DESIGN OF THE DOBRA CHANTI SUSPENSION BRIDGE IN DISTRICT TEHRI GARHWAL, UTTARAKHAND, INDIA

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Abstract

Since the Tehri dam was constructed on the River Bhagirathi in 2006, considerable productive land areas, many villages, including old Tehri town in Tehri-Garhwal district has been submerged. It has also disconnected the travel and transportation routes along the east slopes of the reservoir, making the local residents lose access to the New Tehri town, which is equipped with resident-friendly facilities including health and education institutions and markets. Accordingly, the Uttarakhand Government has proposed to build the Dobra-Chanti H.M.V. Suspension Bridge to meet the local demand for an easy intra-regional accessibility, especially between the left and right sides of the River Bhagirathi. The project consists of a single-span suspension bridge, an approach bridge at each end of the suspension bridge, and slope protection work on each side. The suspension bridge has a 440m-long stiffening truss girder, 57m-tall steel towers, locked coil cable systems including suspenders, and anchor blocks. The approach bridges are reinforced concrete bridges with T-shaped beams. And river side slopes installed on both banks are protected and stabilized through CC blocks, shotcrete, and anchor bolts. All cek dimension has met the requirement.

Keywords: Tehri, suspension bridge, tower leg, cable suspend.

1. INTODUCTION

Since the Tehri dam was constructed on the River Bhagirathi in 2006, considerable productive land areas, many villages, including old Tehri town in Tehri-Garhwal district has been submerged. It has also disconnected the travel and transportation routes along the east slopes of the reservoir, making the local residents lose access to the New Tehri town, which is equipped with resident-friendly facilities including health and education institutions and markets. Accordingly, the Uttarakhand Government has proposed to build the Dobra-Chanti H.M.V. Suspension Bridge to meet the local demand for an easy intra-regional accessibility, especially between the left and right sides of the River Bhagirathi. The bridge is located 8.1km north of New Tehri, Uttarakand and crosses the River Bhagirathi (back water of Tehri dam reservoir).

Figure 1. Location project

Figure 2 Side view of Tehri Bridge

The project consists of a single-span suspension bridge, an approach bridge at each end of the suspension bridge, and slope protection work on each side. The suspension bridge has a 440m-long stiffening truss girder, 57m-tall steel towers, locked coil cable systems including suspenders, and anchor blocks. The approach bridges are reinforced concrete bridges with T-shaped beams. And river side slopes installed on both banks are protected and stabilized through CC blocks, shotcrete, and anchor bolts.

2. LITERATURE REVIEW

2.1 Geometric Design Criteria

Basically, the geometric design criteria are based on the existing design results by I.I.T. Roorkee. Some of revised geometric features are designed in accordance with IRC:86-1983. Geometric Design Standards for Urban Roads in Planes and IRC:73-1980 Geometric Design Standards for Rural(Non-urban) Highways. There is no definition and explanation regarding design speed in the existing design by I.I.T. Roorkee. Design speed is related to the function of a road. It is the basic parameter which determines all other geometric design features. 30 km/hr is reasonable to adopt considering road classification and terrain conditions in the site.

Table 1. Geometric Design Criteria

Sl. No.	Road Classification	Design speed, km/h							
		Plain terrain (Slope 0~10%)		Rolling terrain (Slope 10~25%)		Mountainous terrain (Slope 25~60%)		Steep terrain (Greater than 60%)	
		Ruling design speed	Min. Design speed	Ruling design speed	Min. Design speed	Ruling design speed	Min. Design speed	Ruling design speed	Min. Design speed
1	National and State Highways	100	80	80	65	50	40	40	30
2	Major District Roads	80	65	65	50	40	30	30	20
3	Other District Roads	65	50	50	40	30	25	25	20
4	Village Roads	50	40	40	35	25	20	25	20

2.2 Bridge Design Criteria

Basically, limit state design method is applied for the detailed design of the bridge. The Standard Specifications and Code of Practice for Road Bridges are mainly applied for the design of the bridge and the Standard Specifications for Road Bridges, Standards and Codes of Ministry of Road Transport and Highways (MORTH), Ministry of Rural Development (MORD) and Indian Standard (IS) are also used. Additionally, in case appropriate design code are not available in above design specifications, some international design specifications and guidelines, such as Euro code and Korean Cable-supported bridge design specification is adopted for the design of particular structural components, such as cable systems. Table 2 are the summary of specifications, guideline and recommendations in design work to be applied. Table 3 and table 4 are design Load for Bridge design.

Table 2. Standard Specification

Standards Codes	Titles	Version	Remarks
IRC:5-1998	Standard Specifications and Code of Practice for Road Bridges, Section I – General Features of Design	Seventh Revision	
IRC:6-2014	Standard Specifications and Code of Practice for Road Bridges, Section-II Loads and Stresses	Sixth Revision	
IRC:24-2010	Standard Specifications and Code of Practice for Road Bridges, Steel Road Bridges (Limit State Method)	Third Revision	
IRC:78-2014	Standard Specifications and Code of Practice for Road Bridges, Section VII- Foundations and Substructures	Revised Edition	
IRC:112-2011	Code of Practice for Concrete Road Bridges	-	
IS:800-2007	General Construction in Steel - Code of Practice	Third Revision	
IS:875-1987	Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures, Part 3: Wind Loads	Third Revision	Wind
IS:1893-2002	Criteria for Earthquake Resistant Design of Structures, Part 1: General Provision and Buildings Part 3: Bridges and Retaining Walls	Fifth Revision	Earthquake

Table 3. Bridge Design Loads

Permanent Load	Items	Value	Remarks
Dead Load	Reinforced Concrete	2.5 ton/m^3	
	Asphalt	2.3 ton/m^3	
	66mm dia. Locked Coil Rope	0.0269 ton/m	
	25mm dia. Spiral strand	0.00309 ton/m	
	Structural Steel	7.8 ton/m^3	
Superimposed Dead Load	Railing	0.4 kN/m/side	
	Barrier	0.62 kN/m/side	
	Inspection way	0.42 kN/m	
	Attachment (electricity)	0.5 kN/m	
Prestress and Secondary effect of prestress	N/A		
Earth pressure	N/A		
Settlement Effect	**Items**	**Value**	**Remarks**
In case adding to the permanent loads	Rotation of abutment Longitudinal displacement of anchor block	1.8(L/h) (units : 10^{-4} rad) 0.02 L (unit : cm) where, L=span length (m)	Korean design specification

Table 4 Variable Bridge Design Loads

Variable Loads	Items	Value	Remarks
Carriageway Live load	Vertical	2 lanes of CLASS 18R loading Or Single lane of Class B loading	
	Longitudinal Braking Force	20% of the first train load + 10% of the load of the succeeding trains	
Pedestrian Load		1.509 kN/m^2	Footway only
Thermal Load	Range of Temperature	-5°C ~ 45 °C (±25 °C)	
	Temperature differences		
Wind Load	Transverse Load	V_B = 39m/sec	Without traffic
	Longitudinal Load	50% of the transverse load	
	Vertical Load	F_V=P_z x A_3 x G x C_L	
Live load surcharge effects	N/A		
Construction Dead Loads	Weight of equipment		
Accidental Effects	**Items**	**Value**	**Remarks**
Vehicle Collision	N/A		
Barge Impact	N/A		
Impact due to floating bodies	N/A		
Cable Rupture	Rupture of one suspender		
Seismic Effects	**Items**	**Value**	**Remarks**
Response Spectrum	Zone factor (Z) Importance factor (I)	0.24 0.12	Zone IV Important

2.3 Load Combination

The load combination of the design for the Dobra-Chanti suspension bridge is applied in accordance with Annex B in IRC:6-2014.

1. Combination of Loads for the Verification of Equilibrium and Structural Strength under Ultimate State Loads are required to be combined to check the equilibrium and the structural strength under ultimate limit state. The equilibrium of the structure shall be checked against overturning, sliding and uplift. It shall be ensured that the disturbing loads (overturning, sliding, and uplift) shall always be less than the stabilizing or restoring actions. The structural strength under ultimate limit state shall be estimated in order to avoid internal failure or excessive deformation. The equilibrium and the structural strength shall be checked under basic, accidental and seismic combinations of loads.
2. Combination of Loads for the Verification of Serviceability Limit State Loads are required to be combined to satisfy the serviceability requirements. The serviceability limit state check shall be carried out in order to have control on stress, deflection, vibration, crack width, settlement and to estimate shrinkage and creep effects. It shall be ensured that the design value obtained by using the appropriate combination shall be less than the limiting value of serviceability criterion as per the relevant code. The rare combination of loads shall be used for checking the stress limit. The frequent combination of loads shall be used for checking the deflection, vibration and crack width. The quasi-permanent combination of loads shall be used for checking the settlement, shrinkage creep effects and the permanent stress in concrete.
3. Combination for Design of Foundation For checking the base pressure under foundation and to estimate the structural strength which includes the geotechnical loads, the partial safety factor for loads for 3 combinations shown in Table 3.4 of Annex A, IRC:6-2014 shall be used. The material safety factor for the soil parameters, resistance factor and the allowable bearing pressure for these combinations shall be as per relevant code.

3. METODOLOGY

The analysis of a suspension bridge is divided into completed state analysis and construction stage analysis. The completed state analysis is performed to check the behavior of the completed bridge. At this stage, the structure is in balance under self-weight, and the deflection due to the self-weight has already occurred. This stage is referred to as the initial equilibrium state of the suspension bridge. The initial equilibrium state analysis will provide the coordinates and tension forces in the cables. The completed state analysis of the suspension bridge is performed to check the behavior of the structure under additional loads such as live, seismic and wind loadings. The self-weight loading in the initial equilibrium state will also be added to the total loading for the completed state analysis. Suspension bridges exhibit significant nonlinear behavior during the construction stages. But it can be assumed that the bridge behaves linearly for additional loads (vehicle, wind load, etc.) in the completed state analysis. This is due to the fact that sufficient tension forces are induced into the main cables and hangers under the initial equilibrium state loading. It is thus possible to perform a linearized analysis for the additional static loads at the completed state by converting the tension forces in the main cables and hangers resulting from the initial equilibrium state loading into increased geometric stiffness of those components. This linearized analytical procedure to convert section forces to geometric stiffness is referred to as the linearized finite displacement method. This procedure is adopted because a solution can be found with relative ease within acceptable error limits in the completed state analysis. Construction stage analysis is performed to check the structural stability and to calculate section forces during erection. In carrying out the construction stage analysis, large displacement theory (geometric nonlinear theory) is applied in which equilibrium equations are formulated to represent the deformed shape. The effect of large displacements cannot be ignored during the construction stage analysis. The construction stage analysis is performed in a backward sequence from the state of equilibrium as defined by the initial equilibrium state analysis.

4. DISCUSSION

The 3D analytical models of the suspension bridge were developed using two independent structural analysis software, MIDAS/Civil and RM2009, as it can verify the results of the two independent models. Main cable and suspender loads are determined from the RM2009 model, and other components are determined from the MIDAS/Civil.

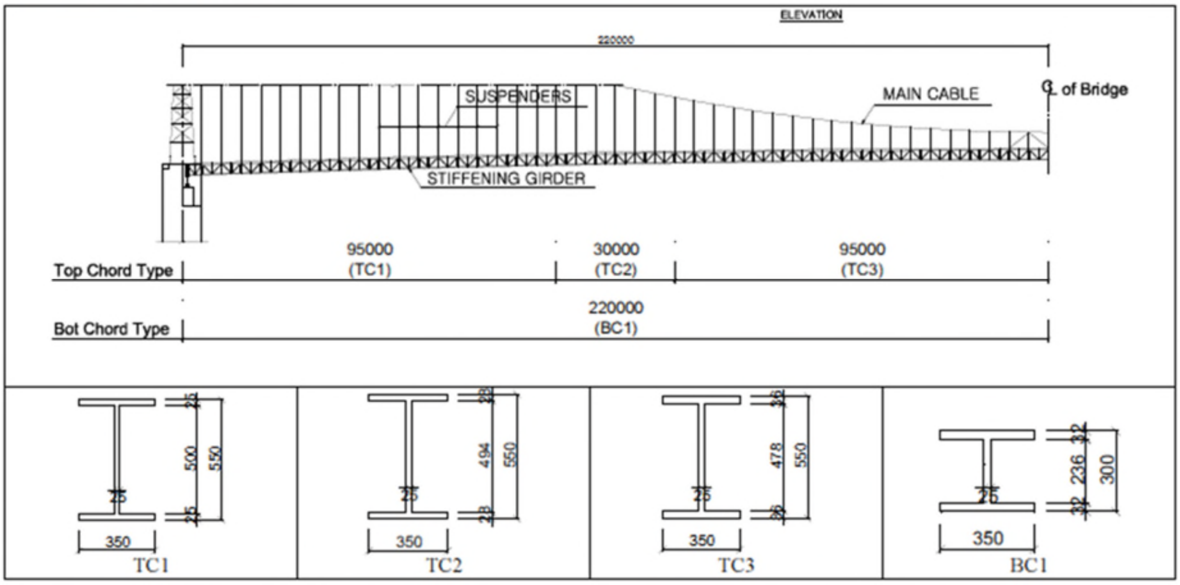
4.1 Design of Stiffening Truss Girder

Stiffening truss girder is designed in accordance with IRC:24-2010, and the design process of the stiffening truss girder is shown in Table 4.8 as below.

Process	Check point	Code
Classification of cross-sections	• Limiting width to thickness ratio	IRC:24-2010 in Clause 503.7
Design of compression members	• Check the members of the factored design compression and the design strength of the member	IRC:24-2010 in Section 507
Design of the members subjected to combined forces	• Check the members subjected to combined shear and bending • Check the members subjected to combined axial force and bending	IRC:24-2010 in Section 510
Design of the bolted connection	• Check the splices of the factored design tension and the design strength governed by yielding, rupture and block shear • Check the factored design force and the design strength of the bolt	IRC:24-2010 in Section 506 IS800-2007 in Section 10,
Design of the welded connection	• Check the factored design force and the design strength of the weld	IRC:24-2010 in Clause 512.4

The result of top and bottom chords are as figure below

a) Section Properties



b) Limiting Width to Thickness Ratio

Section	ε	Flange				Web(Axial Compression)				Shear buckling		
		b (mm)	t_f (mm)	b/t_f	check	d (mm)	t_w (mm)	d/t_w	check	d/t_w	67ε	check
TC1	0.78	175	25	7.0	Class2	500	25	20.0	Class3	20.0	52.3	No Need
TC2	0.78	175	28	6.3	Class1	494	25	19.8	Class3	19.8	52.3	No Need
TC3	0.78	175	36	4.9	Class1	478	25	19.1	Class3	19.1	52.3	No Need
BC1	0.78	175	32	5.5	Class1	236	25	9.4	Class3	9.4	52.3	No Need

c) Design of Compression Members

Section	Major Axis			Minor Axis		
	P_{dz} (N)	P (N)	check	P_{dz} (N)	P (N)	check
TC1	11,425,560	3,909,280	OK	10,056,419	3,909,280	OK
TC2	12,172,870	5,124,510	OK	10,771,336	5,124,510	OK
TC3	14,162,816	5,851,300	OK	12,660,592	5,851,300	OK
BC1	10,368,018	4,738,840	OK	9,792,818	4,738,840	OK

d) Members subjected to combined forces

- Section check in relation to axially compressive force

Section	A_e (mm^2)	S_{top} (mm^3)	S_{left} (mm^3)	$f_{top\text{-}left}$ (MPa)	$f_{top\text{-}right}$ (MPa)	$f_{bot\text{-}left}$ (MPa)	$f_{bot\text{-}right}$ (MPa)	Check
TC1	30,000	5,335,227	1,024,554	155.8	153.5	107.2	153.5	OK
TC2	31,950	5,773,112	1,147,009	194.0	175.4	145.4	175.4	OK
TC3	37,150	6,889,776	1,473,557	183.0	166.5	148.5	166.5	OK
BC1	28,300	2,876,732	1,308,423	202.2	167.6	167.3	167.6	OK

- Section check in relation to axially tensile force

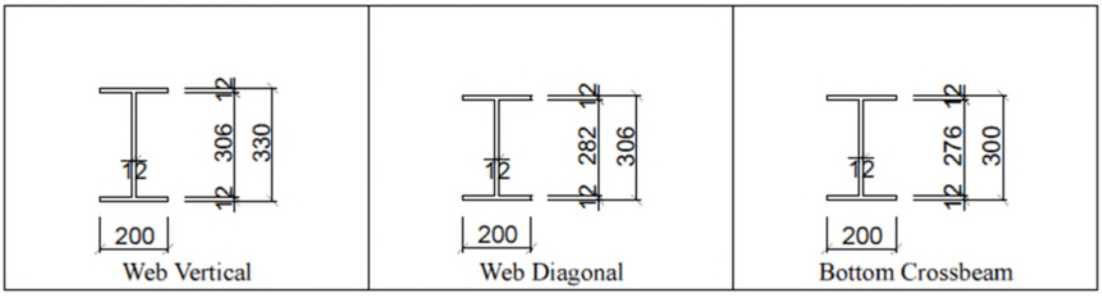
Section	A_e (mm^2)	S_{top} (mm^3)	S_{left} (mm^3)	$f_{top\text{-}left}$ (MPa)	$f_{top\text{-}right}$ (MPa)	$f_{bot\text{-}left}$ (MPa)	$f_{bot\text{-}right}$ (MPa)	Check
TC1	22,350	4,006,890	685,251	209.0	187.1	162.4	187.1	OK
TC2	23,688	4,307,346	767,081	249.0	229.5	203.5	229.5	OK
TC3	27,256	5,073,549	985,295	240.3	224.6	202.0	224.6	OK
BC1	20,497	2,082,134	874,708	310.6	292.5	239.1	292.5	OK

- Overall member strength check in relation to bending and axial tension force

Section	M (N·mm)	T (N)	ψ	Z_{ec} (mm^3)	M_{eff} (N·mm)	M_d (N·mm)	Check
TC1	1.756E+08	1.809E+06	0.8	5.335E+06	1.698E+08	1.989E+09	OK
TC2	2.032E+08	2.221E+06	0.8	5.773E+06	2.299E+08	2.152E+09	OK
TC3	2.234E+08	4.528E+05	0.8	6.890E+06	1.318E+08	2.568E+09	OK
BC1	7.435E+07	5.449E+06	0.8	2.877E+06	5.374E+08	1.072E+09	OK

4.2 Web Vertical, web diagonal and bottom cross beam

a) Section properties



b) Limiting Width to Thickness Ratio

Section	ε	Flange				Web(Axial Compression)				Shear buckling		
		b (mm)	t_f (mm)	b/t_f	check	d (mm)	t_w (mm)	d/t_w	check	d/t_w	67ε	check
WV	0.85	100	12	8.3	Class3	306	12	25.5	Class3	25.5	56.6	No Need
WD	0.85	100	12	8.3	Class3	282	12	23.5	Class3	23.5	56.6	No Need
Bcross	0.85	100	12	8.3	Class3	276	12	23.0	Class3	23.0	56.6	No Need

c) Design of Compression Members

Section	Major Axis			Minor Axis		
	P_{dz} (N)	P (N)	check	P_{dz} (N)	P (N)	check
TC1	2.705E+06	5.827E+05	OK	2.132E+06	5.827E+05	OK
TC2	2.487E+06	6.373E+05	OK	1.709E+06	6.373E+05	OK
TC3	2.413E+06	1.592E+05	OK	1.551E+06	1.592E+05	OK

d) Members subjected to combined forces

- Section Strength Check : Axially compressive force

Section	A_e (mm²)	S_{top} (mm³)	S_{left} (mm³)	$f_{top\text{-}left}$ (MPa)	$f_{top\text{-}right}$ (MPa)	$f_{bot\text{-}left}$ (MPa)	$f_{bot\text{-}right}$ (MPa)	Check
WV	8,472	909,449	160,441	107.6	49.7	87.9	49.7	OK
WD	8,184	824,880	160,406	99.3	64.2	91.5	64.2	OK
Bcross	8,112	804,100	160,397	64.3	10.3	29.0	10.3	OK

- Section Strength Check : Axially tensile force

Section	A_e (mm²)	S_{top} (mm³)	S_{left} (mm³)	$f_{top\text{-}left}$ (MPa)	$f_{top\text{-}right}$ (MPa)	$f_{bot\text{-}left}$ (MPa)	$f_{bot\text{-}right}$ (MPa)	Check
WV	8,472	909,449	160,441	86.2	31.6	42.9	31.6	OK
WD	6,348	630,570	115,299	149.5	93.0	131.0	93.0	OK
Bcross	6,276	613,028	115,291	51.9	41.6	6.6	41.6	OK

- Overall member Strength in relation to bending and axial tension force

Section	M (N·mm)	T (N)	ψ	Z_{ec} (mm³)	M_{eff} (N·mm)	M_d (N·mm)	Check
WV	3.330E+07	1.736E+05	0.80	9.094E+05	1.839E+07	2.894E+08	OK
WD	1.093E+07	6.407E+05	0.80	8.249E+05	5.567E+07	2.625E+08	OK
Bcross	1.387E+07	1.514E+05	0.80	8.041E+05	1.646E+06	2.558E+08	OK

- Overall member Strength in relation to bending and axial compression force

Section	n_y	n_z	k_y	k_z	k_{LT}	ψ	C_m	λ_{LT}	M_{cr} (N·mm)	Major axis	Minor axis	Check
WV	0.27	0.22	1.11	1.00	0.96	-1.0	0.40	0.20	1.442E+09	0.37	0.31	OK
WD	0.37	0.26	1.23	1.02	0.93	-1.0	0.40	0.28	7.347E+08	0.43	0.32	OK
Bcross	0.10	0.07	1.07	1.01	0.98	-1.0	0.40	0.31	5.983E+08	0.21	0.17	OK

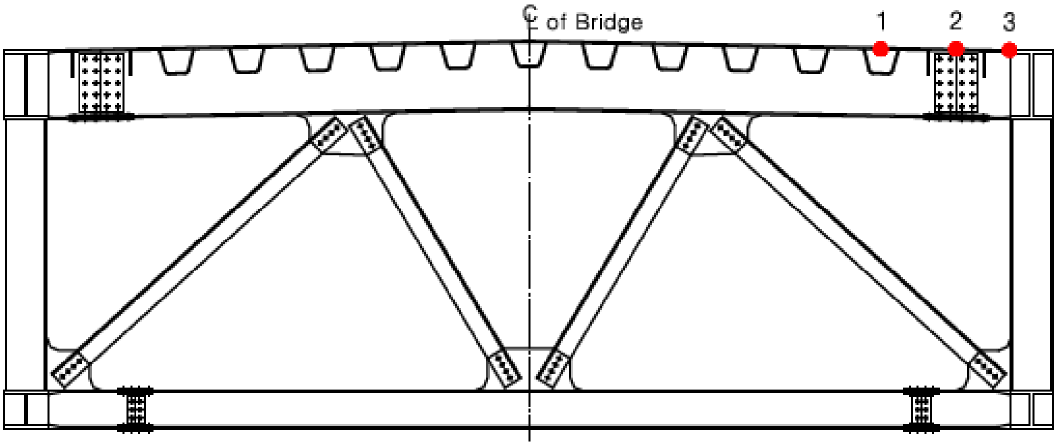
4.3 Design of deck slab

The bridge deck is continuous without expansion joints from the Chanti-side Pylon to the Dobra-side Pylon, a total length of 440m. A truss type girder with the orthotropic deck has been adopted for the suspended superstructure. The truss type section has a total width of 8.35m with a depth of 3.0m and provides considerable rigidity in resisting torsional effects due to wind, seismic and unsymmetrical live load. The orthotropic deck consists of a 14mm deck plate with longitudinal 196mm deep hermetically sealed trapezoidal closed ribs to be fabricated from 8mm thick bent plates for the all bridge span. An open truss type diaphragm is adopted at 2.5m spacing in longitudinal direction, which is more economical than the full plate diaphragm. The diaphragm spacing of 2.5m meets the maximum deflection criteria (less than 3.1mm, L/800).

The orthotropic deck is checked by local effect and the combined action of global effect and local effect. The global effect is calculated by the 3-D analysis model and the local effect is calculated using Pelikan-Esslinger method in which the load effects on a closed rib is calculated from wheel loads placed over one rib only without regard for the effects of the adjacent transversely located wheel loads. A local 3D model composed with plate and beam elements is used to verify the resistance and stability of transversal frame such as upper crossbeam and diagonals of diaphragm.

The stress verification considering global loads combination includes the following steps.

- The computation of the longitudinal stresses due to the bridge global behavior for ULS load combinations
- The consideration of the longitudinal stresses caused by the local bending of the upper orthotropic plate due to axles loads, in order to compute the total longitudinal stresses
- The consideration of transverse stresses in the deck plate due to their collaboration to the transverse bending of the diaphragms, in order to compute the total Von Mises stresses taking the longitudinal (global + local) and transverse stresses into account
- The final verification that the maximum Von Mises stress does not exceed the steel yield stress, ensuring the deck resistance at the ULS load combinations



[Unit: MPa]

Check point		$\sigma_{x,g}$	f_{cd}, f_{td}	τ_{xy}	σ_{vm}	f_y	Check
1	Compression	-117.9	276.4	10.3	119.2	350.0	O.K
	Tension	119.6	318.2	10.3	120.9	350.0	O.K
2	Compression	-133.1	245.2	8.8	134.0	350.0	O.K
	Tension	134.9	318.2	8.8	135.8	350.0	O.K
3	Compression	-152.1	250.7	6.6	152.5	410.0	O.K
	Tension	153.8	372.7	6.6	154.2	410.0	O.K

4.4 Design of main cable

Main cable analysis has been performed by RM Bridge Program which can be used both Non-linear analysis and Large Displacement Analysis. Most of cable system is designed in accordance with Korean Design Guidelines for Steel Cable-Supported Bridges, as there is no detailed design specification, guidelines and manual for cable members in IRC.

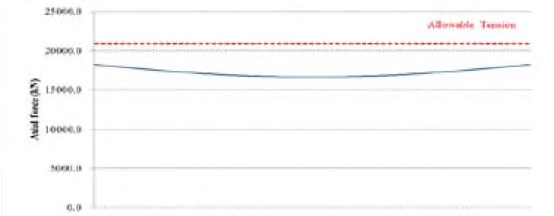
Material Properties contained

- Cable Type = Locked Coil Rope Φ66mm H12ea
- Cable Area = 2936mm2
- Cable Strength = 1570MPa
- Allowable Force = 4350kN * 12 Nos / 2.5 = 20880 kN (S.F=2.5)

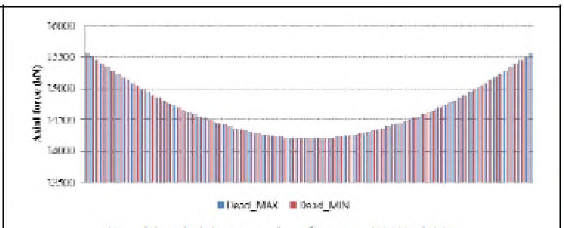
Load and Load Combination

- DL : Dead load
- LL : Live load
- WS : Wind load on structure
- TG : Temperature
- EQ : Earthquake
- L(PS1) : Live load in case suspender replacement
- L(PS2) : Live load in case of suspender rupture

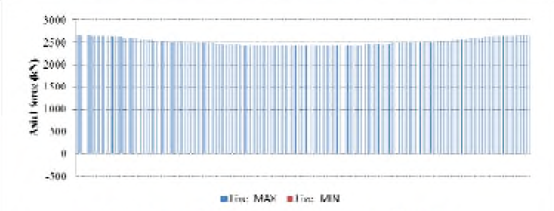
Design results of main cable are summarized in Figure 4.37. Maximum force ratio compared to allowable force is 87.4% in case of load combination 1.



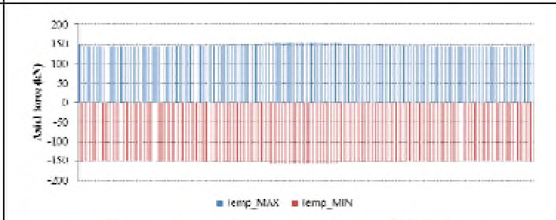
Load Combination (Max. tension force = 18252 kN)



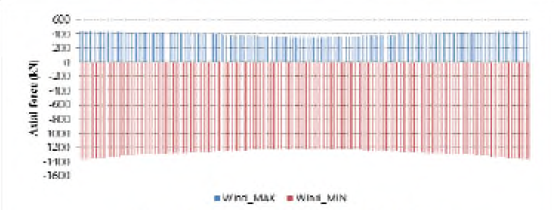
<Dead load (Max. tension force = 15576 kN) >



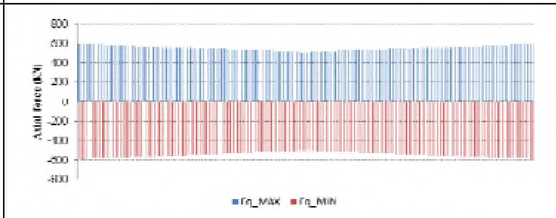
<Live load (Max. tension force = 2677 kN) >



<Temperature (Max. tension force = 153 kN) >



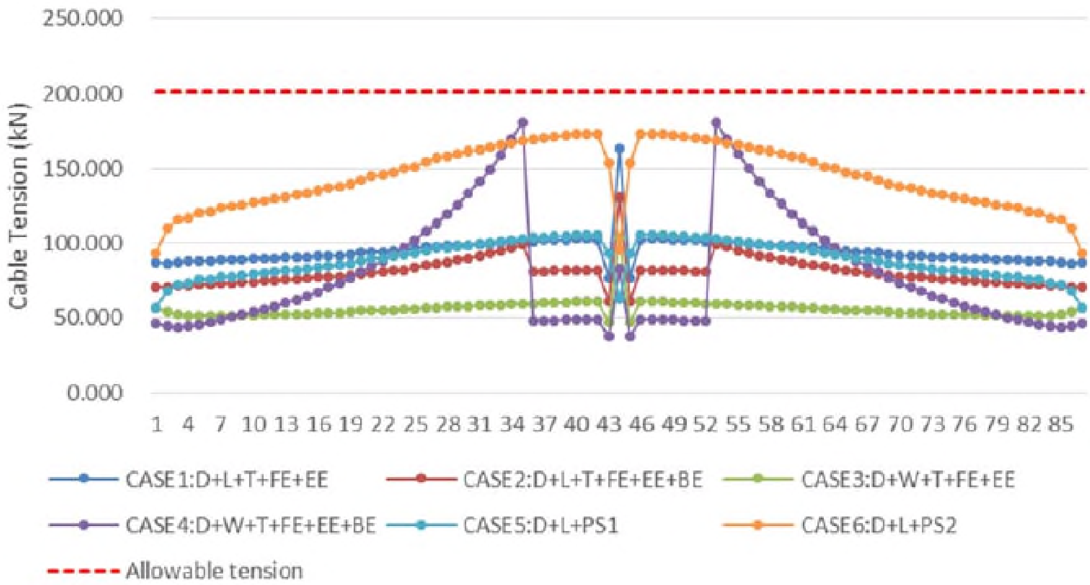
<Wind (Max. tension force = 451 kN) >



<Earthquake (Max. tension force = 591 kN) >

4.5 Design of suspender

All loads and load combination are applied same as those of main cable. Material Properties used Cable Type = Spiral Strand Φ25mm H2ea, Cable Area = 379mm2 , Cable Strength = 1570MPa , Allowable Force = 503 * 2 Nos / 2.5 = 402 kN (S.F=2.5). Design results of suspenders are summarized in figure

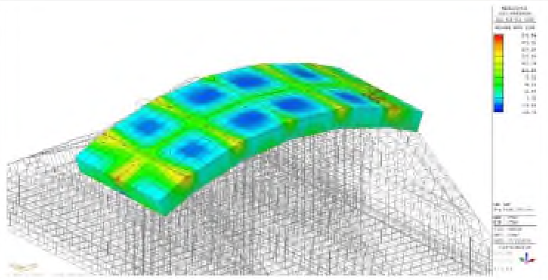


4.6 Design Of Sad

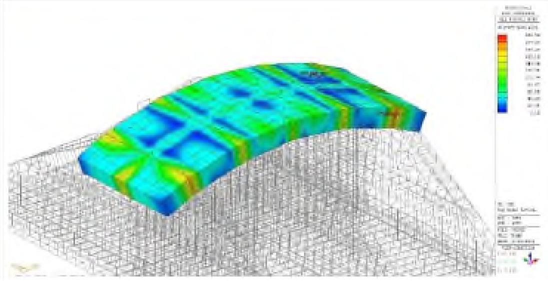
In order to sustain maximum tensions occurred by 12 sets of main cables, the transverse pressure and slipping of saddle were reviewed and checked. Also reviewed Maximum Principal Stress and Von-Mises

Stress through 3-Dimensional FEM Modelling for design check of the saddle. Transverse pressure check As a result of transverse pressure review which occurs to the rope by bolt clamping force of 359kN, it confirms secure the safety. (qEd=33MPa < qRk=40MPa … O.K)

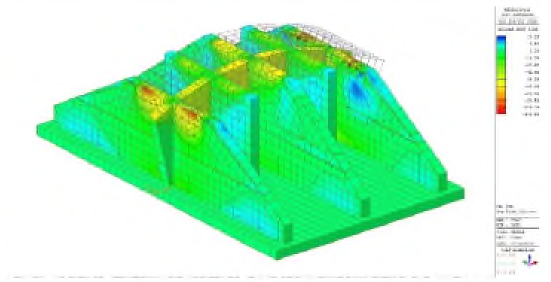
Saddle was reviewed by applying of steel grade E550 (Casting steel CS700) and through 3-dimensional FEM analysis.



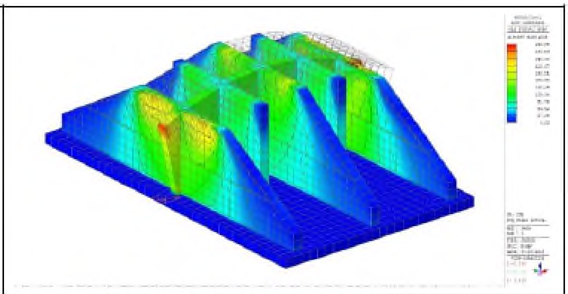
Maximum Principal Stress
: 232.64MPa < 341MPa …O.K



Von-Mises Stress
: 229.52MPa < 375MPa …O.K

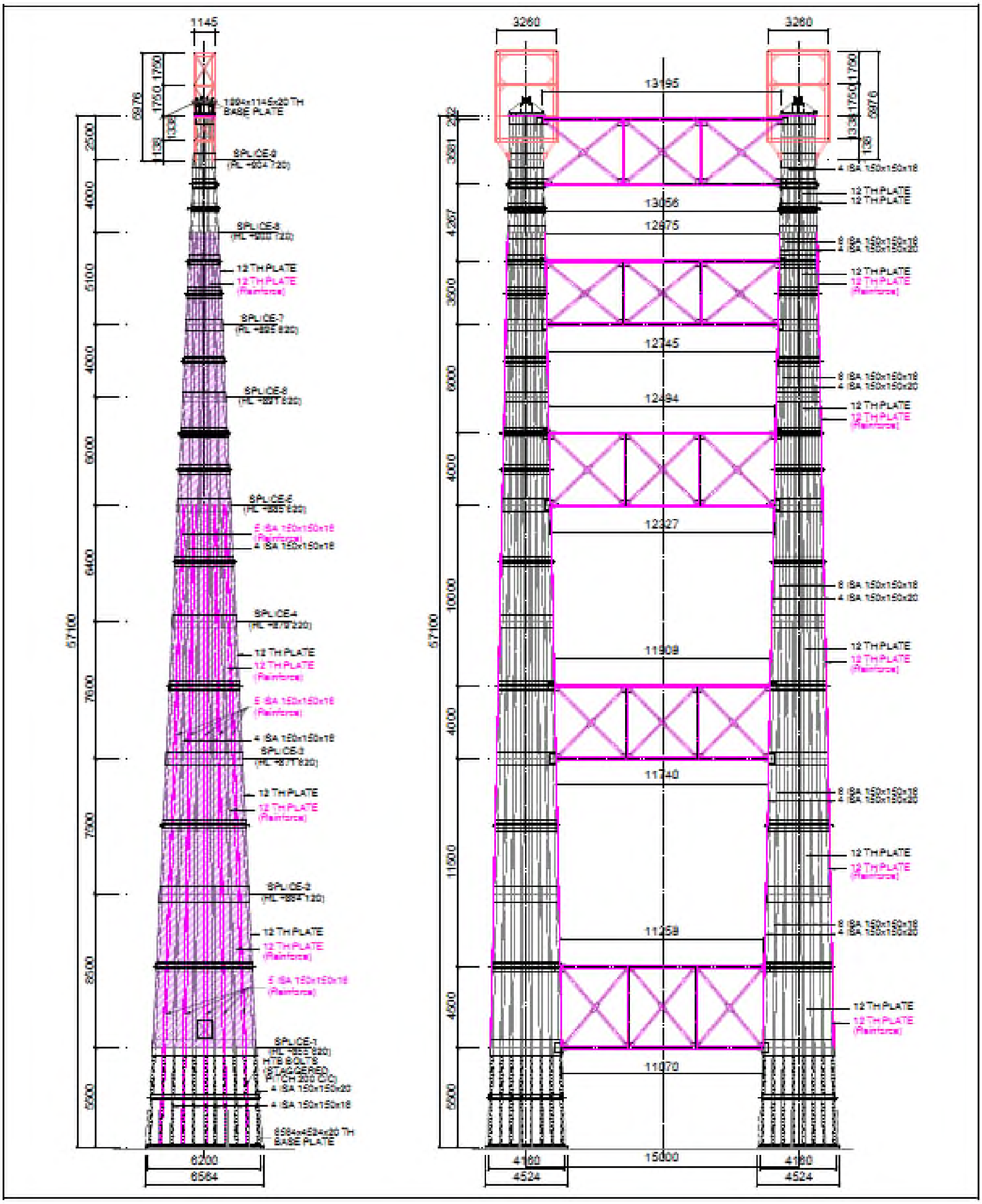


Maximum Principal Stress
: 19.18MPa < 306MPa …O.K



Von-Mises Stress
: 299.85MPa < 336MPa …O.K

4.7 Design of Tower Leg



Result of checking tower leg and base plate are shown in figure … and … ang …. And …

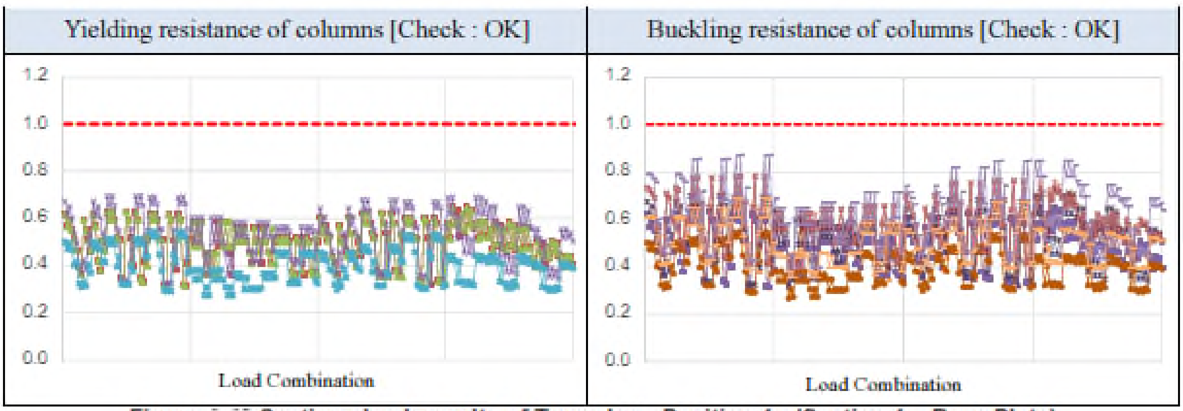


Figure Section check results of Tower leg - Position 1 : (Section 1 – Base Plate)

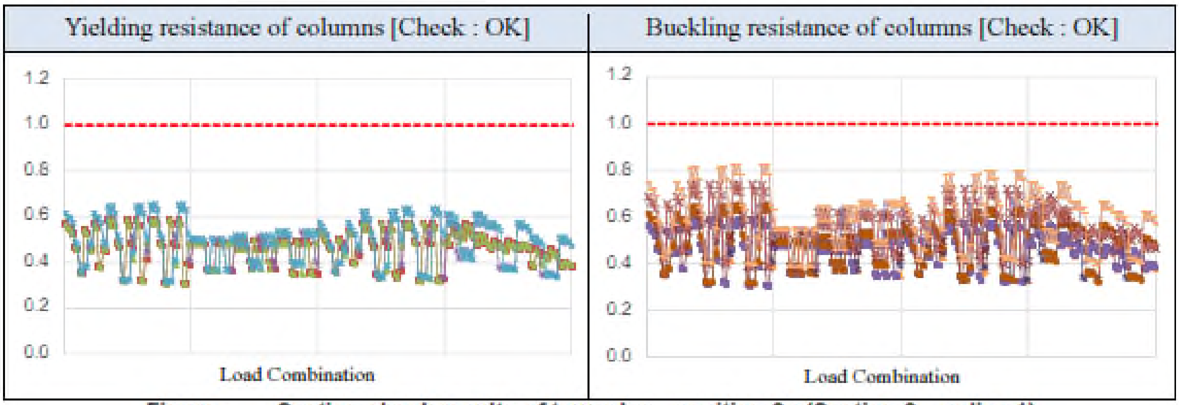


Figure Section check results of tower leg - position 2 : (Section 2 – splice 1)

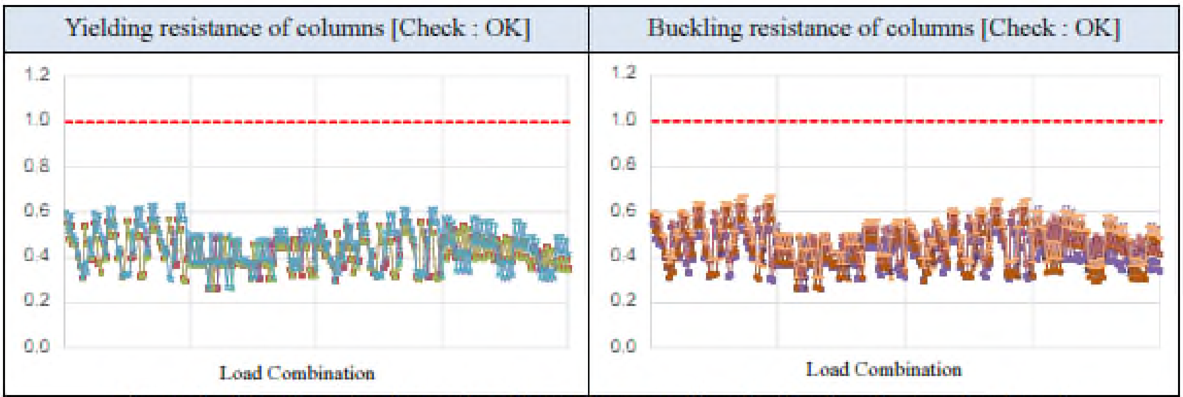


Figure Section check results of tower leg - position 3 : (Section 3 – bracing truss)

5. CONCLUSION

a. The Standard Specifications and Code of Practice for Road Bridges are mainly applied for the design of the bridge and the Standard Specifications for Road Bridges, Standards and Codes of Ministry of Road Transport and Highways (MORTH), Ministry of Rural Development (MORD) and Indian Standard (IS) are also used.

b. All calculation design of Tehri bridge met the requireiremt that are describe in the methodology method and have accorded with standard and criteria design.

REFERENCES

[1] Yooshin Engineering Corporation and VKS Infratech Management Pvt. Ltd , 2015, Project Management & Engineering Consultancy for Construction of 440 M. Span Dobra-Chanti H.M.V. Suspension Bridge including Fabrication, Erection/ Launching etc. over river Bhagirathi (Tehri Dam Reservoir) in Distt. Tehri Garhwal, Uttarakhand, India

[2] Indian Roads Congress, 2010, Standard Specifications and code Of Practice For Road Bridges , India

[3] Indian Roads Congress, 2011, Code of practice for concrete road bridges, India

[4] Indian Standart, IS-875-1987 Code of practice for design l oads (Otherthanearthquake) For buildings and structures, India

[5] Indian Standart, , IS:1893-2002, Code of practice for design loads earthquake For buildings and structures, India