Form No. 2: Bridge Design

Form No. 2

Bridge Design
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1. **Cables and Standard Tower Selection**
2. **Main Cable Anchor Blocks**
3. **Walkway & Tower Foundations**
4. **Windguy Cable Anchor Blocks**
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Bridge No & Name: ……

River Name: ……

District Name: ……

Designed by: ……

Approved by: ……

Date: ……

Bridge No: …… **Bridge Name :**……
District:……...

Span: …… . **m,** **Walkway Width : 106cm**

1. Cables and Standard Tower Selection for Suspension Bridge Type

A. Survey Data & Calculation of Freeboard

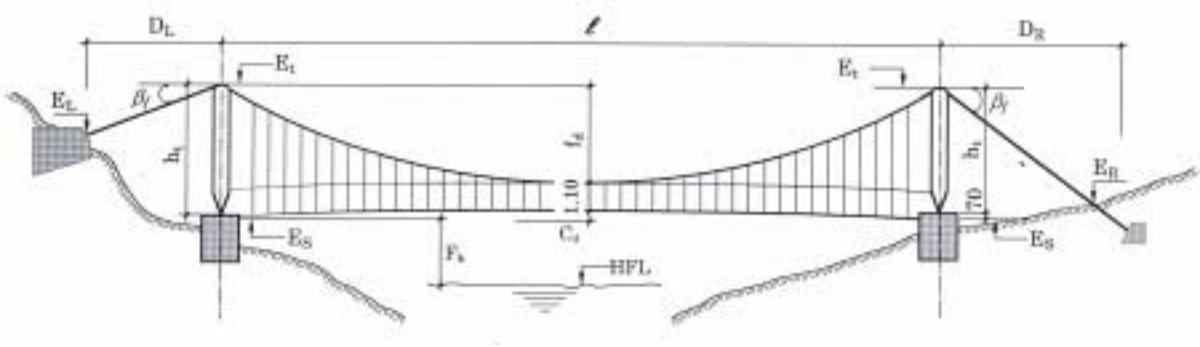


Figure 1.1 Bridge Geometry

1. Span of the Bridge (should be rounded off to the nearest meter) ℓ = ... m

2. Elevation of the Spanning Cable Anchor Point E_s = ... m

3. Highest Flood Level **HF**L = ... m

4. **Freeboard** (min. 5.00m) F_b = E_s **- HFL** = F_b = ... m

(If the freeboard is less than 5.00m, try either to raise the elevation of the spanning cable anchor point by increasing the height of the Walkway and Tower Foundation, or to adjust the span to gain the required elevation.)

B. Selection of Cables and Standard Tower (Pylon)

Select the Main and Spanning Cable combinations, standard tower type and tower height $\mathbf{h_t}$ and the Bridge Geometry according to the span from the following table No1.1. The Bridge Geometry refers to main cable dead load sag $\mathbf{f_d}$, dead load camber $\mathbf{c_d}$ of spanning cable and the main cable inclination at tower saddle $\mathbf{\beta_f}$ in full load case.

Table No. 1.1: Selection of Cables and Standard Towers

Span	Tower Height/(Type)	Cables Nos. and Diameter			Dead Load Sag	Hoisting Sag	Camber	Full load Backstay Angle
l	h_t	Main	Spanning	Windguy	f_d	f_h	c_d	ß$_f$
m	m	mm	mm	mm	m	m	m	deg.
30.0	5.50 (1)	2 ø 26	2 ø 26	Not Required	4.20	4.13	0.90	29.83
31.0					4.15	4.07	0.95	28.83
32.0					4.10	4.02	1.00	27.88
33.0					4.10	4.01	1.00	27.24
34.0					4.08	3.99	1.02	26.55
35.0					4.05	3.95	1.05	25.84
36.0					4.22	4.12	0.88	26.14
37.0					4.19	4.09	0.91	25.49
38.0					4.16	4.05	0.94	24.88
39.0					4.13	4.01	0.97	24.31
40.0					4.10	3.97	1.00	23.77
41.0					4.10	3.96	1.00	23.39
42.0					4.10	3.96	1.00	23.03
43.0					4.30	4.16	0.80	23.48
44.0					4.40	4.26	0.70	23.53
45.0					4.40	4.25	0.70	23.20
46.0		2 ø 32	2 ø 32		3.92	3.77	1.18	20.45
47.0					3.90	3.74	1.20	20.10
48.0					4.05	3.89	1.05	20.39
49.0					4.05	3.88	1.05	20.13
50.0					4.10	3.93	1.00	20.07
51.0					4.10	3.92	1.00	19.83
52.0					4.10	3.91	1.00	19.61
53.0					4.10	3.90	1.00	19.40
54.0					4.10	3.88	1.00	19.20
55.0					4.25	4.04	0.85	19.46
56.0	7.35 (2)				5.47	5.30	1.48	22.82
57.0					5.44	5.26	1.51	22.46
58.0					5.41	5.22	1.54	22.12
59.0					5.38	5.18	1.57	21.79
60.0					5.35	5.13	1.60	21.48
61.0					5.35	5.12	1.60	21.26
62.0					5.45	5.22	1.50	21.32
63.0					5.65	5.42	1.30	21.65

64.0					5.85	5.63	1.10	21.97
65.0					5.95	5.72	1.00	22.01

Table No. 1.1 (continued)

Span	**Tower Height/(Type)**	**Cables Nos. and Diameter**			**Dead Load Sag**	**Hoisting Sag**	**Camber**	**Full load Backstay Angle**
l **m**	h_t **m**	**Main mm**	**Spanning mm**	**Windguy mm**	f_d **m**	f_h **m**	c_d **m**	$ß_f$ **deg.**
66.0	**9.20 (3)**	**2 ø 32**	**2Ø 32**	**Not Required**	7.02	6.81	1.78	24.48
67.0					6.99	6.77	1.81	24.15
68.0					6.96	6.73	1.84	23.83
69.0					6.93	6.69	1.87	23.54
70.0					7.20	6.97	1.60	23.97
71.0					7.40	7.17	1.40	24.22
72.0					7.60	7.37	1.20	24.47
73.0					7.70	7.46	1.10	24.47
74.0					7.65	7.40	1.15	24.14
75.0					7.65	7.40	1.15	23.93
76.0	**11.05 (4)**	**4 ø 26**			8.57	8.36	2.08	25.38
77.0					8.54	8.33	2.11	25.07
78.0					8.51	8.29	2.14	24.77
79.0					8.48	8.25	2.17	24.48
80.0					8.45	8.22	2.20	24.20
81.0				**Ø 26 (Optional only)**	8.42	8.18	2.23	23.93
82.0					8.39	8.14	2.26	23.67
83.0					8.36	8.10	2.29	23.41
84.0					8.33	8.06	2.32	23.16
85.0					8.30	8.02	2.35	22.92
86.0					8.27	7.98	2.38	22.68
87.0					8.24	7.94	2.41	22.46
88.0					8.21	7.90	2.44	22.24
89.0					8.35	8.04	2.30	22.34
90.0					8.55	8.24	2.10	22.56
91.0					8.85	8.54	1.80	22.96
92.0					9.05	8.74	1.60	23.16
93.0					9.25	8.95	1.40	23.36
94.0					9.25	8.94	1.40	23.20
95.0					9.20	8.87	1.45	22.96
96.0		**4 ø 32**			7.98	7.68	2.67	20.00
97.0					8.05	7.75	2.60	20.00
98.0					8.13	7.82	2.52	20.00
99.0					8.20	7.89	2.45	20.00

100.0					8.28	7.96	2.37	20.00

Table No. 1.1 (continued)

Span	**Tower Height/(Type)**	**Cables Nos. and Diameter**			**Dead Load Sag**	**Hoisting Sag**	**Camber**	**Full load Backstay Angle**
l	h_t	**Main**	**Spanning**	**Windguy**	f_d	f_h	c_d	$ß_f$
m	**m**	**mm**	**mm**	**mm**	**m**	**m**	**m**	**deg.**
101.0					8.35	8.03	2.30	20.00
102.0					8.40	8.07	2.25	20.00
103.0					8.50	8.17	2.15	20.00
104.0					8.57	8.23	2.08	20.00
105.0					8.65	8.31	2.00	20.00
106.0					8.71	8.36	1.94	20.00
107.0					8.80	8.45	1.85	20.00
108.0					8.85	8.49	1.80	20.00
109.0					8.94	8.58	1.71	20.00
110.0	**11.05 (4)**	**4 ø 32**	**2 ø 32**	**ø 26 (Optional only)**	9.00	8.63	1.65	20.00
111.0					9.00	8.62	1.65	19.88
112.0					8.95	8.55	1.70	19.70
113.0					8.95	8.54	1.70	19.60
114.0					8.95	8.53	1.70	19.50
115.0					8.90	8.46	1.75	19.34
116.0					8.90	8.45	1.75	19.24
117.0					8.85	8.38	1.80	19.09
118.0					8.85	8.37	1.80	19.00
119.0					8.85	8.36	1.80	18.92
120.0					8.85	8.34	1.80	18.83

The above Cable Combinations and Towers have been calculated for the following specifications and bridge geometry as per Figure 1:

Cables: construction 7 x 19, wire strand core, **160 kg/mm^2 (**1.57 kN/mm^2**)** tensile strength of wire
Safety Factor: minimum **3**

Live load $p = (300 + \frac{5000}{span})\ kg/m^2$ or $(3 + \frac{50}{span})\ kN/m^2$

or

p = 400 kg/m^2 (4 kN/m^2**)** if the span is 50.0 m or less

Backstay Angle $\beta_f \cong$ **18° to 30°**

Camber c_d = **1.5% to 3% of the span**

Safety factor for Tower = 1.6

Example: *Span =* ***88m***

⇒ *selected cable combination:*

Main Cables	*:*	***nos. 4∅26mm***
Spanning Cables	*:*	***nos. 2∅ 32mm***
Windguy Cable	*:*	***not applicable***

Dead Load Sag, ***fd = 8.21m***
Dead Load Camber, ***Cd = 2.44m***
Backstay Angle, β_f ***= 22°***

⇒ *selected Tower:* *Standard Tower Height,* h_t ***= 11.05m / Type 4***

Selected Cable combination, Bridge Geometry and Standard Towers from Table 1.1:

MC	Main Cables:	**nos. .. ∅ ..…..mm**
SC	Spanning Cables:	**nos. 2 ∅ …...mm**
HRC	Handrail Cables:	**nos. 2 ∅ 13 mm**
FC	Fixation Cables:	**nos. 2 ∅ 13 mm**
WGC	Windguy Cables (optional):	**nos. 2 ∅ …...mm**
Dead Load Sag,		f_d **= …….m**
Dead Load Camber,		c_d **= …….m**
Standard Tower Type:		**Type……..**
Tower Height,		h_t **= .....m**

C. Fixing the Backstay Lengths (D_L and D_R) and Main Cable Anchorage Elevations (E_L and E_R)

- Fix the position of the Main Anchorage Foundation Blocks and their Cable Anchorage Elevations on the right bank and the left bank in the bridge profile considering the topography and geological condition of the ground (refer to Chapter 3.3.4 of the Technical Handbook, Vol. I for detailed procedures).
- Measure the backstay length $\mathbf{D_L}$ and $\mathbf{D_R}$ with a scale in the bridge profile.
- Calculate the Main Cable Anchorage Elevation.

Calculated Backstay Length (D_L and D_R) and Main Cable Anchorage Elevations, (E_L and E_R):

$\mathbf{E_t = E_s + 0.70 + h_t}$	=…….....m
β_f (from Table 1.1)	=……m
$\mathbf{D_L}$ (measured from the bridge profile)	=…….....m
$\mathbf{D_R}$ (measured from the bridge profile)	=…….....m
$\mathbf{E_L = E_t - (D_L \times \tan \beta_f)}$	=……m
$\mathbf{E_R = E_t - (D_R \times \tan \beta_f)}$	=……m

D. Calculation of Cable Lengths

Type of Cable	dia (mm)	Nos	Backstay Length [m]		Cutting Length* [m/pc]
			D_L	D_R	
Main Cable	……	……	……	……	
Spanning Cable	……	2	0	0	
Handrail Cable	13	2	0	0	
Fixation Cable	13	2	0	0	
Windguy Cable** (Optional)	26	1 (U/S)	0	0	
		1 (D/S)	0	0	
Windties** (Optional)	13	1	0	0	

*** Cutting Length:**

Main Cable = 1.08 x Span + 1.15 (D_L+D_R) + Anchorage Length on the Right Bank + Anchorage Length on the Left Bank.

Calculate the Anchorage Lengths only after selection of the Main Cable Anchor Blocks.

Spanning Cable = 1.025 x Span + 3.5 m.
Handrail Cable = Span
Fixation Cable = Span

* * Windguy Cable = Refer to Design of Windguy Arrangement (Chapter 6)
** Windties = Refer to Design of Windguy Arrangement (Chapter 6)

E. Calculation of Hoisting Sag

This calculation has to be made after the tower erection work has been completed.

1. Actual Span measured in the field ℓ =..... m
2. Hoisting Sag (from Table No 1.1 as per actual span) $\mathbf{f_h}$ = ……. m
3. Tower Height $\mathbf{h_t}$ =…..… m
4. Marking Point on Tower (from steel tower base) at hoisting sag elevation = $\mathbf{h_t - f_h}$ = ……. m

2. Main Cable Anchor Design

A. Design Data

☞ **Fill in the following Design Data from Form No. 1: Survey Form and Checklist**

Main Cables: Nos. …..…∅…….mm			
Right Bank Condition			
Geology:	Soil ☐		
If **Soil**, how is the Ground Surface?	Flat ☐ (up to 15° slope)	or	Hill Slope ☐ (more than 15° slope)
What is the Soil Type?	Gravelly ☐	Sandy ☐	Silty ☐
If **Rock**, what is the Rock Type?	Hard Rock ☐ (only a few fractures)	Hard Rock ☐ (highly fractured)	Soft Rock ☐
Left Bank Condition			
Geology	Soil ☐		
If **Soil**, how is the Ground Surface?	Flat ☐ (up to 15° slope)	or	Hill Slope ☐ (more than 15° slope)
What is the Soil Type?	Gravelly ☐	Sandy ☐	Silty ☐
If **Rock**, what is the Rock Type?	Hard Rock ☐ (only a few fractures)	Hard Rock ☐ (highly fractured)	Soft Rock ☐

B. Selection of Anchor Types

Select the appropriate Anchor Types for the Right and Left Banks according to the above design data. Followings are the rules for selecting the anchor blocks:

- One Main Cable Anchor should always have turnbuckle for fine adjustment during sag setting, whereas for economic reasons, the main cable anchor on the other bank should always have a direct cable connection.
- Always select an Anchor Block with turnbuckle for one bank and an Anchor Block with direct cable connection for the other bank.
- If one bank is soil and the other bank is rock, always select a Drum Anchor for the rocky bank.
- If both banks are rocky, select an Anchor Block for one bank and a Drum Anchor for the other bank.

Procedure for selection:

- According to the Soil type and Slope of ground or the Rock type, refer to the respective tables for the selection of the Anchor Types as per below.

In Soil and Flat Ground	(Cable Connection with Turnbuckle)	: **Table 2.1**
In Soil and Flat Ground	(Direct Cable Connection)	: **Table 2.2**
In Soil and Hill Slope	(Cable Connection with Turnbuckle)	: **Table 2.3**
In Soil and Hill Slope	(Direct Cable Connection)	: **Table 2.4**

In Hard, Soft or Fractured Rock (Cable Connection with Turnbuckle) : **Table 2.5**
In Hard Rock (Direct Cable Connection) : **Table 2.6**
In Fractured Hard Rock or Soft Rock (Direct Cable Connection) : **Table 2.7**

- **In the table match the design data:** Number and Diameter of Main Cables → if Soil, Soil type → select Anchor type and corresponding Drawing No. for right bank and left bank respectively.

Anchorage Type Selection Tables

- ***In Soil and Flat Ground (Ground slope up to 15°)***

Table 2.1: Selection of Main Cable Deadman Anchor in Soil and Flat Ground (Cable Connection with Turnbuckle)

Main Cable	Foundation Soil Type	Anchor Type	Drawing No
2x26	All	DA 1	42/1Ncon
2x32	All	DA 2	42/3Ncon
4x26	All	DA 3	44/1Ncon
4x32	All	DA 4	44/3Ncon

Table 2.2: Selection of Main Cable Deadman Anchor in Soil and Flat Ground (Direct Cable Connection)

Main Cable	Foundation Soil Type	Anchor Type	Drawing No
2x26	All	DA 5	42/2Ncon
2x32	All	DA 6	42/4Ncon
4x26	All	DA 7	44/2Ncon
4x32	All	DA 8	44/4Ncon

- ***In Soil and Hill Slope***

Table 2.3: Selection of Main Cable Anchor Block in Soil and Hill Slope (Cable Connection with Turnbuckle)

Main Cable	Foundation Soil Type	Anchor Type	Drawing No
2x26	All	AB 1	42/5Ncon
2x32	All	AB 2	42/7Ncon
4x26	All	AB 3	44/5Ncon
4x32	Gravelly or Sandy	AB 4	44/7Ncon
	Silty	AB 5	44/9Ncon

Table 2.4: Selection of Main Cable Anchor Block in Soil and Hill Slope (Direct Cable Connection)

Main Cable	Foundation Soil Type	Anchor Type	Drawing No
2x26	All	AB - 6	42/6Ncon
2x32	All	AB - 7	42/8Ncon
4x26	All	AB - 8	44/6Ncon

4x32	Gravelly or Sandy	AB - 9	44/8Ncon
	Silty	AB - 10	44/10Ncon

- ***In Hard, Soft or Fractured Rock***

Table 2.5: Selection of Main Cable Anchor Block in Hard, Soft or Fractured Rock (Cable Connection with Turnbbuckle)

Main Cable, mm	Anchor Type	Drawing No
2x26 or 2x32	AB - 11	45Ncon
4x26 or 4x32	AB - 12	46Ncon

- ***In Hard Rock***

Table 2.6: Selection of Main Cable Drum Anchor in Hard Rock (Direct Cable Connection)

Main Cable, mm	Anchor Type	Drawing No
2x26 or 2x32	DR-1	47Ncon
4x26 or 4x32	DR-2	48Ncon

- ***In Fractured Hard Rock or Soft Rock***

Table 2.7: Selection of Main Cable Drum Anchor in Fractured Hard Rock or Soft Rock (Direct Cable Connection)

Main Cable, mm	Anchor Type	Drawing No
2x26 or 2x32	DR-3	49Ncon
4x26 or 4x32	DR-4	50Ncon

⇒ **Selected Main Cable Anchor type and corresponding Drawings from the Table above*:***

Right Bank: Anchor Type……..., Drawing No……

Left Bank: Anchor Type……..., Drawing No…….

***Example**:*

Design Data

Fill in the following design data

Main Cable:	**Nos. 4 ∅ 26 mm**		
Right Bank Condition			
Geology:	Soil ☑		
If **Soil**, how is the Ground Surface?	Flat (up to 15° slope) ☑	or	Hill Slope (more than 15° slope) ☐
What is the Soil Type?	Gravelly ☐	Sandy ☑	Silty ☐
If **Rock**, what is the Rock Type?	Hard Rock (only a few fractures) ☐	Hard Rock (highly fractured) ☐	Soft Rock ☐
Left Bank Condition			
Geology	Soil ☐		
If **Soil**, how is the Ground Surface?	Flat (up to 15° slope) ☐	or	Hill Slope (more than 15° slope) ☐
What is the Soil Type?	Gravelly ☐	Sandy ☐	Silty ☐
If **Rock**, what is the Rock Type?	Hard Rock (only a few fractures) ☑	Hard Rock (highly fractured) ☐	Soft Rock ☐

⇒ ***Selected Anchorage type and corresponding drawings from the table above:***

Right Bank: Anchor Type DA-3,	*Drawing No. 44/1 Ncon*
Left Bank: Anchor Type DR-2,	*Drawing No. 48 Ncon*

3. Walkway and Tower Foundation Design

A. Design Data

☞ **Fill in the following Design Data from Form No. 1: Survey Form and Checklist**

• **Main Cable:**	**Nos. …. ∅ ……. mm**			
• **Spanning Cable:**	**Nos. 2 ∅ ……. mm**			
Right Bank Condition				
Geology:	Soil ☐			
If **Soil**, what is the Soil Type?	Gravelly ☐	Sandy ☐	Silty ☐	
Foundation Block Height (H) from the Ground (data from bridge profile):	1.0m ☐	2.0m ☐	3.0m ☐	4.0m ☐
If **Rock**, what is the Rock Type?	Hard Rock ☐ (only a few fractures)	Hard Rock ☐ (highly fractured)	Soft Rock ☐	
Foundation Block Height (H) from the Ground (data from bridge profile):	☐ 1.0m in case of Rock			
Left Bank Condition				
Geology	Soil ☐			
If **Soil**, What is the Soil Type?	Gravelly ☐	Sandy ☐	Silty ☐	
Foundation Block Height (H) from the Ground (data from bridge profile):	1.0m ☐	2.0m ☐	3.0m ☐	4.0m ☐
If **Rock**, what is the Rock Type?	Hard Rock ☐ (only a few fractures)	Hard Rock ☐ (highly fractured)	Soft Rock ☐	
Foundation Block Height (H) from the Ground (data from bridge profile):	☐ 1.0m in case of Rock			

B. Selection of Walkway and Tower Foundations

Select the appropriate Walkway and Tower Foundations for the Right and the Left Banks according to the above design data.

Procedure for selection:

- According to the Soil or Rock type, refer to the respective tables for the selection of the Walkway and Tower Foundations as per below.

  In Soil : **Table 3.1**
  In Hard Rock : **Table 3.2**
  In Fractured Hard Rock or Soft Rock : **Table 3.3**

- If the bank is rock, always take the foundation block height **H** as 1.0m,
  If the bank is soil on a hill slope, always take the foundation block height **H** as 1.0m.
  If the bank is soil on flat ground but the foundation block height **H** needs to be raised, always take the foundation block height as 1.0, or 2.0, or 3.0, or 4.0m (maximum).

- **In the table, match the design data:** Number and Diameter of Main Cables → Foundation Block Height, **H** → if Soil, Soil type → select Foundation type and corresponding Drawing No. for right bank and left bank respectively.

Walkway and Tower Foundations Selection Tables

- ***In Soil***

Table 3.1: Selection of Walkway and Tower Foundations in Soil

Main Cable	Foundation Block Height (H) m	Soil Type	Foundation Type	Drawing No
2x26 and 2x32mm	1.0	All	TF-1	92/1Ncon
	2.0	All	TF-2	92/2Ncon
	3.0	All	TF-3	92/3Ncon
	4.0	All	TF-4	92/4Ncon
4x26mm	1.0	All	TF-6	94/1Ncon
	2.0	All	TF-7	94/2Ncon
	3.0	Gravelly/Sandy	TF-8	94/3Ncon
		Silty	TF-9	94/4Ncon
	4.0	Gravelly/Sandy	TF-10	94/5Ncon
		Silty	TF-11	94/6Ncon
4x32mm	1.0	All	TF-6	94/1Ncon
	2.0	All	TF-7	94/2Ncon
	3.0	Gravelly/Sandy	TF-8	94/3Ncon
		Silty	TF-9	94/4Ncon
	4.0	Gravelly/Sandy	TF-10	94/5Ncon
		Silty	TF-11	94/6Ncon

- ***In Hard Rock***

Table 3.2: Selection of Walkway and Tower Foundations in Hard Rock

Main Cable	Foundation Block Height (H) M	Foundation Type	Drawing No.
2x26 or 2x32mm	1.0	TF-5	92/5Ncon
4x26 or 4x32mm	1.0	TF-12	94/7Ncon

- ***In Fractured Hard Rock or Soft Rock***

Table 3.3: Selection of Walkway and Tower Foundations in Fractured Hard Rock or Soft Rock

Main Cable	Foundation Block Height (H) m	Foundation Type	Drawing No.
2x26 or 2x32mm	1.0	TF-1	92/1Ncon
4x26 or 4x32mm	1.0	TF-6	94/1Ncon

⇒ ***Selected Walkway and Tower Foundations and corresponding drawings from the table above:***

Right Bank: Foundation Type……..., Drawing No……

Left Bank: Foundation Type……..., Drawing No…….

Example:

Design Data

Fill in the following design data:

- **Main Cable:** **Nos 4 ∅ 26 mm**
- **Spanning Cable:** **Nos 2 ∅ 32 mm**

Right Bank Condition				
Geology:	Soil ☑			
If **Soil**, what is the Soil Type?	Gravelly ☐	Sandy ☑	Silty ☐	
Foundation Block Height (H) from the Ground (data from bridge profile):	1.0m ☐	2.0m ☑	3.0m ☐	4.0m ☐
If **Rock**, what is the Rock Type?	Hard Rock (only a few fractures) ☐	Hard Rock (highly fractured) ☐	Soft Rock ☐	
Foundation Block Height (H) from the Ground (data from bridge profile):	☐ 1.0m in case of Rock			
Left Bank Condition				
Geology	Soil ☐			
If **Soil**, what is the Soil Type?	Gravelly ☐	Sandy ☐	Silty ☐	
Foundation Block Height (H) from the Ground (data from bridge profile):	1.0m ☐	2.0m ☐	3.0m ☐	4.0m ☐
If **Rock**, what is the Rock Type?	Hard Rock (only a few fractures) ☑	Hard Rock (highly fractured) ☐	Soft Rock ☐	
Foundation Block Height (H) from Ground (data from bridge profile):	☑ 1.0m in case of Rock			

⇒ ***Selected Walkway and Tower Foundations and corresponding drawings from the table above:***

Right Bank: Foundation Type TF-7, Drawing No. 94/2Ncon

Left Bank Foundation Type TF-12, Drawing No. 94/7Ncon

4. Windguy Anchorage Foundation Blocks Design (Optional)

A. Design Data

☞ **Fill in the following Design Data from Form No. 1: Survey Form and Checklist.**

Windguy Cable: …..nos ∅ …….mm				
Right Bank / Upstream				
Geology:	Soil ☐			
If **Soil**, what is the Soil Type?	Gravelly ☐	Sandy ☐	Silty ☐	
Anchor Block Height from Ground (data from bridge profile):	1.0m ☐	2.0m ☐	3.0m ☐	4.0m ☐
If **Rock**, what is the Rock Type?	Hard Rock (only a few fractures) ☐	Hard Rock (highly fractured) ☐	Soft Rock ☐	
Anchor Block Height from the Ground (data from bridge profile):	☐ 1.0m in case of Rock			
Right Bank / Downstream				
Geology	Soil ☐			
If **Soil**, what is the Soil Type?	Gravelly ☐	Sandy ☐	Silty ☐	
Anchor Block Height from the Ground (data from bridge profile):	1.0m ☐	2.0m ☐	3.0m ☐	4.0m ☐
If **Rock**, what is the Rock Type?	Hard Rock (only a few fractures) ☐	Hard Rock (highly fractured) ☐	Soft Rock ☐	
Anchor Block Height from the Ground (data from bridge profile):	☐ 1.0m in case of Rock			

Left Bank / Upstream				
Geology:	Soil ☐			
If **Soil**, what is the Soil Type?	Gravelly ☐	Sandy ☐	Silty ☐	
Anchor Block Height from the Ground (data from bridge profile):	1.0m ☐	2.0m ☐	3.0m ☐	4.0m ☐
If **Rock**, what is the Rock Type?	Hard Rock ☐ (only a few fractures)	Hard Rock ☐ (highly fractured)	Soft Rock ☐	
Anchor Block Height from the Ground (data from bridge profile):	☐ 1.0m in case of Rock			
Left Bank / Downstream				
Geology	Soil ☐			
If **Soil**, what is the Soil Type?	Gravelly ☐	Sandy ☐	Silty ☐	
Anchor Block Height from the Ground (data from bridge profile):	1.0m ☐	2.0m ☐	3.0m ☐	4.0m ☐
If **Rock**, what is the Rock Type?	Hard Rock ☐ (only a few fractures)	Hard Rock ☐ (highly fractured)	Soft Rock ☐	
Anchor Block Height from the Ground (data from bridge profile):	☐ 1.0m in case of Rock			

B. Selection of Windguy Cable Anchor Blocks (Optional only)

Provision of a windguy cable arrangement is optional. For details refer to Chapter 6.
Select appropriate Windguy Cable Anchor Blocks for the Right and Left Banks according to the above design data. Followings are the rules for selection of the anchor blocks.

- If the bank is rock, always take block height as 1.0m.
- If the bank is soil in hill slope, always take block height as 1.0m.
- If one bank is soil and the other bank is rock, always select a Drum Anchor for the rocky bank.
- If both banks are rocky, select an Anchor Block for one bank and a Drum Anchor for the other bank.
- If the bank is soil but on flat ground and the Anchor Block Height needs to be raised, always take the foundation block height as 1.0, or 2.0, or 3.0, or 4.0m (maximum).

Procedure for selection:

- According to the Soil or Rock type, refer to the respective tables for selection of the Windguy Cable Anchor Blocks as per below:

In Soil	:	**Table 4.1**
In all types of Rock (Anchor Block)	:	**Table 4.2**
In Hard Rock (Drum Anchor)	:	**Table 4.3**
In Fractured Hard Rock or Soft Rock (Drum Anchor)	:	**Table 4.4**

- **In the table, match the design data:** Diameter of Windguy Cable → Soil or Rock type → if soil → Anchorage Block Height → select Anchor Block type and corresponding Drawing No. for right bank upstream and downstream and for left bank upstream and downstream respectively.

Select the appropriate Windguy Cable Anchor blocks from the following table.

- ***In Soil***

Table 4.1: Selection of Windguy Cable Anchor Block in Soil

Windguy Cable [mm]	Anchor Block Height	Soil Type	Anchor Type	Drawing No
26	1	All	WAB - 1	55/1Acon
	2	All	WAB – 2	55/2Acon
	3	All	WAB – 3	55/3Acon
	4	All	WAB – 4	55/4Acon

- ***In Hard, Fractured or Soft Rock***

Table 4.2: Selection of Windguy Cable Anchor Block in all types of Rocks

Windguy Cable [mm]	Anchor Type	Drawing No
26	WAB - 5	56Acon

- ***In Hard Rock***

Table 4.3: Selection of Windguy Cable Drum Anchor in Hard Rock

Windguy Cable [mm]	Anchor Type	Drawing No
26	WDR - 1	57Acon

- ***In Fractured or Soft Rock***

Table 4.4: Selection of Windguy Cable Drum Anchor in Fractured or Soft Rock

Windguy Cable [mm]	Anchor Type	Drawing No
26	WDR - 2	58Acon

⇒ **Selected Windguy Cable Anchor and corresponding Drawings from the table above:**

Right Bank, Upstream: Anchor Type……..., Drawing No……
Downstream: Anchor Type……..., Drawing No……

Left Bank, Upstream: Anchor Type……..., Drawing No……
Downstream: Anchor Type……..., Drawing No……

Example

Design Data

☞ **Fill in the following Design Data from Form No. 1: Survey Form and Checklist.**

• **Windguy Cable:**	**∅ 26 mm**			
Right Bank / Upstream				
Geology:	Soil ☑			
If **Soil**, what is the Soil Type?	Gravelly ☐	Sandy ☑	Silty ☐	
Anchor Block Height from the Ground (data from bridge profile):	1.0m ☐	2.0m ☑	3.0m ☐	4.0m ☐
If **Rock**, what is the Rock Type?	Hard Rock (only a few fractures) ☐	Hard Rock (highly fractured) ☐	Soft Rock ☐	
Anchor Block Height from the Ground (data from bridge profile):	☐ 1.0m in case of Rock			
Right Bank / Downstream				
Geology	Soil ☑			
If **Soil**, what is the Soil Type?	Gravelly ☐	Sandy ☑	Silty ☐	
Anchor Block Height from the Ground (data from bridge profile):	1.0m ☐	2.0m ☑	3.0m ☐	4.0m ☐
If **Rock**, what is the Rock Type?	Hard Rock (only a few fractures) ☐	Hard Rock (highly fractured) ☐	Soft Rock ☐	
Anchor Block Height from the Ground (data from bridge profile):	☐ 1.0m in case of Rock			

Left Bank / Upstream				
Geology:	Soil ☐			
If **Soil**, what is the Soil Type?	Gravelly ☐	Sandy ☐	Silty ☐	
Anchor Block Height from the Ground (data from bridge profile):	1.0m ☐	2.0m ☐	3.0m ☐	4.0m ☐
If **Rock**, what is the Rock Type?	Hard Rock (only a few fractures) ☑	Hard Rock (highly fractured) ☐	Soft Rock ☐	
Anchor Block Height from the Ground (data from bridge profile):	☑ 1.0m in case of Rock			
Left Bank / Downstream				
Geology	Soil ☐			
If **Soil**, what is the Soil Type?	Gravelly ☐	Sandy ☐	Silty ☐	
Anchor Block Height from the Ground (data from bridge profile):	1.0m ☐	2.0m ☐	3.0m ☐	4.0m ☐
If **Rock**, what is the Rock Type?	Hard Rock (only a few fractures) ☑	Hard Rock (highly fractured) ☐	Soft Rock ☐	
Anchor Block Height from the Ground (data from bridge profile):	☑ 1.0m in case of Rock			

⇒ ***Selected Windguy Cable Anchor and corresponding Drawings from the table above:***

Right Bank, Upstream: Anchor Type…WAB - 2, Drawing No. 55/2Acon

Downstream: Anchor Type…WAB - 2, Drawing No. 55/2Acon

Left Bank, Upstream: Anchor Type…WDR - 1, Drawing No. 57Acon

Downstream: Anchor Type…WDR - 1, Drawing No. 57Acon

5. Suspender List

Calculate the Suspender List using the computer program **"Suspender Design"** which is included in the CD-ROM at the back cover page of the "Technical Hand Book, Vol. I".

The calculation is based on the fixed geometry of the bridge as per Chapter 1 (Table 1.1) and the design of the suspender as per the figure below.

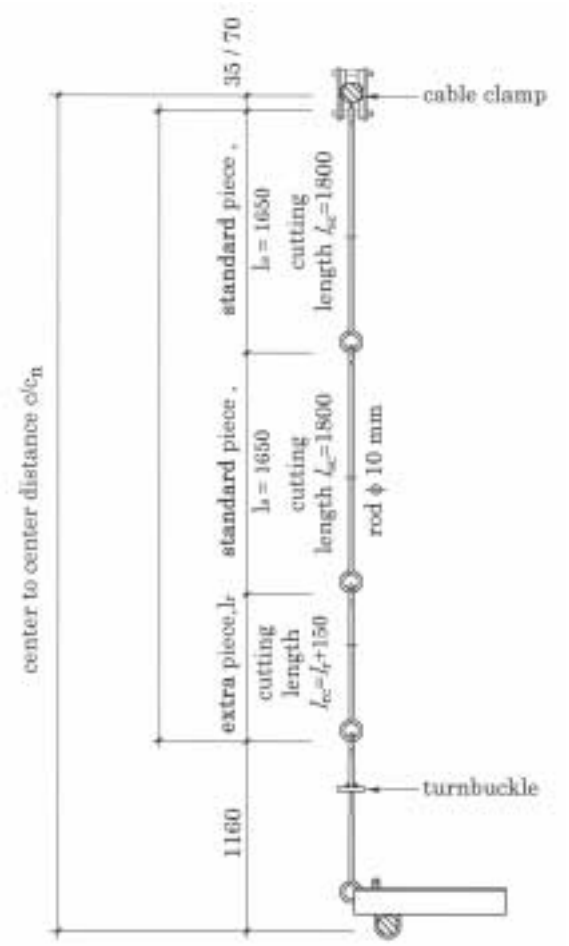


Figure 5.1: Typical Design of Suspender

The only input data required for the calculation is the span, `l.` The procedure for the Suspender List calculation is as follows:

- Open the computer program SSTB Design > "Suspender Design".
- Enter the input data: Bridge Name, Bridge Span and width "B" of the Walkway and Tower Foundation.
- Print result.

Attach the printout of the Suspender List with the drawing of the suspenders (Drawing No 31N or 32N).

6. Design of Windguy Arrangement

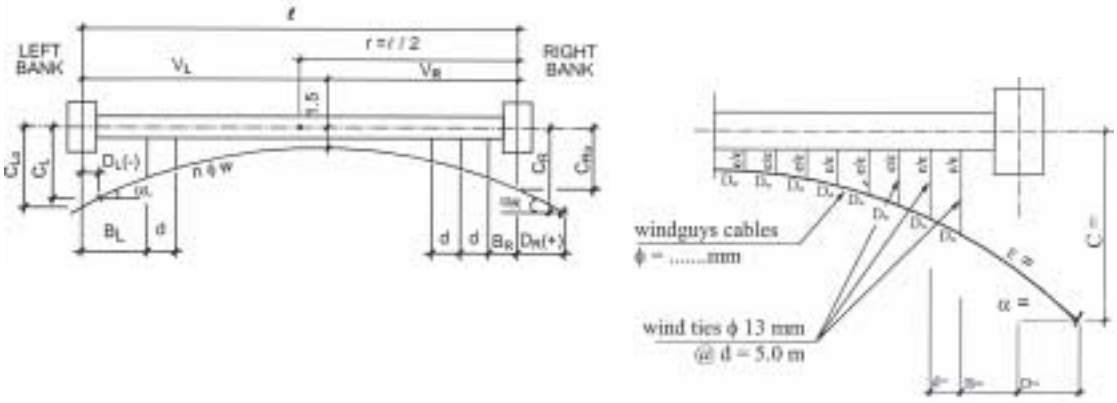
For Nepal, in general, no wind guy arrangement is necessary in this standard suspension bridge for spans of up to120m (for more details refer to Chapter 3.3.9 of the "Technical Hand Book, Vol. I").

For special cases, i.e., when the bridge span is more than 120m or in extremely windy areas with wind speeds in excess of 160 km/hr and unfavorable nature of the wind flow, a windguy system is mandatory.

For calculation of the Windguy Arrangement use the computer program "**Windguy Design**" which is included in the CD-ROM at the back cover page of the "Technical Hand Book, Vol. I".

The calculation is based on the fixed geometry of the bridge as per Chapter 1 (Table 1.1) and the figure below.

Plan



Side Elevation

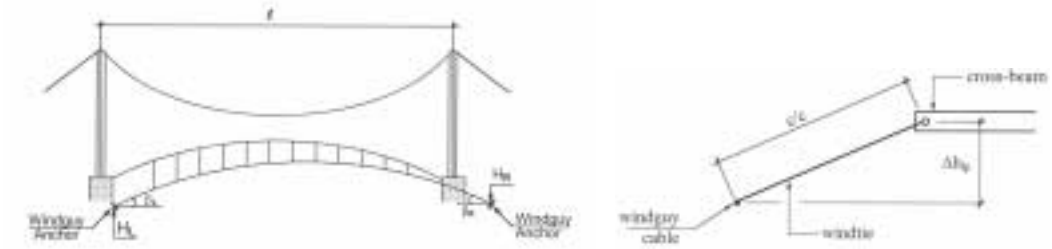


Figure 6.1: Layout of Windguy Arrangement

The calculation procedure is as following.

- Open the computer program SSTB Design > "Windguy Design".
- Enter the general input data: Bridge Name, Bridge Span and elevation of Steel Tower Base.
- Enter the tentative position of the first windtie $\mathbf{B_L}$ and $\mathbf{B_R}$ as per the topography. The program will adjust to the nearest actual values.
- Give the level of the windguy anchorage on the right bank $\mathbf{H_L}$ and the left bank $\mathbf{H_R}$. $\mathbf{H_L}$ and $\mathbf{H_R}$ should be at or below the level of the spanning cable at the anchorage point (Es).
- Give (select) the windguy anchor position on the right bank (or the left bank), i.e. $\mathbf{C_R}$ and $\mathbf{D_R}$ or ($\mathbf{C_L}$ and $\mathbf{D_L}$). Accordingly, the windties listing will be from right bank to left bank or vise versa.
- Input the value $\mathbf{V_R}$ (distance up to the vertex of the windguy cable) if the selected windguy anchor position is on the right bank or $\mathbf{V_L}$ if the selected windguy anchor position is on the left bank.
- Check the span and sag ratio of the wind guy cable, *l*/b. It should be not less than 8 and not more than 10. If this condition is not met, input new **V** till *l*/b is within the recommended limit.
- Check the lowest point of the windguy cable $\mathbf{\Delta h_{lp}}$. It should not be negative (-). If Δh_{lp} is negative, input new $\mathbf{H_L}$and $\mathbf{H_R}$ with a lower value.
- Input the value of $\mathbf{D_{Lo}}$ (or $\mathbf{D_{Ro}}$) = 0. The result will show $\mathbf{C_{Lo}}$ (or $\mathbf{C_{Ro}}$), and the horizontal angle α_L (or α_R).
- Draw a straight line with the given $\mathbf{C_{Lo}}$ (or $\mathbf{C_{Ro}}$), and horizontal angle α_L (or α_R). Fix the windguy anchor position on the left bank (or the right bank) along this line. The anchorage block should be placed on safe ground and at the optimum foundation location so that it has sufficient embedded depth and also so that deep excavation can be avoided.
- After fixing the anchorage position, measure the actual $\mathbf{C_L}$ (or $\mathbf{C_R}$). The result will give $\mathbf{D_L}$ (or $\mathbf{D_R}$)

- Draw longitudinal sections along the windguy cables at the foundations and determine the exact position of the front of the foundations ($\mathbf{D_R}$, $\mathbf{C_R}$ **and** $\mathbf{D_L}$, $\mathbf{C_L}$) and the windguy cable elevations ($\mathbf{H_R}$, $\mathbf{H_L}$).
- If the final position of the foundations does not match the design as above, repeat the calculation process from the second bullet till all the foundations are located at the optimum positions.
- Calculate the Windguy Arrangement for both upstream and downstream.

Attach the printout of the results (Windguy Arrangement) with the drawing of the Windtie cable Clamps (Drawing No. 11A) and also transfer it to the General Arrangement Drawing.

7. Bridge Standard Drawings

Select the required Steel Drawings and Construction Drawings from the design as above and the following drawing list.

7.1 Steel Drawings

Drawing Title		Drawing No.	Required Drawing
Walkway and Anchors			
Steel Crossbeams	Spanning Cable ∅ 26 or 32mm	07N	07N
Suspenders	for 2 main cables ∅ 26 or 32mm	31N	…….
	for 4 main cables ∅ 26 or 32mm	32N	
Main Cable Anchors with Turnbuckle	for 2 main cables ∅ 26 or 32mm	42N	…….
	for 4 main cables ∅ 26 or 32mm	44N	
Walkway and Tower Foundation	C/c1 = 2.5m	92N	…….
	C/c1 = 3.5m	94N	
Steel Deck	Standard Panel	08A	08A
	Special Panel	10A	10A

Towers			
Assembly and Layout	Tower No.1, Height = 5.50m	141N	……..
	Tower No. 2, Height = 7.35m	142N	
	Tower No. 3, Height = 9.20m	143N	
	Tower No. 4, Height = 11.05m	144N	
Base Element	Tower No.1, 2, 3 & 4	100N	100N
Intermediate Element	Tower No.1, 2, & 3	109N	…….
	Tower No. 4	110N	
Top Element	Tower No. 1, 2, & 3	119N	…….
	Tower No. 4	121N	
Saddle	Tower No.1, 2, 3 & 4	135N	135N

Optional			
Windguy Parts	Windtie Cable Clamps for One Cable ∅ 26 or 32mm	11A	…….
	Windguy Cable Anchorage for one Cable ∅ 26 or 32mm	50A	…….

7.2 Construction Drawings

As per the design made through Chapters 2 to 4, fill in the required drawings in the following Drawing list.

Drawing Title	Drawing No	Required Drawing
Walkway Fitting	19Ncon	19Ncon
Main Cable Anchors	42/1Ncon, ……..…, 50 Ncon	RB: …….
		LB: …….
Walkway and Tower Foundations	92/1Ncon, ……., 94/7 Ncon	RB: …….
		LB: …….
Windguy Cable Anchors (Optional)	55/1Acon, …….., 58Acon	RB/US: …….
		RB/DS: …….
		LB/US: …….
		LB/DS: …….

Designed by: ……... **Date:** …….

Cable hoisted by: …… **Date:** ……..

Example:

⇒ ***Selected Drawings***

Steel Drawings

Drawing Title		Drawing No	Required Drawing
Walkway and Anchors			
Steel Crossbeams	Spanning Cable ∅ 26 or 32mm	07N	**07N**
Suspenders	for 2 main cables ∅ 26 or 32mm	31N	**32N**
	for 4 main cables ∅ 26 or 32mm	32N	
Main Cable Anchors with Turnbuckle	for 2 main cables ∅ 26 or 32mm	42N	**44N**
	for 4 main cables ∅ 26 or 32mm	44N	
Walkway and Tower Foundation	c/c1 = 2.5m	92N	**94N**
	c/c1 = 3.5m	94N	
Steel Deck	Standard Panel	08A	**08A**
	Special Panel	10A	**10A**
Towers			
Assembly and Layout	Tower No. 1, Height = 5.50m	141N	**144N**
	Tower No. 2, Height = 7.35m	142N	
	Tower No. 3, Height = 9.20m	143N	
	Tower No. 4, Height = 11.05m	144N	
Base Element	Tower No.1, 2, 3 & 4	100N	**100N**
Intermediate Element	Tower No.1, 2, & 3	109N	**110N**
	Tower No.4	110N	
Top Element	Tower No.1, 2, & 3	119N	**121N**
	Tower No. 4	121N	
Saddle	Tower No.1, 2, 3 & 4	135N	**135N**
Optional			
Windguy Parts	Windguy Cable Clamps for One Cable ∅ 26 or 32mm	11A	**NA**
	Windguy Cable Anchorage for one Cable ∅ 26 or 32mm	50A	**NA**

Construction Drawings

Drawing Title	Drawing No	Required Drawing
Walkway Fitting	19Ncon	**19Ncon**
Main Cable Anchors	42/1Ncon, ……..…,50 Ncon	RB: **44/1Ncon**
		LB: **48 Ncon**
Walkway and Tower Foundations	92/1Ncon, ……..,94/7 Ncon	RB: **94/2Ncon**
		LB: **94/7Ncon**
Windguy Cable Anchors (Optional)	55/1Acon, …….., 58Acon	RB/US: **NA**
		RB/DS: **NA**
		LB/US: **NA**
		LB/DS: **NA**