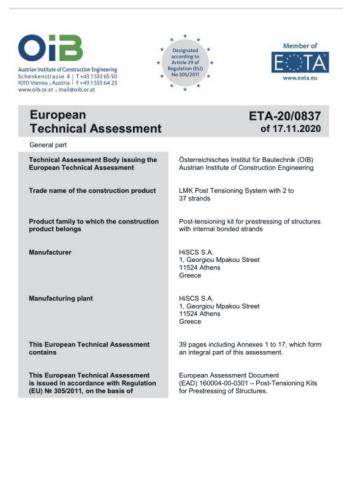


LMK



**LMK CABLE SYSTEM
FOR EXTRADOSED BRIDGE**

HISCS SMSA



Contents

Contents.....	1
Company profile.....	2
Extradosed bridge.....	3
Structure of cablesystem for extradosed bridge.....	4
Technical parameters and component of cable system.....	5
Anchorage type ASM(cable type PSP and type MSS are alternative)	6
Anchorage type BSM(cable type PSP and type MSS are alternative)	7
Anchorage type CSM(cable type PSP and type MSS are alternative)	8
Anchorage type DSM(cable type PSP and type MSS are alternative)	9
Saddle of cable system for Extradosed bridge.	10
Anti-sliding socket of saddle	11
Pipes of cable system.....	12
Cable body and strand used.....	13
Epoxy filling coated strand	14
Installation Of cable system.....	15

Company Profile

The LMK prestressed anchorage system derives from a collaboration between:

Highway Special Construction Systems (HiSS) Engineering Company (from Greece).

And

Liuzhou Jinxin Technology (LJT) Co., Ltd.

Extensive research, testing and development efforts have been performed in the field of post-tensioning and stayed cable applications to assure LMK's highest quality. All components are subjected to the most stringent testing and quality assurance procedures, based on internationally recognized codes and recommendations.

The LMK anchorage system combines LJT'S advanced production experience, by emerging a product among the fastest international developments in China, meeting the requirements of international AD/ETAG (European Assessment Documentation-former European Technical Approval Guideline), C (European Union Consortium Product Quality Certification), AASHTO LRFD (American Highway Standards), FIB (International Federation for Structural Concrete) & PTI (Post Tensioning and Prestressing Institute) standards.

The LMK anchorage system includes all types of anchorage applications, providing at the same time high quality services regarding design, installation-supervision and complete technical & construction support.

Business Scope:

1. Supply of LMK anchorage system
2. Supply of PC related materials and equipment for infrastructure applications.
3. Supply of strands including epoxy coated strand
4. Supply of cable systems for bridges including installation services.

EXTRADOSSED BRIDGE



An extradosed bridge employs a structure that combines the main elements of both a prestressed box girder bridge and a cable-stayed bridge. The name comes from the word "extrados", the exterior or upper curve of an arch, and refers to how the "stay cables" on an extradosed bridge are not considered as such in the design, but are instead treated as external prestressing tendons deviating upward from the deck. In this concept, they remain part of (and define the upper limit of) the main bridge superstructure.

Compared to a cable-stayed bridge of comparable span, an extradosed bridge uses much shorter pylons than the cable-stayed bridge, and a significantly shallower deck structure. This arrangement results in the typical extradosed "look" with shallow angle of stay cables. The extradosed bridge form is mostly suited to medium-length spans between 100 m (330 ft) and 250 m (820 ft), combining material savings compared to stayed cable bridges. They are frequently used when overall height, navigation clearance, or aesthetic requirements have made the cable-stayed less feasible.

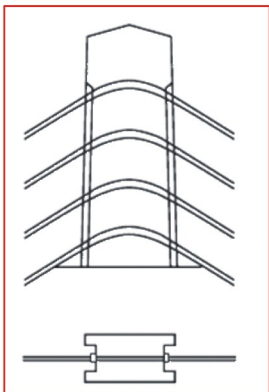
Merit of extradosed bridges:

+ Compared to prestressed concrete continuous bridges:

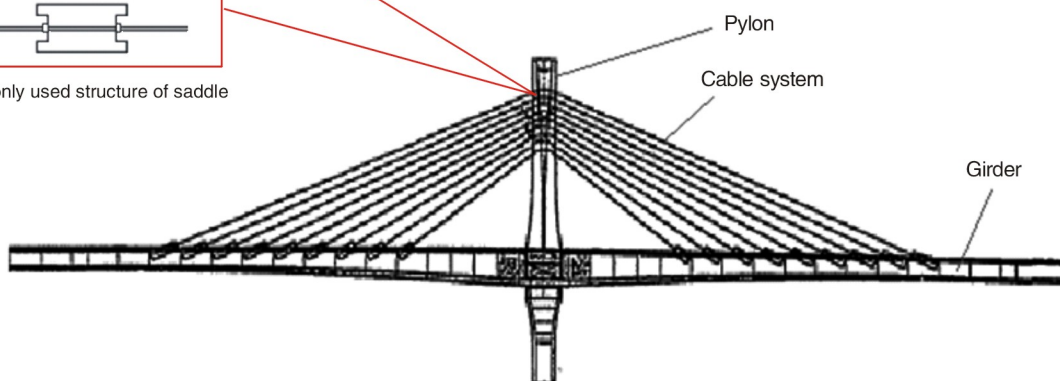
- (1) Longer span: It could double the span with the same midpoint height of girder.
- (2) Economical: It would be economical with the same span as continuous bridge for long-span applications.

+ Compared to stayed cable bridge:

- (1) Lower pylon: Easy construction with simple structure of pylon.
- (2) Lower change range of stress amplitude: It could be designed to use higher stress at 0.5–0.6 times of standard stress while stayed cable bridges are in the range of 0.4–0.45 times of standard stress improving the structure economy.
- (3) High stiffness: It is especially applicable to high load state with minor deformation.

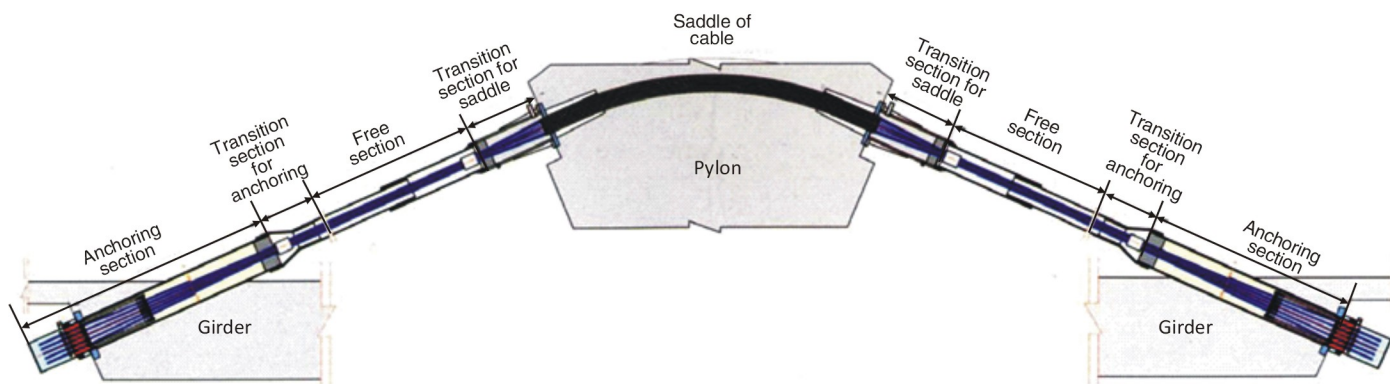


Commonly used structure of saddle



Typical sketch of extradosed bridge

STRUCTURE OF CABLE SYSTEM FOR EXTRADOSED BRIDGE



Structure of cable system for extradosed bridges:

- + Anchoring section
- + Transition section for anchoring
- + Free section
- + Transition section for saddle
- + Saddle of cable

Detail component as following:

- ①. Anchorage;
(The same structure of anchor at two sides of girder)
- ②. Damper;
- ③. Transition pipe (with waterproof);
- ④. Hoop;
- ⑤. HDPE pipe;
- ⑥. Strand (different types can be utilized);
- ⑦. Sliding sleeve;
- ⑧. Saddle (with anti-sliding device).

Standards applied to LMK's cable system for extradosed bridge:

- + Recommendations for Stay Cable Design, Testing and Installation (PTI-USA);
- + Acceptance of Stay Cable Systems Using Prestressing Steels (fib);
- + Acceptance Standards for Post-Tensioning Systems (PTI);
- + ASTM A882/A882M-04a: Standard Specification for Filled Epoxy-Coated Seven-Wire Prestressing Steel Strand;
- + ASTM D3035-12: Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter;
- + ASTM F714-12a: Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter;
- + ASTM A416/A416M-12a: Standard Specification for Steel Strand, Uncoated Seven-wire for Prestressing Concrete;
- + JIS G3536-2014: Uncoated Stress-Relieved Steel Wires and Strands for Prestressed Concrete;
- + NF A35-035-2001;
- + XP A35-037-2(type P);
- + XP A35-037-3(type SC).

TECHNICAL PARAMETERS AND COMPONENT OF CABLE SYSTEM

Technical parameters of LMK' cable system for extradosed bridge

1). Mechanical properties

+ Anchoring coefficient $\eta_A \geq 95\%$, Total breaking elongation $\xi \geq 2\%$.

+ Strand mechanical properties:

A. Minimum ultimate tensile stress:

$$f'_s = 1860 \text{ MPa}$$

B. Minimum yield stress:

$$f'_y = 0.90f'_s$$

C. Elastic modulus:

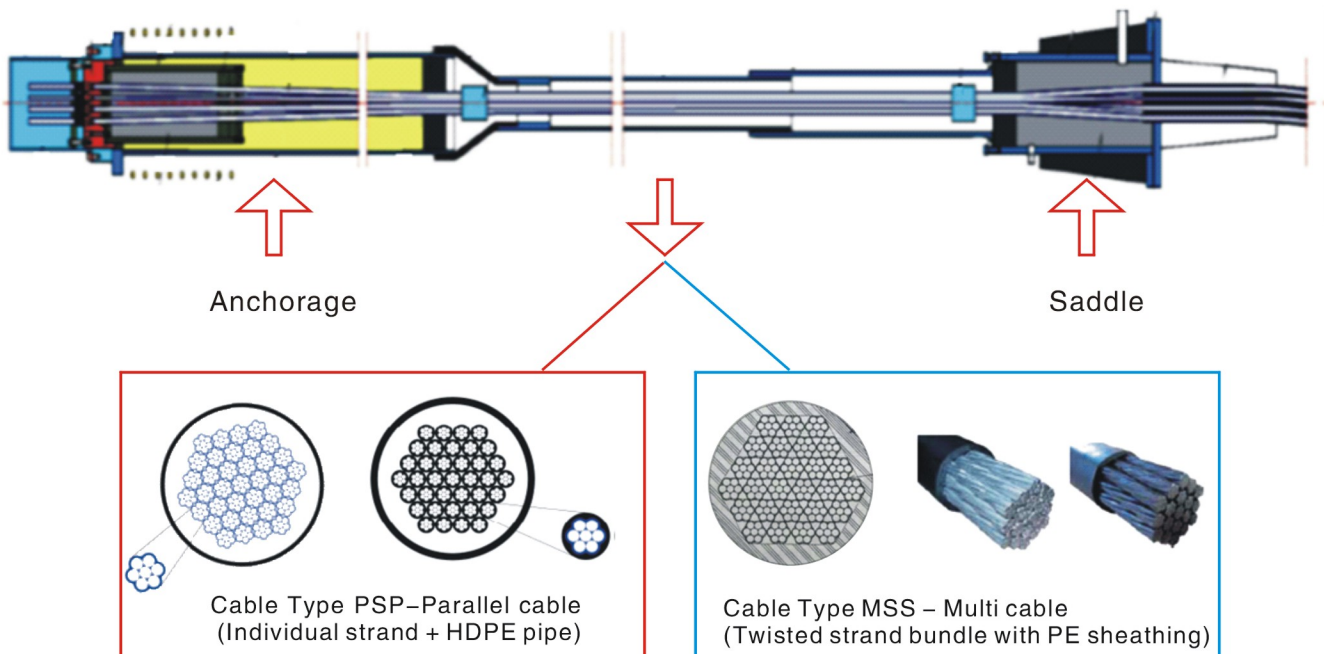
$$E = 197,000 \text{ MPa} \pm 5\%$$

2). Anti-corrosion properties:

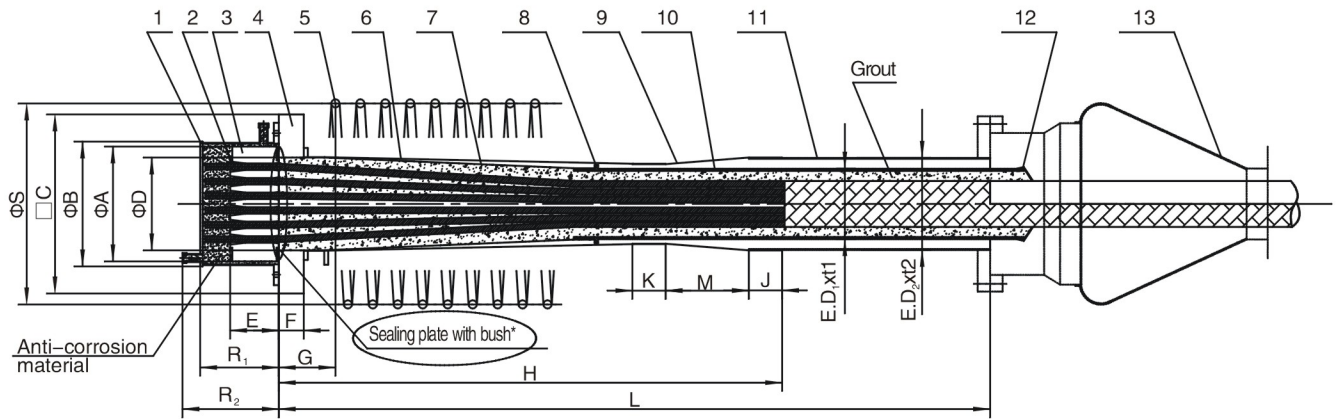
Good anti-corrosion with each part of system to be protected completely.

3). Excellent workability and replaceability of cable.

Component of cable system for extradosed bridges

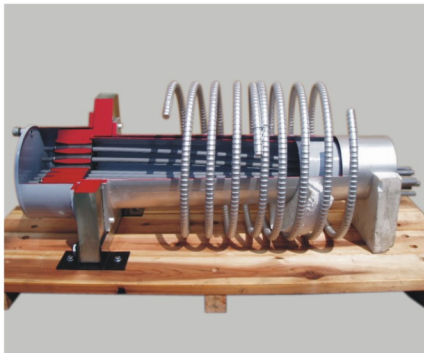


ANCHORAGE TYPE ASM (cable type PSP and type MSS are alternative)



- | | | | | |
|-------------------|-------------------------|-------------------------|----------------------------|-----------------------|
| 1. Protecting cap | 4. Anchor plate | 7. Inner trumpet sleeve | 10. HDPE pipe | 13. Waterproof funnel |
| 2. Wedge | 5. Spiral reinforcement | 8. Stopper ring | 11. Steel pipe with flange | |
| 3. Anchor head | 6. Outer trumpet sleeve | 9. Connecting tube | 12. PE joint pipe | |

*:The sealing plate with bush shall be set if using cable type PSP.



Parameters of anchorage type ASM

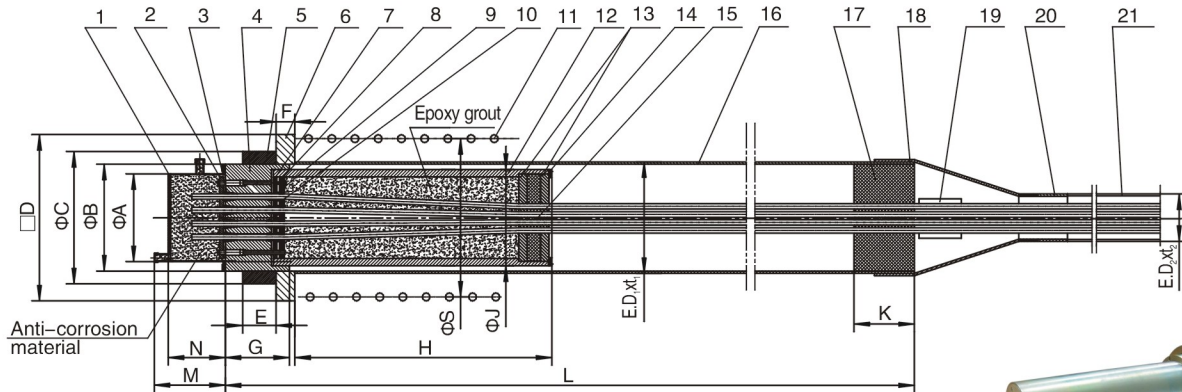
Unit:mm

Dimension Type	Protecting cap			Anchor head		Anchor plate		Spiral reinforcement		Inner trumpet sleeve	Connecting tube	HDPE pipe		Steel pipe with flange		H	J	K	L
	ΦB	R ₁	R ₂	ΦA	E	□C	F	ΦS	G	ΦD	M	E.D ₁	t ₁	E.D ₂	T ₂				
LMK16S15.2	250	370	420	220	80	350	50	330	120	170	200	160	8	203	6	1100	80	80	1500
LMK19S15.2	255	380	430	225	90	380	55	360	120	170	200	160	8	203	6	1110	80	80	1500
LMK27S15.2	290	400	450	260	110	420	60	400	120	205	200	180	8	219	6	1210	80	80	1600

Note:1.Subject to modification as per requirement of project or different load parameters.

2.The structural drawing of type ASM shown above is a example for using cable type MSS.It will be changed a little if using cable type PSP.

ANCHORAGE TYPE BSM (cable type PSP and type MSS are alternative)



- | | | | |
|----------------------|------------------------|--------------------------|-----------------------|
| 1. Protecting cap | 6. Bearing plate | 11. Spiral reinforcement | 16. Pre-embedded pipe |
| 2. Wedge | 7. Sealing spacer | 12. Extension socket | 17. Damper |
| 3. Anti-Loose device | 8. Sealing press plate | 13. Spacing plate | 18. Waterproof funnel |
| 4. Anchor head | 9. Sealing ring | 14. Pressing ring | 19. Hoop |
| 5. Ring nut | 10. Wear reducing bush | 15. Sealing plate | 20. Connecting pipe |
| | | | 21. HDPE pipe |



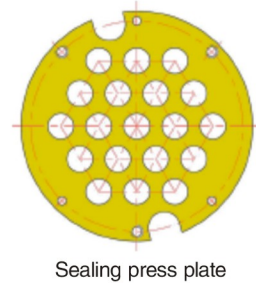
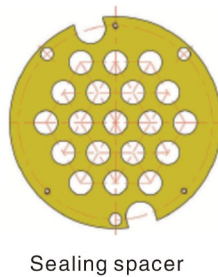
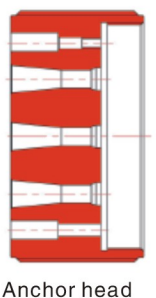
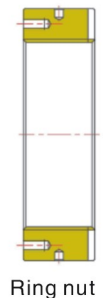
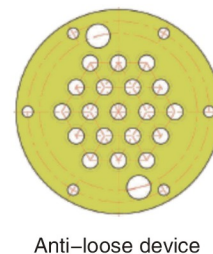
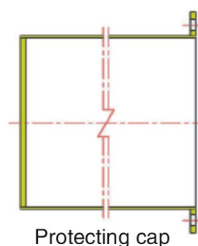
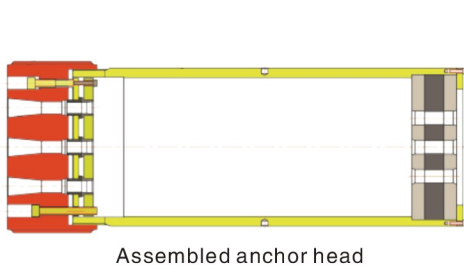
Parameters of anchorage type BSM

Unit:mm

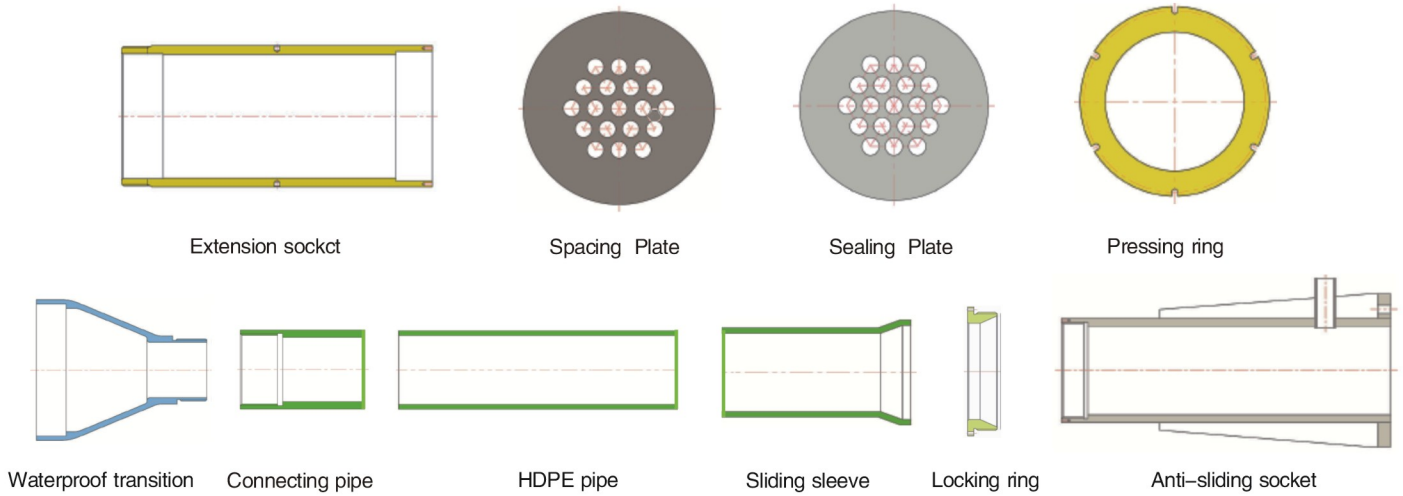
Dimension Type	Protecting cap		Anchor head		Ring nut		Bearing plate		Spiral reinforcement	Extension socket		Pre-embedded pipe			Damper	HDPE pipe		
	ΦA	M	N	ΦB	G	ΦC	E	□D		F	ΦJ	H	E.D ₁	t ₁		L	K	E.D ₂
LMK-BSM16S15.2	170	350	300	200	120	280	90	350	50	330	180	450	230	8	≥ 1800	120	160	8
LMK-BSM19S15.2	180	350	300	215	120	290	90	380	55	360	195	450	245	8	≥ 1800	120	160	8
LMK-BSM27S15.2	210	350	300	245	130	320	100	420	60	400	205	600	273	8	≥ 2000	140	180	8
LMK-BSM31S15.2	220	350	300	255	150	330	120	440	60	420	235	650	299	8	≥ 2000	140	200	10
LMK-BSM37S15.2	240	350	300	280	160	350	130	500	70	480	260	700	325	8	≥ 2100	150	200	10
LMK-BSM43S15.2	270	350	300	310	170	370	140	520	80	500	290	800	351	10	≥ 2200	150	235	10
LMK-BSM55S15.2	290	350	300	330	180	410	150	560	80	540	310	900	377	10	≥ 2200	150	235	10

Note:1. Subject to modification as per requirement of project or different load parameters.

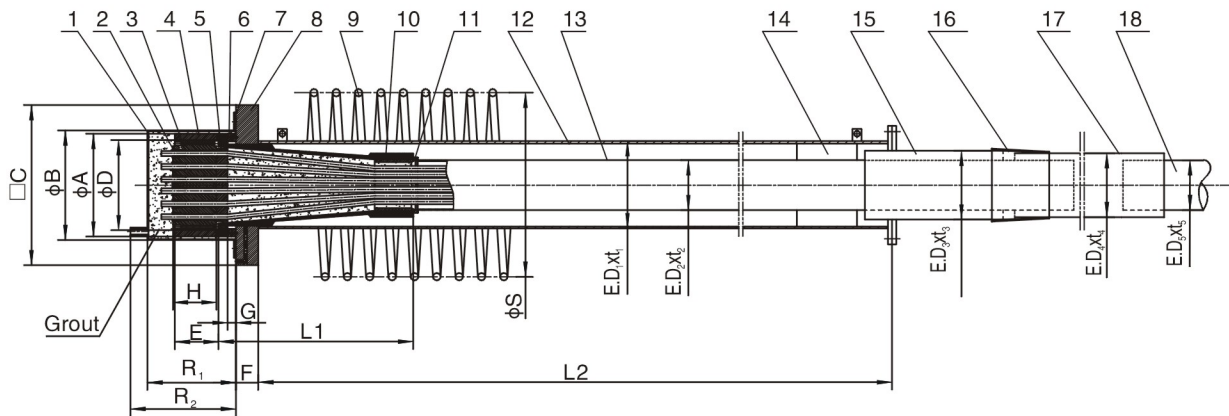
2. The structural drawing of type BSM shown above is a example for using cable type MSS. It will be changed a little if using cable type PSP.



CABLE SYSTEM FOR EXTRADOSSED BRIDGE **LMK**



ANCHORAGE TYPE CSM (cable type PSP and type MSS as alternatives)



- | | | |
|-------------------|-------------------------|---------------------|
| 1. Protecting cap | 7. Sealing packing | 13. Protecting pipe |
| 2. Wedge | 8. Bearing plate | 14. Damper |
| 3. Anchor head | 9. Spiral reinforcement | 15. Adapting tube |
| 4. Nut | 10. Trumpet socket | 16. Sealing boot |
| 5. Spacer | 11. Sealing bush | 17. Connecting pipe |
| 6. Shim | 12. Protecting pipe | 18. HDPE pipe |



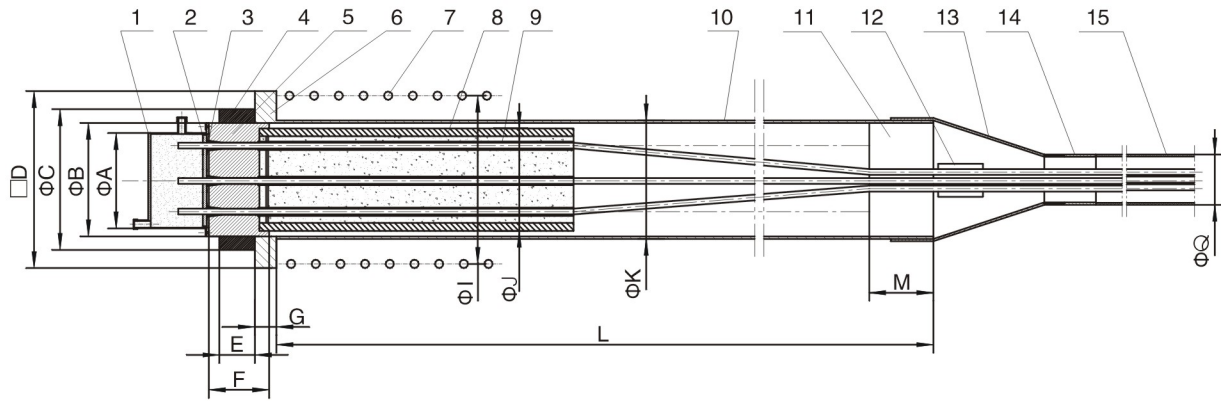
Parameters of anchorage type CSM

rs:	Protecting cap		Anchor head		Nut		Shim	Bearing plate	Spiral reinforcement	Trumpet socket	Pre-embedded pipe			Protecting pipe		Adapting tube		Connecting pipe		HDPE pipe			
	φB	R ₁	R ₂	φD	H	φA	E	G	□C	F	φS	L ₁	E.D ₁	t ₁	L ₂	E.D ₂	t ₂	E.D ₃	t ₃	E.D ₄	t ₄	E.D ₅	t ₅
	Unit: mm																						
LMK-CSM16S152	305	450	500	200	120	280	90	20×2	350	50	330	450	230	8	≥1800	160	8	200	6	180	10	160	8
LMK-CSM19S152	320	450	500	215	120	290	90	20×2	380	55	360	450	245	8	≥1800	160	8	210	6	180	10	160	8
LMK-CSM27S152	350	450	500	245	130	320	100	20×2	420	60	400	600	273	8	≥2000	180	8	230	6	200	10	180	8

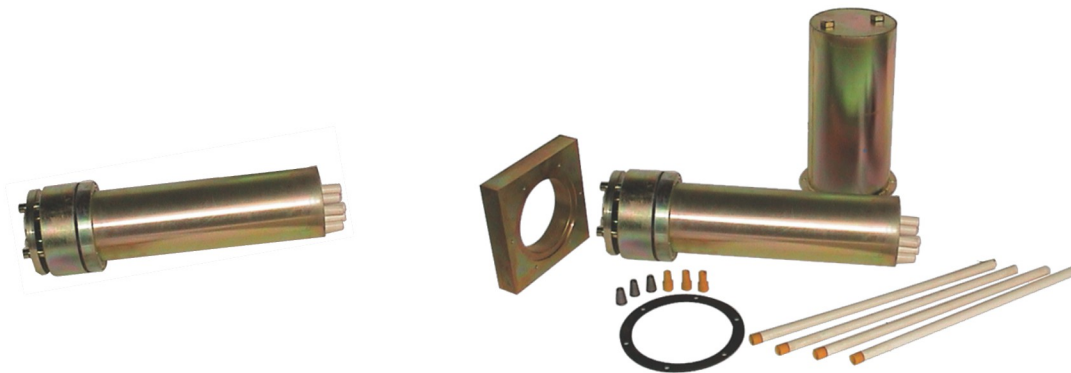
Note:1. Subject to modification as per requirement of project or different load parameters.

2. The structural drawing of type CSM shown above is a example for using cable type MSS (with minor changes if using cable type PSP).

ANCHORAGE TYPE DSP (only the cable type PSP is applicable)



- | | | | | |
|----------------------|------------------|-------------------------|-----------------------|---------------------------|
| 1. Protecting cap | 4. Ring nut | 7. Spiral reinforcement | 10. Pre-embedded pipe | 13. Waterproof transition |
| 2. Anti-loose device | 5. Anchor head | 8. Extension socket | 11. Damper | 14. Connecting pipe |
| 3. Wedge | 6. Bearing plate | 9. PE tube | 12. Hoop | 15. HDPE pipe |



Parameters of anchorage type DSP

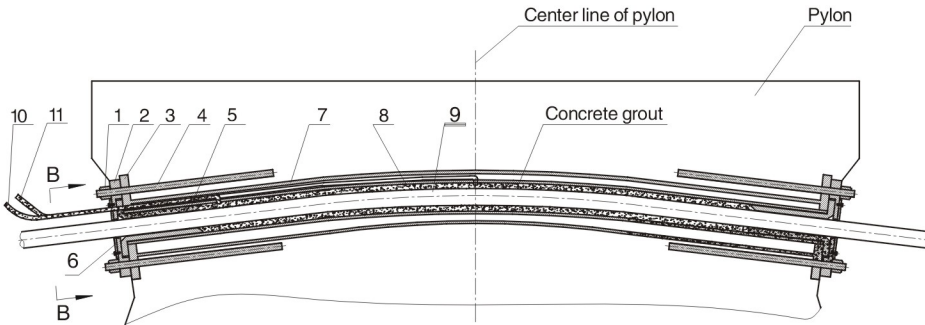
Unit: mm

Dimension Type	Protecting cap	Ring nut		Anchor head		Bearing plate		Spiral reinforcement	Extension socket	Pre-embedded pipe		Damper	HDPE pipe
	ΦA	ΦC	E	ΦB	F	□D	G	ΦI	ΦJ	K	L	M	Q
LMK-DSP16S15.2	170	280	90	200	120	350	50	330	180	230	≥ 900	120	160
LMK-DSP19S15.2	180	290	90	215	120	380	55	360	195	245	≥ 900	120	160
LMK-DSP27S15.2	210	320	100	245	130	420	60	400	205	273	≥ 1200	140	180
LMK-DSP31S15.2	220	330	120	255	150	440	60	420	235	299	≥ 1300	140	200
LMK-DSP37S15.2	240	350	130	280	160	500	70	480	260	325	≥ 1400	150	200
LMK-DSP43S15.2	270	370	140	310	170	520	80	500	290	351	≥ 1600	150	235
LMK-DSP55S15.2	290	410	150	330	180	560	80	540	310	377	≥ 1800	150	235

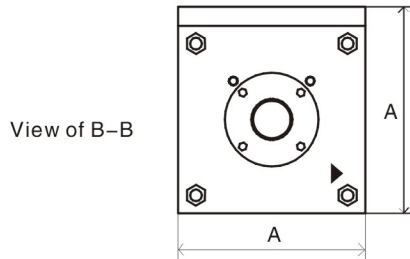
Note: 1. Subject to modification as per requirement of project or different load parameters.

SADDLE OF CABLE SYSTEM FOR EXTRADOSED BRIDGE

Saddle type DPC



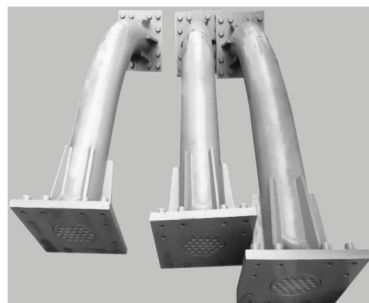
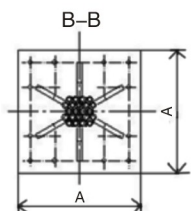
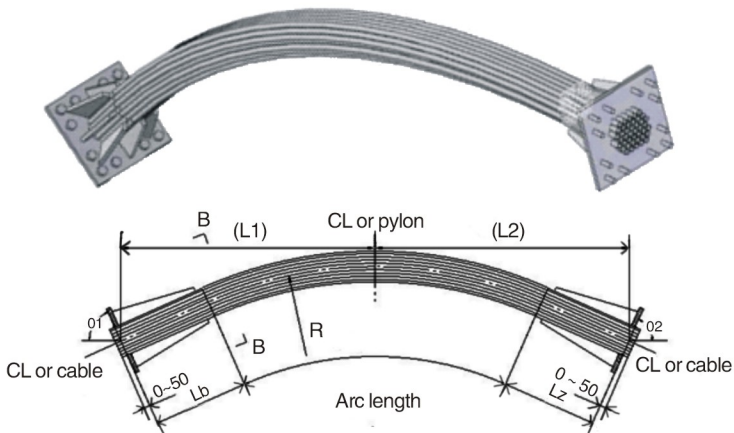
1. Nut 2. Pressing plate 3. Flange of outer pipe 4. Anchor bar 5. Wedge 6. Sealing plate
7. Outer pipe 8. Inner pipe 9. Cable 10. Grouting hose 11. Venting hose



Unit:mm

Type	Size	AXA
16S15.2		350X350
19S15.2		400X400
27S15.2		500X500

Saddle type SIT

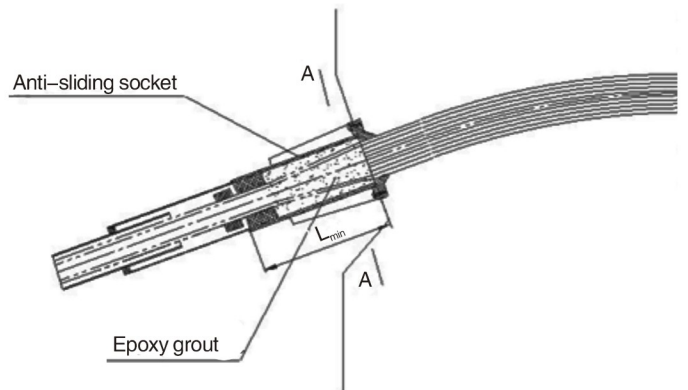


Unit:mm

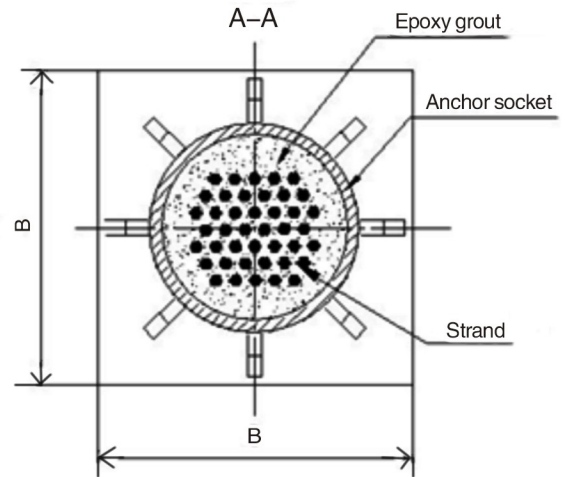
Type	Size	AXA
16S15.2		350X350
19S15.2		400X400
27S15.2		500X500
31S15.2		500X500
37S15.2		500X500
43S15.2		500X500
55S15.2		500X500

LMK CABLE SYSTEM FOR EXTRADOSED BRIDGE

Anti-sliding Socket of Saddle



Unit:mm		
Type \ Size	BXB	L _{min}
16S15.2	350X350	650
19S15.2	400X400	700
27S15.2	500X500	700
31S15.2	500X500	800
37S15.2	500X500	800
43S15.2	500X500	900
55S15.2	500X500	900



Damper of cable system for extradosed bridge



PIPES OF CABLE SYSTEM



HDPE pipe with helical ribs



Extension sleeve



HDPE Pipe smooth type

Properties of HDPE pipe (Inspected by method ASTM)

Unit:mm

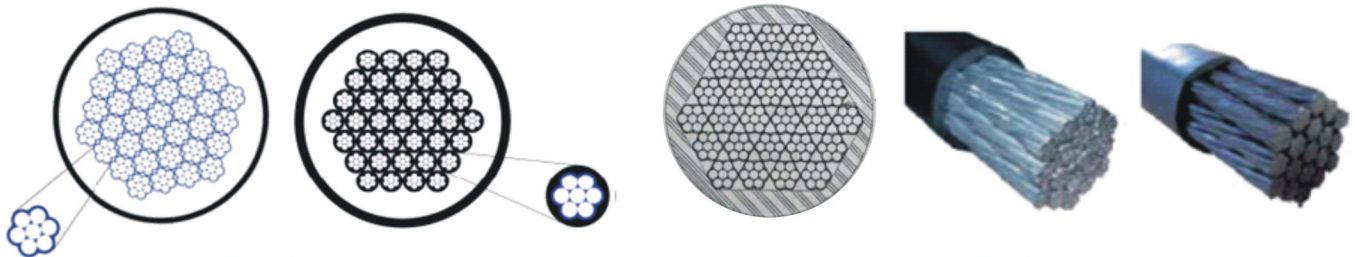
Property	ASTM Test method	Value required
Density(g/cm ³)	D 1505	0.941–0.965
Melt index(g/10cm ³)	D 1238	0.2–1.0
Flexural modulus(MPa)	D 790	500–1100
Tensile strength at yield(MPa)	D 638	21–28
Elongation at rupture	D 638	500%–700%
Hardness	D 2240	64–65
Low temperature brittleness	D 746	–40°C at 50% of flexibility(Min)

Properties of HDPE pipe(Tested by method JIS)

Unit:mm

Item	Property	Testing method
Melt flow rate	0.11 ± 0.04g/10min	JIS K 6922–2
Density	≥ 942kg/m ³	JIS K 6922–2
Tensile stress at yield point	≥ 20MPa	JIS K 6922–2
Duro meter hardness	≥ HDD60	JIS K 7215
Vicat softness temperature	≥ 115°C	JIS K 7208

CABLE BODY AND STRAND USED



Cable Type PSP-Parallel
(Individual strand + HDPE pipe)

Cable Type MSS-Multi cable
(Twisted strand bundle with PE sheathing)

STRAND USED TO CABLE



Hot-dip zinc coated prestressing
7-wire strand
(Φ 15.7mm)



Hot-dip zinc coated prestressing
7-wire strand
(Φ 15.2mm)



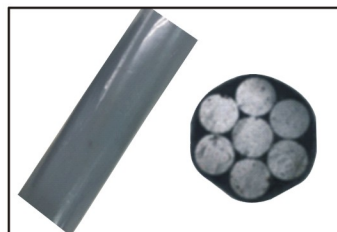
Epoxy-coated 7-wire
prestressing steel strand



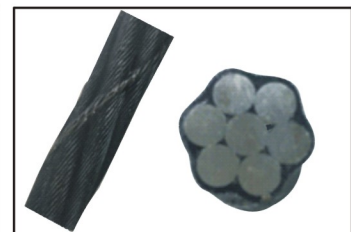
Unbonded strand(epoxy
coated strand with one layer
HDPE sheath)



Unbonded strand(galvanized
strand with one layer HDPE
sheath)



Type-NB



Type-BW

Supro-strand

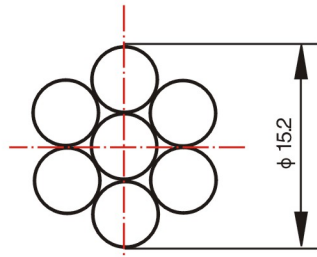
HOT-DIP ZINC COATED STRAND

Parameters of hot-dip zinc coated prestressing seven-wire strands

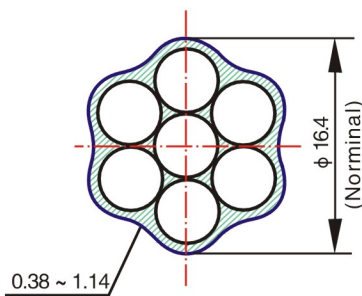
Unit:mm

Standard	Nominal diameter (mm)	Tensile strength (MPa)	Breaking load (KN)	Yield load KN ≥	Elongation Agt (%) ≥	Relaxation (70% of specified minimum breaking strength at 1000h) (%) (Max)	Unit weight (kg/m)	Cross- section area (mm ²)	Weight of zinc coating (g/m ²)
French standard NF A35 -035-2001	12.5	1860	173	154	3.5	2.5	0.726	93	190 ~ 350
	12.9	1860	186	166			0.781	100	190 ~ 350
Chinese standard YB/T 152 -1999	15.2	1860	260	230			1.093	140	190 ~ 350
	15.7	1860	279	248			1.172	150	190 ~ 350

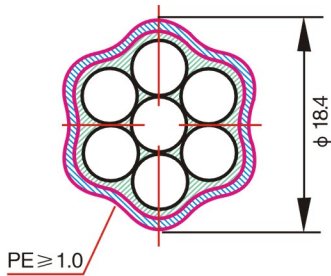
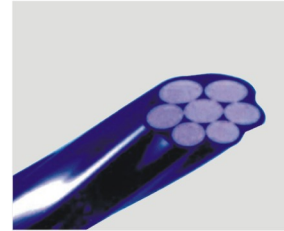
EPOXY FILLING COATED STRAND



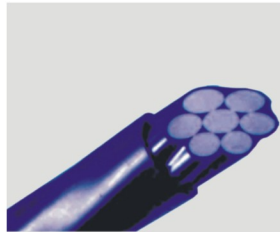
Bare strand



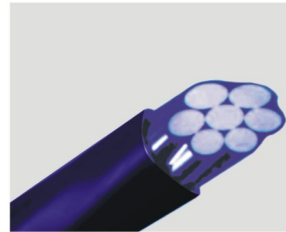
Epoxy filling coated strand



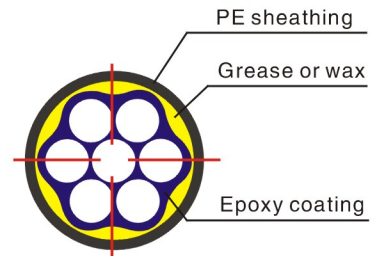
PE ≥ 1.0



Epoxy filling coated strand with PE sheath (without grease)



Epoxy filling coated strand with PE sheath (with grease)

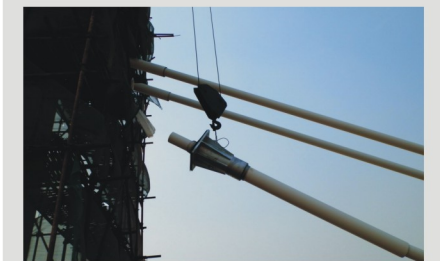
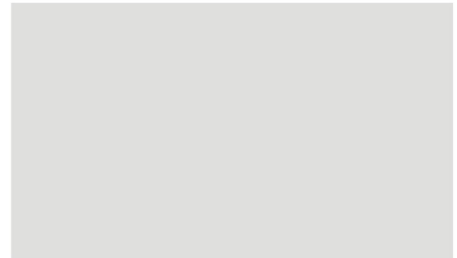
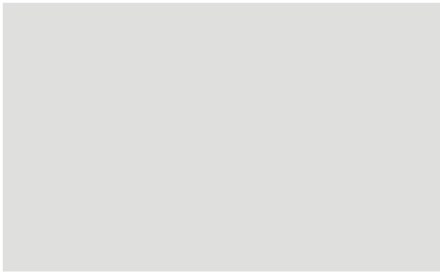


Parameters of epoxy coated strand(ASTM A882/A882M-04a)

Unit:mm

Index products	Nominal diameter (mm)	Overall diameter (mm)	Section area (mm ²)	Unit weight (Kg/m)	Coating thickness (mm)	Tensile strength (MPa) ≥	Breaking load (KN) ≥	Yield load (KN) ≥	Elongation (%) ≥	Relaxation (70% of specified minimum breaking strength at 1000h) (%) ≤	Weight of grease (g/m)	Remarks
Epoxy filling coated strand	16.4	15.8-17.4	140	1.155	0.38 ~ 1.14	1860	260	234	3.5	6.0	/	/
Epoxy filling coated strand with PE sheath	18.4	18.0-20.5	140	1.225	PE ≥ 1.0	1860	260	234	3.5	6.0	/	Without grease
Epoxy filling coated strand with PE sheath	18.8	18.2-20.8	140	1.255	PE ≥ 1.0	1860	260	234	3.5	6.0	20 ~ 50	filled with grease

INSTALLATION OF CABLE SYSTEM



	5	9
1	6	10
2	7	
3	8	
4		

1. HDPE pipe welding
2. Anchorage setup
3. Saddle's anti-sliding socket setup
4. HDPE pipe setup and hanging
5. Strand threading
6. Stressing end cable
7. Damper setup
8. Hoop setup
9. Anti-corrosion material filling
10. Surface treatment

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