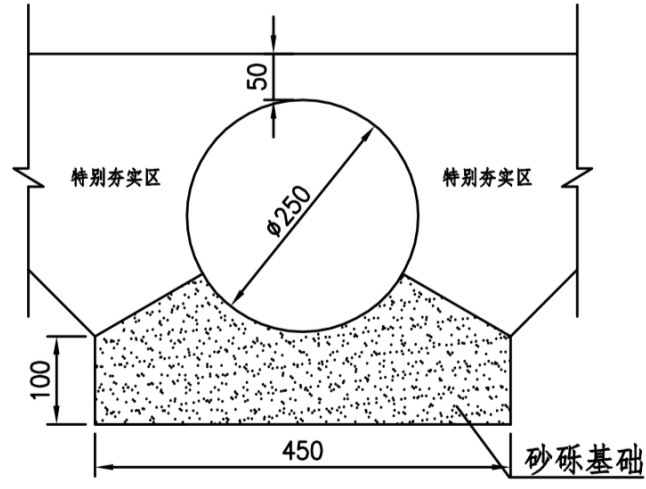
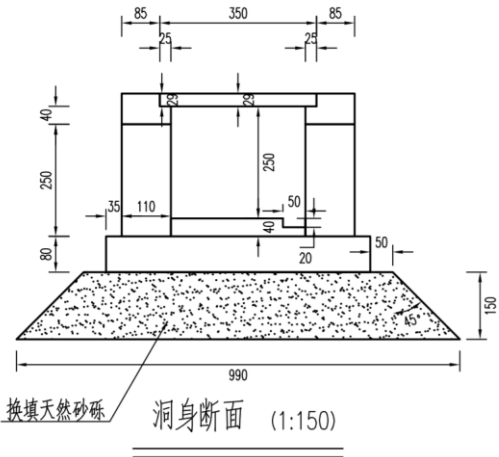
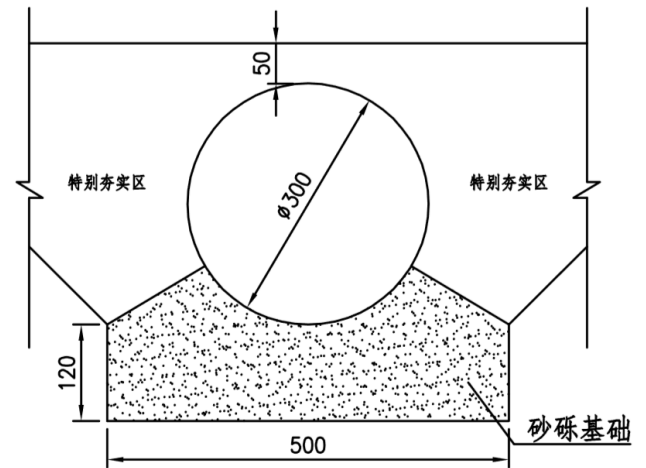
# COMPARE SHEET of CORRUGATED STEEL PIPE & REINFORCED CONCRETE CULVERT

3, PROJECT COST AND CONSTRUCTION PERIOD						
Item		Reinforced Concrete Culvert		Corrugated Steel Pipe		
Section Selection	Water Culvert	Refer to the following figure and table for the cross section of the corrugated steel pipe				
		Completion culvert		Corrugated steel pipe		
		Model	Section area (m²)	Model	Section area (m²)	
		1	1-Φ1.5m	1.77	1-Φ1.5m	1.77
		2	1-2.0×2.0m	4.00	1-Φ2.5m	4.90
		3	1-3.0×2.5m	6.25	1-Φ3.0m	7.07
		4	1-3.0×3.0m	9.00	1-Φ3.5m	9.62
		5	1-4.0×3.0m	12.00	1-Φ4.0m	12.56
		6	1-4.0×4.0m	16.00	1-Φ4.5m	16.00
						

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Version 1.0

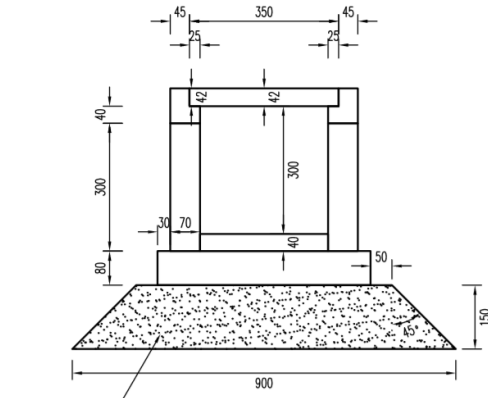
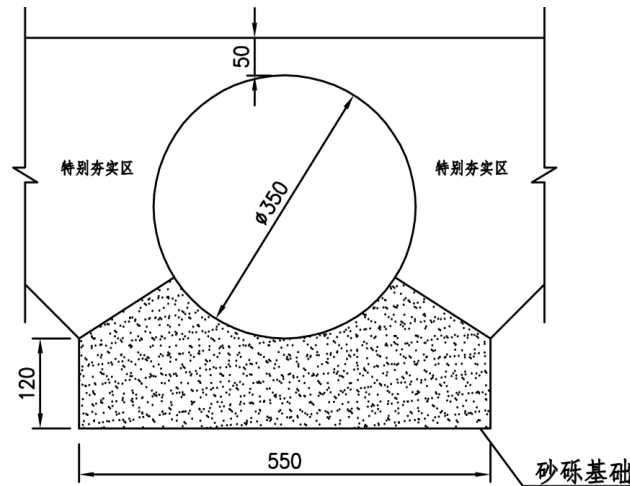
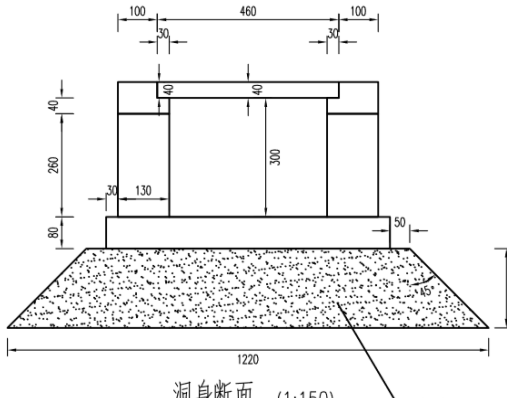
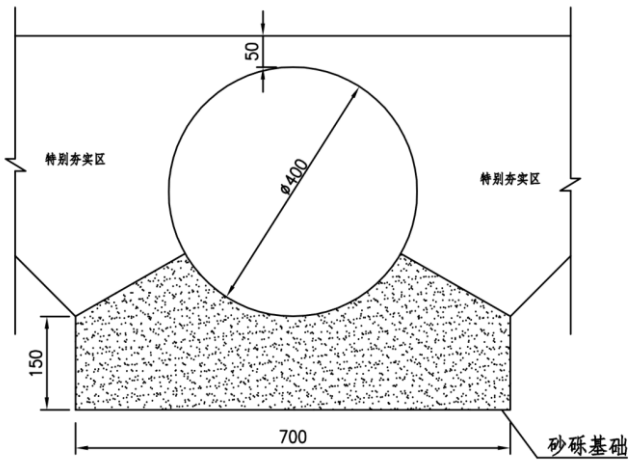
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Section Selection	Water Culvert	 <p>洞身断面 (1:100)</p> <p>换填天然砂砾</p> <p>1-2x2m cover culvert</p>	 <p>砂砾基础</p> <p>1-Φ2.5m CSP</p>
		 <p>洞身断面 (1:150)</p> <p>换填天然砂砾</p> <p>1-3x2.5m cover culvert</p>	 <p>砂砾基础</p> <p>1-Φ3.0m CSP</p>

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Version 1.0

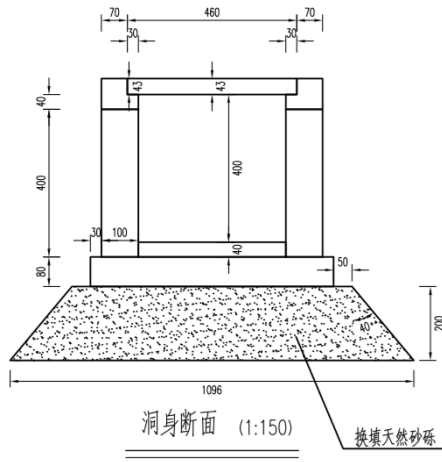
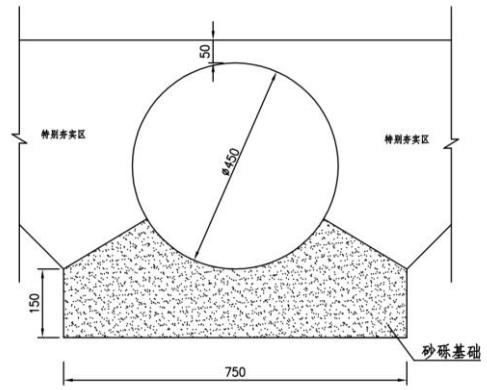
Revision Date: 2016/02/16

Section Selection	Water Culvert	 <p>洞身断面 (1:150)</p> <p>换填天然砂砾</p> <p>1-3x3m cover culvert</p>	 <p>特别夯实区</p> <p>砂砾基础</p> <p>1-Φ3.5m CSP</p>
		 <p>洞身断面 (1:150)</p> <p>换填天然砂砾</p> <p>1-4x3m cover culvert</p>	 <p>特别夯实区</p> <p>砂砾基础</p> <p>1-Φ4.0mCSP</p>

# COMPARE SHEET of CORRUGATED STEEL PIPE & REINFORCED CONCRETE CULVERT

Version 1.0

Revision Date: 2016/02/16

Section Selection	Water Culvert	 <p>1-4x4m cover culvert</p>	 <p>1-Φ4.5mCSP</p>												
Item		Reinforced Concrete Culvert	Corrugated Steel Pipe												
Section Selection	Channel	<p>The corrugated steel plate structure passage is selected with reference to the following figure and table.</p> <table><tr><td>Item</td><td>Model of cover culvert</td><td>Related CSP</td></tr><tr><td>1</td><td>1-4.0×3.0m</td><td>1-Φ5.0m</td></tr><tr><td>2</td><td>1-4.0×4.0m</td><td>1-Φ5.5m</td></tr><tr><td>3</td><td>1-5.0×5.0m</td><td>1-Φ6.5m</td></tr></table>		Item	Model of cover culvert	Related CSP	1	1-4.0×3.0m	1-Φ5.0m	2	1-4.0×4.0m	1-Φ5.5m	3	1-5.0×5.0m	1-Φ6.5m
Item	Model of cover culvert	Related CSP													
1	1-4.0×3.0m	1-Φ5.0m													
2	1-4.0×4.0m	1-Φ5.5m													
3	1-5.0×5.0m	1-Φ6.5m													

## COMPARE SHEET of CORRUGATED STEEL PIPE & REINFORCED CONCRETE CULVERT

Version 1.0

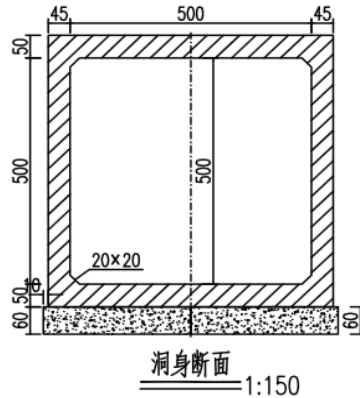
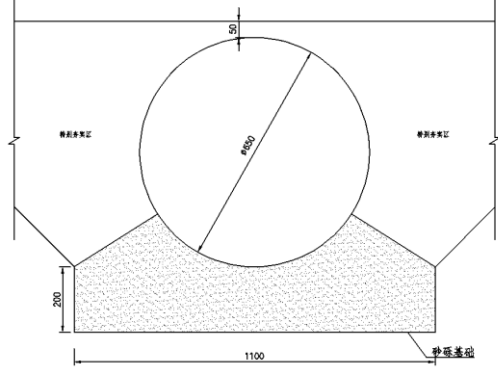
Revision Date: 2016/02/16

Section Selection	Channel	<p>1-4x3m cover culvert</p>	<p>1-Φ5.0m CSP</p>
		<p>1-4x4m cover culvert</p>	<p>1-Φ5.5m CSP</p>

# COMPARE SHEET of CORRUGATED STEEL PIPE & REINFORCED CONCRETE CULVERT

Version 1.0

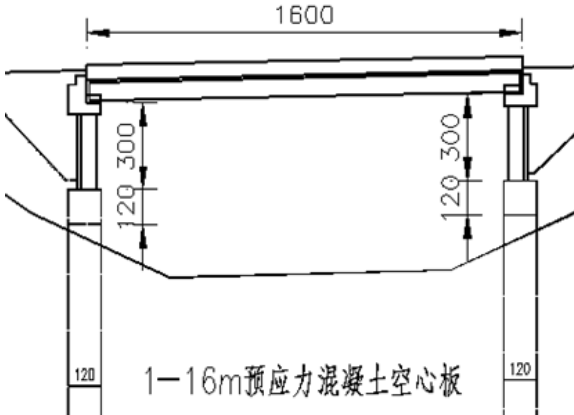
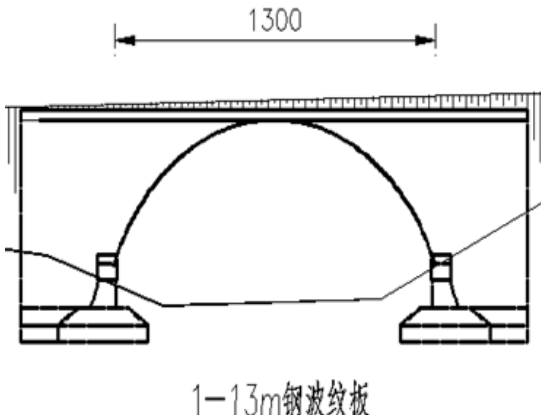
Revision Date: 2016/02/16

Section Selection	Channel	 <p>洞身断面 1:150</p> <p>1-5x5m Box culvert</p>	 <p>1-Φ6.50m CSP</p>														
Item		Reinforced Concrete Culvert	Corrugated Steel Pipe														
Section Selection	Small bridge	<p>For the cross-section form of the corrugated steel structure bridge, refer to the following figure and table selection</p> <table><tr><th rowspan="2">Item</th><th colspan="2">Reinforced concrete slab bridge</th><th colspan="2">Corrugated bridge</th></tr><tr><th>Span</th><th>structure type</th><th>Span</th><th>structure type</th></tr><tr><td>1</td><td>1-16.0m</td><td>Prestressed reinforced concrete hollow slab</td><td>1-13.0m</td><td>R=7.0356m, steel corrugated board with a central angle of 135°</td></tr></table>		Item	Reinforced concrete slab bridge		Corrugated bridge		Span	structure type	Span	structure type	1	1-16.0m	Prestressed reinforced concrete hollow slab	1-13.0m	R=7.0356m, steel corrugated board with a central angle of 135°
Item	Reinforced concrete slab bridge		Corrugated bridge														
	Span	structure type	Span	structure type													
1	1-16.0m	Prestressed reinforced concrete hollow slab	1-13.0m	R=7.0356m, steel corrugated board with a central angle of 135°													

# COMPARE SHEET of CORRUGATED STEEL PIPE & REINFORCED CONCRETE CULVERT

Version 1.0

Revision Date: 2016/02/16

Section Selection	Small bridge	 <p>1-16m RC slab Bridge</p>	 <p>1-13m span Corrugated Bridge</p>							
Cost comparison	Water culvert	Comparative analysis of comprehensive unit price of 1.5m round pipe culvert and 1.5m corrugated steel pipe culvert								
		Item	Project Name		Unit	Unit price	1.5m round pipe culvert		Steel corrugated pipe	
							Quantity	Total	Quantity	Total
		1	Tube section	Steel bar	kg	6	94	564		
		2		C30 concrete	M <sup>2</sup>	580	0.82	475.6		
		3		CSP	m	2750			1	2750
		4	Foundation	Excavation earthwork	M <sup>3</sup>	12	17.8	213.6	8.5	102
		5		Refilling gravel	M <sup>3</sup>	98	11.6	1136.8	6.45	632.1
		6		Foundation of C20 concrete	M <sup>3</sup>	420	2.74	1150.8		
		Total cost			CNY/m			3540.8		3484.1

# COMPARE SHEET of CORRUGATED STEEL PIPE & REINFORCED CONCRETE CULVERT

Version 1.0

Revision Date: 2016/02/16

Cost comparison	Water culvert	Comparative Analysis of Comprehensive Unit Price of 1-2x2m Cover Culvert and 2.5m Corrugated Steel Pipe Culvert								
		Item	Item		Unit	Unit Price	Cover culvert		Corrugated Steel Pipe	
							Quantity.	Total	Quantity	Total
		1	Cave	steel bar	kg	6	157	942		
		2		C30 concrete	M²	580	0.71	411.8		
		3		C25concrete	M²	530	5.6	2968		
		4		CSP	m	5200			1	5200
		5	Foundation	Excavation earthwork	M³	12	13	156	5.4	64.8
		6		Refilling gravel	M³	98	14	1372	6	588
		7		C20 concrete foundation	M³	420	0.81	340.2		
Total Cost			CNY/m			6190		5852.8		

# COMPARE SHEET of CORRUGATED STEEL PIPE & REINFORCED CONCRETE CULVERT

Version 1.0

Revision Date: 2016/02/16

Cost comparison	Water culvert	Comparative Analysis of Comprehensive Unit Price of 1-3x2.5m Cover Culvert and 3.0m Corrugated Steel Pipe Culvert								
		Item	Item	Unit	Unit Price	Cover culvert		Corrugated Steel Pipe		
						Quantity	Total	Quantity	Total	
		1	Cave	steel bar	kg	6	227	1362		
		2		C30 concrete	M <sup>2</sup>	580	1.04	603.2		
		3		C25concrete	M <sup>2</sup>	530	11.57	6132.1		
		4		CSP	m	6980			1	6980
		5	Foundati on	Excavation earthwork	M <sup>3</sup>	12	10	120	8.9	106.8
		6		Refilling gravel	M <sup>3</sup>	98	13.12	1285.76	7	686
		7		C20 concrete foundation	M <sup>3</sup>	420	1.2	504		
		Total cost			CNY /m			10007.06		7772.8

# COMPARE SHEET of CORRUGATED STEEL PIPE & REINFORCED CONCRETE CULVERT

Version 1.0

Revision Date: 2016/02/16

Cost comparison	Water culvert	Comparative Analysis of Comprehensive Unit Price of 1-3x3m Cover Culvert and 3.5m Corrugated Steel Pipe Culvert								
		Item	Project Name		Unit	Unit Price	Cover culvert		Corrugated Steel Pipe	
							Quantity	Total	Quantity	Total
		1	Cave	steel bar	kg	6	271	1626		
		2		C30 concrete	M <sup>2</sup>	580	1.46	846.8		
		3		C25concrete	M <sup>2</sup>	530	11	5830		
		4		CSP	m	8390			1	8390
		5	Foundati on	Excavation earthwork	M <sup>3</sup>	12	11.4	136.8	10	120
		6		Refilling gravel	M <sup>3</sup>	98	13	1274	7.5	735
		7		C20 concrete foundation	M <sup>3</sup>	420	1.56	655.2		
Total cost			CNY/m			10368.8		9245		

# COMPARE SHEET of CORRUGATED STEEL PIPE & REINFORCED CONCRETE CULVERT

Version 1.0

Revision Date: 2016/02/16

Cost comparison	Water culvert	Comparative Analysis of Comprehensive Unit Price of 1-4x3m Cover Culvert and 4.0m Corrugated Steel Pipe Culvert								
		Item	Item	Unit	Unit Price	Cover culvert		Corrugated Steel Pipe		
						Quantity	Total	Quantity	Total	
		1	Cave	steel bar	kg	6	294	1764		
		2		C30 concrete	M <sup>2</sup>	580	1.82	1055.6		
		3		C25 concrete	M <sup>2</sup>	530	15.4	8162		
		4		CSP	m	9280			1	9280
		5	Foundati on	Excavation earthwork	M <sup>3</sup>	12	21	252	14	168
		6		Refilling gravel	M <sup>3</sup>	98	20.4	1999.2	12.6	1234.8
		7		C20 concrete foundation	M <sup>3</sup>	420	1.6	672		
		Total cost			CNY/m			13904.8		10682.8

# COMPARE SHEET of CORRUGATED STEEL PIPE & REINFORCED CONCRETE CULVERT

Version 1.0

Revision Date: 2016/02/16

Cost comparison	Water culvert	Comparative analysis of comprehensive unit price of 1-4x4m cover culvert and 4.5m corrugated steel pipe culvert								
		Item	Item	Unit	Unit Price	Cover culvert		Corrugated Steel Pipe		
						Quantity	Total	Quantity	Total	
		1	Cave	steel bar	kg	6	428	2568		
		2		C30 concrete	M <sup>2</sup>	580	1.96	1136.8		
		3		C25concrete	M <sup>2</sup>	530	16.3	8639		
		3		CSP	m	11609			1	11609
		4	Foundation	Excavation earthwork	M <sup>3</sup>	12	21	252	21	252
		5		Refilling gravel	M <sup>3</sup>	98	18.5	1813	18.7	1832.6
		6		C20 concrete foundation	M <sup>3</sup>	420	1.6	1041.2		
		Total cost			CNY/m				15450	13693.6

# COMPARE SHEET of CORRUGATED STEEL PIPE & REINFORCED CONCRETE CULVERT

Version 1.0

Revision Date: 2016/02/16

Cost comparison	Tunnel	Comparative Analysis of Comprehensive Unit Price of 1-4x3m Cover Culvert and 5.0m Corrugated Steel Pipe Culvert								
		Item	Item	Unit	Unit Price	Cover culvert		Corrugated Steel Pipe		
						Quantity	Total	Quantity	Total	
		1	Cave	Steel bar	kg	6	294	1764		
		2		C30 concrete	M <sup>2</sup>	580	1.82	1055.6		
		3		C25 concrete	M <sup>2</sup>	530	15.4	8162		
		4		C25 concrete paving	M <sup>2</sup>	480	1.2	576		
		5		Corrugated Steel Pipe	m	12580			1	12580
		6	Foundati on	Excavation earthwork	M <sup>3</sup>	12	21	252	14	168
		7		Refilling gravel	M <sup>3</sup>	98	20.4	1999.2	12.6	1234.8
		8		C20 concrete foundation	M <sup>3</sup>	420	1.6	672		
		Total cost			CNY/m			14480.8		13982.8

# COMPARE SHEET of CORRUGATED STEEL PIPE & REINFORCED CONCRETE CULVERT

Version 1.0

Revision Date: 2016/02/16

Cost comparison	Tunnel	Comparative analysis of comprehensive unit price of 1-4x4m cover culvert and 5.5m corrugated steel pipe culvert								
		Item	Item	Unit	Unit Price	Cover culvert		Corrugated Steel Pipe		
						Quantity	Total	Quantity	Total	
		1	Cave	Steel bar	kg	6	428	2568		
		2		C30 concrete	M <sup>2</sup>	580	1.96	1136.8		
		3		C25 concrete	M <sup>2</sup>	530	16.3	8639		
		4		C25 concrete paving	M <sup>2</sup>	480	1.2	576		
		5		Corrugated Steel Pipe	m	14090			1	14090
		6	Foundati on	Excavation earthwork	M <sup>3</sup>	12	21	252	26	312
		7		Refilling gravel	M <sup>3</sup>	98	18.5	1813	21	2058
		8		C20 concrete foundation	M <sup>3</sup>	420	1.6	672		
		Total cost			CNY/m			16026		16460

# COMPARE SHEET of CORRUGATED STEEL PIPE & REINFORCED CONCRETE CULVERT

Version 1.0

Revision Date: 2016/02/16

Cost comparison	Tunnel	Comparative analysis of comprehensive unit price of 1-5x5m box culvert and 6.5m corrugated steel tube culvert								
		Item	Item	Unit	Unit Price	Cover culvert		Corrugated Steel Pipe		
						Quantity	Total	Quantity	Total	
		1	Cave	Steel bar	kg	6.5	1728	11232		
		2		C30 concrete	M²	680	11.25	7650		
		3		C25 concrete	M²	530				
		4		C25 concrete paving	M²	480				
		5		Corrugated Steel Pipe	m	17230			1	17230
		6	Foundati on	Excavation earthwork	M³	12	18.5	222	27	324
		7		Refilling gravel	M³	98	6	588	24	2352
		8		C20 concrete foundation	M³	420	0	0		
Total cost			CNY/m			19692		19906		

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Version 1.0

Revision Date: 2016/02/16

Cost comparison	Small Bridge	Comparative Analysis of Comprehensive Unit Price of 1-16m Small Bridge and 13m Corrugated Steel Plate Bridge								
		Item	Item	Unit	Unit Price	Cover culvert		Corrugated Steel Pipe		
						Quantity	Total	Quantity	Total	
		1	Upper	steel bar	kg	6	39990	239940		
		2		steel strand	kg	12	4456	53472		
		3		C50 concrete	M <sup>2</sup>	700	205	143500		
		4		C35 concrete	M <sup>2</sup>	680	48	32640		
		5		support	↑	80	400	32000		
		6		corrugated steel plate	m	45890			29	1330810
		7	Foundati on	Excavation earthwork	M <sup>3</sup>	12	596	7152	27	324
		8		C30 concrete	M <sup>3</sup>	540	1250	675000	312	168480
		9		C25 concrete	M <sup>3</sup>	480	1014	486720	460	220800
		10		steel bar	kg	6	123001	738006	48000	288000
		11		Acoustic Pipe	kg	7	380	2660		
		Total cost			CNY/S et			2411090		2008414

# COMPARE SHEET of CORRUGATED STEEL PIPE & REINFORCED CONCRETE CULVERT

Version 1.0

Revision Date: 2016/02/16

Construction period comparison	Item	According to the construction process and process of the circular pipe culvert, the cover culvert, the small bridge and the corrugated steel structure, the construction period is estimated as follows																																										
	Water culvert	<div>Comparison water culvert construction period</div> <table><tr><th rowspan="2">Item</th><th colspan="2">Completion culvert</th><th colspan="2">Corrugated steel pipe</th></tr><tr><th>Structure Type</th><th>Days</th><th>Structure Type</th><th>Days</th></tr><tr><td>1</td><td>1-Φ1.5m</td><td>30</td><td>1-Φ1.5m</td><td>15</td></tr><tr><td>2</td><td>1-2.0×2.0m</td><td>35</td><td>1-Φ2.5m</td><td>17</td></tr><tr><td>3</td><td>1-3.0×2.5m</td><td>40</td><td>1-Φ3.0m</td><td>20</td></tr><tr><td>4</td><td>1-3.0×3.0m</td><td>45</td><td>1-Φ3.5m</td><td>22</td></tr><tr><td>5</td><td>1-4.0×3.0m</td><td>48</td><td>1-Φ4.0m</td><td>26</td></tr><tr><td>6</td><td>1-4.0×4.0m</td><td>55</td><td>1-Φ4.5m</td><td>30</td></tr></table> <div>Note: The length of the culvert is assumed to be 40 meters.</div>				Item	Completion culvert		Corrugated steel pipe		Structure Type	Days	Structure Type	Days	1	1-Φ1.5m	30	1-Φ1.5m	15	2	1-2.0×2.0m	35	1-Φ2.5m	17	3	1-3.0×2.5m	40	1-Φ3.0m	20	4	1-3.0×3.0m	45	1-Φ3.5m	22	5	1-4.0×3.0m	48	1-Φ4.0m	26	6	1-4.0×4.0m	55	1-Φ4.5m	30
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Tunnel	<div>Channel duration comparison</div> <table><tr><th rowspan="2">Item</th><th colspan="2">Completion culvert</th><th colspan="2">Corrugated steel pipe</th></tr><tr><th>Structure Type</th><th>Days</th><th>Structure Type</th><th>Days</th></tr><tr><td>1</td><td>1-4.0×3.0m</td><td>50</td><td>1-Φ5.0m</td><td>32</td></tr><tr><td>2</td><td>1-4.0×4.0m</td><td>58</td><td>1-Φ5.5m</td><td>35</td></tr><tr><td>3</td><td>1-5.0×5.0m</td><td>65</td><td>1-Φ6.5m</td><td>38</td></tr></table> <div>Note: The length of the culvert is assumed to be 40 meters.</div>				Item	Completion culvert		Corrugated steel pipe		Structure Type	Days	Structure Type	Days	1	1-4.0×3.0m	50	1-Φ5.0m	32	2	1-4.0×4.0m	58	1-Φ5.5m	35	3	1-5.0×5.0m	65	1-Φ6.5m	38																
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# COMPARE SHEET of CORRUGATED STEEL PIPE & REINFORCED CONCRETE CULVERT

Version 1.0

Revision Date: 2016/02/16

Construction period comparison	small bridge	Small bridge construction period comparison				
		Item	Reinforced concrete slab bridge		Corrugated bridge	
			Structure Type	Days	Structure Type	Days
		1	1-16m prestressed reinforced concrete hollow slab	100	1-13m, R=7.0356m, steel corrugated bridge	60

## 4, SUMMARY:

Through the above comparison, the bellows has the following advantages:

1 High strength, due to its unique corrugated structure, it is 15 times more compressive than cement pipes of the same diameter

2 Convenient transportation, the weight of bellows culvert is only 1/10 to 1/5 of the same diameter cement pipe, even if there is no transportation equipment in a narrow place, it can be transported by hand.

3 long service life, steel corrugated pipe culvert is hot-dip galvanized steel pipe, so the service life is long, the life is 80-100 years, when used in a particularly corrosive environment, the steel with inner and outer surface bitumen is used. The bellows can be improved for more than 20 years based on the original service life.

4 Convenient construction: Corrugated pipe culverts are connected by sleeve or flange, and can be customized according to the needs. Even unskilled workers can operate. The construction can be completed in a short time with a small amount of manual operation, which is quick and convenient.

5 Excellent economy: The connection method is simple and can shorten the construction period.