

Release Note

Release Date : April 2023

Product Ver. : Civil 2023 (v1.1)



DESIGN OF CIVIL STRUCTURES

Integrated Solution System for Bridge and Civil Engineering

Enhancements

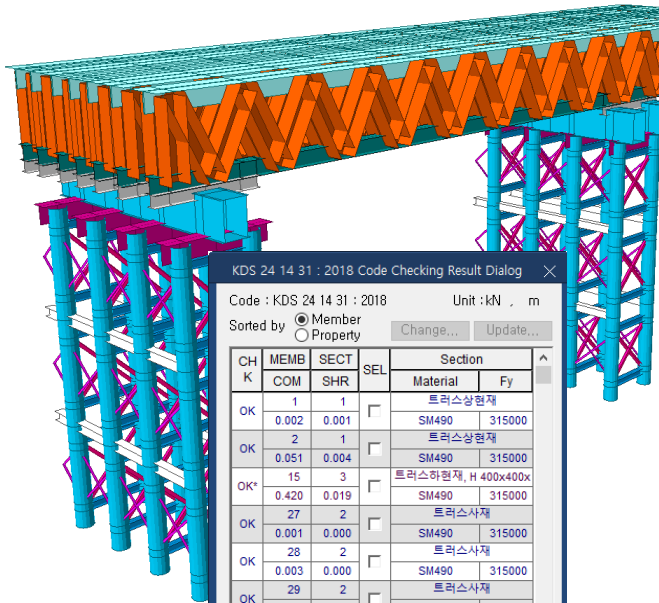
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1. KDS 24 14 31 : 2018 Steel Design 추가

- KDS 24 14 31 : 2018의 강교 한계상태설계법을 제공 → KDS 14 31 10 강구조설계기준(하중저항계수 설계법) 기반으로 진행
- KS 신강종을 고려한 설계 제공
- 통합설계엔진을 기반으로 개발된 설계 계산/출력 속도 개선

MODS > Design > Steel Design > KDS 24 14 31 : 2018



KDS 24 14 31 : 2018 Code Checking Result Dialog

Code : KDS 24 14 31 : 2018 Unit : kN , m

Sorted by Member Property

CH	MEMB	SECT	SEL	Section	
K	COM	SHR		Material	Fy
OK	1	1	<input type="checkbox"/>	트러스상원재	
	0.002	0.001		SM490	315000
OK	2	1	<input type="checkbox"/>	트러스상원재	
	0.051	0.004		SM490	315000
OK*	15	3	<input type="checkbox"/>	트러스하원재, H 400x400x	
	0.420	0.019		SM490	315000
OK	27	2	<input type="checkbox"/>	트러스사재	
	0.001	0.000		SM490	315000
OK	28	2	<input type="checkbox"/>	트러스사재	
	0.003	0.000		SM490	315000
OK	29	2	<input type="checkbox"/>	트러스사재	
	0.006	0.001		SM490	315000
OK	30	2	<input type="checkbox"/>	트러스사재	
	0.004	0.000		SM490	315000
OK	31	2	<input type="checkbox"/>	트러스사재	
	0.003	0.000		SM490	315000
OK	32	2	<input type="checkbox"/>	트러스사재	
	0.003	0.000		SM490	315000
OK	33	2	<input type="checkbox"/>	트러스사재	
	0.002	0.000		SM490	315000

Connect Model View View Result Ratio...

Select All Unselect All Re-calculation >>

Graphic... Detail... Summary... Close

MIDAS Information Technology Co.,Ltd. Civil 2021 (v2.1) / Checking

MEMBER NAME : Beam 62 수평재 (중) (ID : 8)

1. Member Information

- 1) Design Code
KDS 24 14 31 : 2018
- 2) Material
F_y = 315.000MPa, E_s = 210.000.000MPa
- 3) Length
L = 2.000m
- 4) Section Properties

A	8,883.000mm ²	I _y	47,200.000.000mm ⁴	I _z	16,000.000.000mm ⁴	I _{xy}	0.000mm ⁴
C _y	100.000mm	C _z	100.000mm	r _y	88.200mm	r _z	50.200mm
S _{xy}	472.000.000mm ³	S _{yz}	160.000.000mm ³	Z _x	526.000.000mm ³	Z _y	244.000.000mm ³
J	260.000.000mm ⁴	C _w	1.410000e+11mm ⁶				

2. Check Combined Ratio

Combined	LCB	Com1
R _{max}	0.00649	/ 1.000 = 0.006

* Com1 : (1.000) / 가중치 + (1.000) 상부판크리프 + (1.000) 가중치 + (1.000) 물리값 + (1.000) 수평하중

- 1) Calculate interaction ratio of combined strength
P_r / P_c < 0.2

$$\frac{P_r}{2 P_c} + \left(\frac{M_{ry}}{M_{cy}} + \frac{M_{rz}}{M_{cz}} \right) = 0.00649$$

$$\frac{1,901.135}{2 \times 16,714} + \left(\frac{165.690}{-0.344} + \frac{76.860}{-0.00153} \right) = 0.00649$$

3. Axial Capacity (None)

Axial	LCB	Com1
P _u / φP _n	16.714kN	/ 1,901.135kN = 0.009

* Com1 : (1.000) / 가중치 + (1.000) 상부판크리프 + (1.000) 가중치 + (1.000) 물리값 + (1.000) 수평하중

- 1) Calculate axial tensile strength (φ P_n)

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φ = 0.950
P_n = A_g F_y = 1,901.135kN
φ P_n = 2,001.195kN

4. Moment Capacity (y-Dir., None)

Moment	LCB	Com1
M _{uy} / φM _{uy}	0.344kN·m	/ 165.690kN·m = 0.002

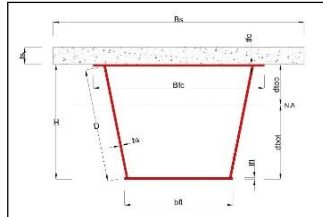
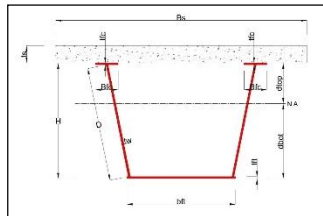
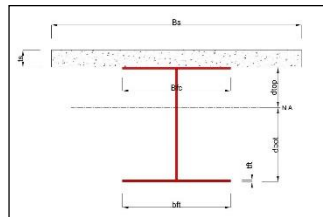
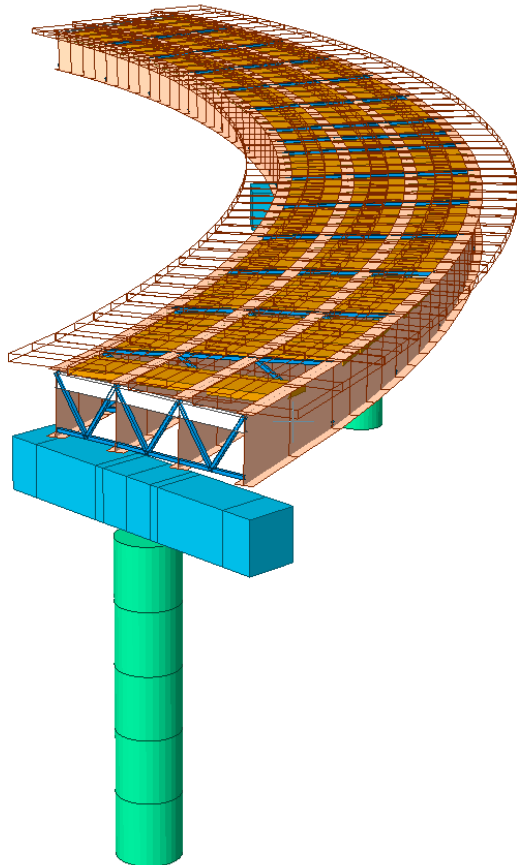
* Com1 : (1.000) / 가중치 + (1.000) 상부판크리프 + (1.000) 가중치 + (1.000) 물리값 + (1.000) 수평하중

- 1) Plastic section modulus referred to tension and compression flange
Z_y = 526,000.000mm³
- 2) Compression flange yielding
M_o = F_y Z_y = 165.690kN·m
- 3) Calculate limiting width-thickness ratio of flange for flexure
λ_p = 0.38 √(E_s/F_y) = 9.812
λ_r = 1.00 √(E_s/F_y) = 25.820
- 4) Check width-thickness ratio of flange
λ_f = 8.333 < λ_p = 9.812
- 5) Calculate limiting width-thickness ratio of web for flexure
λ_p = 3.76 √(E_s/F_y) = 97.083
λ_r = 5.70 √(E_s/F_y) = 147.173
- 6) Check depth-thickness ratio of web
λ_w = 18.750 < λ_p = 97.083
- 7) Lateral torsional buckling
L_b = 1.76 r_y √(E / F_y) = 2,281.239mm
X₁ = (E_s / F_L) √(J / (S_{xx} h₀))
X₂ = 1 + 6.76 ((0.7 F_y S_{xx} h₀ / (E_s J C)))²
L_r = 1.95 r_{ty} X₁ √(1 + (X₂)²) = 8,730.014mm
L_b ≤ L_r
M_{o,LTB} = M_o = 165.690kN·m
- 8) Calculate flexural strength about major axis (φ M_{ny})
φ = 1.000

2. KDS 24 14 31 : 2018 Composite Design 추가

- KDS 24 14 31 : 2018의 강합성교한계상태설계법을 제공 → KDS 14 31 10 강구조설계기준(하중저항계수 설계법) 기반으로 진행
- 단면의 비틀림으로 인한 종방향 뒤틀림력과 횡방향 휨응력 고려 옵션 제공
- 정모멘트부 소성 종립축 계산 시 압축부 철근 고려 옵션 제공
- 강도한계상태 검토 시 힘/전단 저항강도 계산 옵션 제공

MODS > Design > Composite Design > KDS 24 14 31 : 2018



Composite Steel Girder Design Parameters

Code : KDS 24 14 31 : 2018 Update by Code

Strength Resistance Factor

Resistance factor for yielding (Phi _y)	<input type="text" value="0.95"/>
Resistance factor for fracture(Phi _u)	<input type="text" value="0.8"/>
Resistance factor for axial comp.(Phi _c)	<input type="text" value="0.9"/>
Resistance factor for flexure (Phi _f)	<input type="text" value="1"/>
Resistance factor for shear(Phi _v)	<input type="text" value="1"/>
Resistance factor for shear connector(Phi _{se})	<input type="text" value="0.85"/>
Resistance factor for bearing(Phi _b)	<input type="text" value="0.75"/>

Girder Type for Box/Tub Section

Single Box Sections Multiple Box Sections

Consider St. Venant Torsion and Distortion Stresses

Option for Plastic Moment

Consider Compression Reinforcements in Girder under Positive Moment

Option for Strength Limit State

KDS 14 31 10:A2 for Negative Flexure Resistance in Web Compact / NonCompact Sections

Mn <= 1.3RhMy in Positive Flexure and Compact Sections

Post-buckling Tension-field Action for Shear Resistance

Include Normal Stress due to Torsional Warping

Design Parameters

Strength Limit State-Flexure

Strength Limit State-Shear

Service Limit State

Constructibility

Fatigue Limit State

Shear Connectors, Longitudinal Stiffeners

Design Report Print Option

Summary Detail

종방향 뒤틀림력과
횡방향 휨응력 고려

정모멘트부 소성종립축 계
산시 압축철근 고려

힘/전단 저항강도
계산 옵션

2. KDS 24 14 31 : 2018 Composite Design 추가

- 정/부모멘트부소성 중립축 위치 및 소성모멘트 산정 프로세스 제공
- 조밀/비조밀 단면 분류에 따른 휨저항 강도 검토 프로세스 제공
- 조밀 검토 → 강도기반, 비조밀 검토 → 응력기반으로 진행

MODS > Design > Composite Design > KDS 24 14 31 : 2018

소성 중립축 위치/소성모멘트 산정

4) 소성모멘트 산정 (M_p), 부모멘트부 (KDS 14 31 10 : 2017, 표 8.1)
 ① 소성상태의 휨력

- 소성상태의 휨력

P_{cs}	$= F_y A_s$	$= 2905.155$ kN
P_{cs}	$= F_y A_s'$	$= 0.000$ kN
P_t	$= D_b \cdot t_b \cdot F_y$	$= 5951.601$ kN
P_s	$= 2 \cdot H \cdot t_w \cdot F_{yc}$	$= 5884.464$ kN
P_c	$= D_b \cdot t_c \cdot F_{yc}$	$= 6612.890$ kN

- 소성중립축으로부터의 거리

d_{cs}	$= 786.751$ mm (소성중립축에서 상부철근에 작용하는 휨까지 거리)
d_{cs}	$= 786.751$ mm (소성중립축에서 하부철근에 작용하는 휨까지 거리)
d_s	$= 573.899$ mm (소성중립축에서 인장플랜지에 작용하는 휨까지 거리)
d_w	$= 334.151$ mm (소성중립축에서 복부면에 작용하는 휨까지 거리)
d_c	$= 1242.201$ mm (소성중립축에서 압축플랜지에 작용하는 휨까지 거리)

② 소성모멘트 산정

- 소성 중립축의 위치 산정

$$P_c + P_w = 12497.354 \text{ kN} \geq P_t + P_{cs} + P_{cs}' = 8856.756 \text{ kN} \quad \therefore \text{OK}$$

\therefore 소성중립축, Y는 웹 내부에 위치함

- 소성중립축의 위치

$$Y = \frac{D}{2} \cdot \left(\frac{P_c - P_t - P_{cs} - P_{cs}'}{P_w} + 1 \right) = 542.149 \text{ mm}$$

- 소성모멘트

$$M_p = \frac{P_w}{2D} \cdot [Y^2 + (D - Y)^2] + [P_t \cdot d_t + P_{cs} \cdot d_{cs} + P_t \cdot d_t + P_c \cdot d_c] = 16668.963 \text{ kN-m}$$

조밀단면의 휨저항 강도 검토

① $\frac{D}{L} \leq 150$
 $\frac{D}{L} = \frac{1835.647}{14.000} = 131.118 \leq 150 \quad \therefore \text{OK}$

② $\frac{2 \cdot D_{cp}}{L} \leq 3.76 \sqrt{\frac{E_c}{F_{yc}}}$
 $\frac{2 \cdot D_{cp}}{L} = \frac{2 \times 0.000}{14.000} = 0.000 \leq 3.76 \sqrt{\frac{E_c}{F_{yc}}} = \frac{205000.000}{355.000} = 90.355 \quad \therefore \text{OK}$

여기서,
 $D_{cp} = 0.000$ mm : 소성모멘트 적용 시 압축 측 웹의 높이

⚠ 해당 단면은 조밀단면으로 간주

• 하이브리드 단면의 플랜지 응력감소 계수, R_b (KDS 14 31 10 : 2017, 4.3.3.1.10(1))
 $R_b = 1.000$ (균질조밀단면)

• 플랜지 휨방향 휨응력 (KDS 14 31 10 : 2017, 4.3.3.1.1.6)
 불연속적으로 설치된 인장플랜지이므로,
 $f_t = \frac{M_{Ox1}}{S_{y1}} + \frac{M_{Ox2}}{S_{y1}} + \frac{M_{Ox3}}{S_{y1}} = -0.004$

뒤플랜지에 의한
 $f_{tw} = \frac{M_{Ox1}W_{p1}}{I_{w1}} + \frac{M_{Ox2}W_{p2}}{I_{w2}} + \frac{M_{Ox3}W_{p3}}{I_{w3}} = 0.000$

여기서,
 M_b : Bi-moment
 I_w : Warping constant
 w : Warping function at stress point

$f_t = f_{tb} + f_{tw} = -0.004 \leq 0.6F_y = 213.000 \quad \therefore \text{OK}$

• 필강도-정모멘트부 합성단면 (KDS 14 31 10 : 2017, 4.3.3.1.7)
 I. 연속교의 공칭휨강도
 $M_{u1} = 1.3 R_b \cdot M_p = 1.3 \times 1.000 \times 32677.118 = 42480.253$ kN-m

II. 공칭휨강도
 $D_p \leq 0.1D$,
 $D_p = 206.457$ mm $\leq 0.1Dt = 0.1 \times 2102.000 = 210.2$ mm 이므로,
 $M_{u2} = M_p = 36018.935$ kN-m

$\therefore M_u = \min (M_{u1}, M_{u2}) = \min (42480.253, 36018.935) = 36018.935$ kN-m

• 정모멘트부 합성단면의 필강도 검토 (KDS 14 31 10 : 2017, 4.3.3.1.7.1, (4.3-146))
 $M_u \leq \phi_b \cdot M_n$
 $M_u = 22520.114$ kN-m
 $\phi_b \cdot M_n = 1.000 \times 36018.93548 = 36018.935$ kN-m
 $\therefore M_u = 22520.114$ kN-m $\leq \phi_b \cdot M_n = 36018.935$ kN-m $\therefore \text{OK (Ratio = 0.625)}$

비조밀 단면의 휨저항 강도 검토

• 복부면의 국부좌굴에 따른 플랜지 응력 감소계수, R_b (KDS 14 31 10 : 2017, 4.3.3.1.10(2))
 $2 \frac{D_b}{t_w} = \frac{2 \times 968.447}{14.288} = 135.566 \leq \lambda_{wb} = 5.7 \sqrt{\frac{E_c}{F_{yc}}} = 5.7 \sqrt{\frac{210000}{205.000}} = 182.435$

여기서,
 $f_{yc} = 205.000$ MPa (압축플랜지의 최소항복강도)

$R_b = 1.000$

$\lambda_f \leq \lambda_{fb}$ 이므로,
 $F_{nc(FLB)} = R_b \cdot R_b \cdot F_{yc} = 1.000 \times 1.000 \times 205 = 205.000$ MPa

• 소성거동을 보장하는 비지지길이의 한계, L_p (KDS 14 31 10 : 2017, 4.3.3.1.8.2(3))
 $L_p = 1.0 r_f \sqrt{\frac{E}{F_{yc}}} = 1.0 \times 137.168 \times \sqrt{\frac{210000.000}{205.000}} = 4390.223$ mm

여기서,
 $r_f = \sqrt{\frac{I_{yc}}{A_g}} = \sqrt{\frac{I_{yc}}{A_g}} = \sqrt{\frac{508.000}{\pi \times 137.168 \times 137.168}} = 137.168$ mm

• 압축플랜지의 휨비틀림좌굴 강도 (KDS 14 31 10 : 2017, 4.3.3.1.8.2(3))
 $L_u = \pi r_f \sqrt{\frac{E}{F_{yc}}} = \pi \times 137.168 \times \sqrt{\frac{210000.000}{205.000}} = 16484.943$ mm

$L_p = 4390.223$ mm $< L_u = 5664.200$ mm $\leq L_u = 16484.943$ mm 이므로,
 $F_{nc(FLTB)} = C_b \left[1 - \left(1 - \frac{F_{yc}}{R_b \cdot F_{yc}} \right) \left(\frac{L_b - L_p}{L_u - L_p} \right) \right] R_b \cdot R_b \cdot F_{yc}$
 $= 1.22 \times \left[1 - \left(1 - \frac{143.50}{1.00 \times 205.000} \right) \times \left(\frac{5664.20 - 4390.22}{16484.943 - 4390.22} \right) \right] \times 1.00 \times 1.00 \times 205.000$
 $= 241.571$ MPa

$F_{nc(FLTB)} = R_b \cdot R_b \cdot F_{yc} = 1.000 \times 1.000 \times 205.000 = 205.000$ MPa

$\therefore F_{nc(FLTB)} = \min (F_{nc(FLTB)}, F_{nc(FLB)}) = \min (241.571, 205.000) = 205.000$ MPa

$\therefore F_{nc} = \min (F_{nc(FLB)}, F_{nc(FLTB)}) = \min (205.000, 205.000) = 205.000$ MPa

• 불연속적으로 설치된 압축플랜지의 필강도 검토 (KDS 14 31 10 : 2017, 4.3.3.1.8.1(1))
 $f_{tw} + \frac{1}{3} f_t \leq \phi_b \cdot F_{nc}$
 $f_{tw} + \frac{1}{3} f_t = 100.733 + \frac{1}{3} \cdot -7.075 = -103.091$ MPa
 $\phi_b \cdot F_{nc} = 1.000 \times 205.000 = 205.000$ MPa
 $\therefore f_{tw} + \frac{1}{3} f_t = -103.091$ MPa $\leq \phi_b \cdot F_{nc} = 205.000$ MPa $\therefore \text{OK (Ratio = 0.503)}$

2. KDS 24 14 31 : 2018 Composite Design 추가

- 수직/수평보강재 보강 여부에 따른 전단검토 프로세스 제공
- 시공단계해석 결과를 활용한 시공성 휨/전단검토 프로세스 제공

MODS > Design > Composite Design > KDS 24 14 31 : 2018

소성 중립축 위치/소성모멘트 산정

1) 전단

1) 설계부재력 및 발생응력
 하중조합 이름 : sLC83
 하중조합 종류 : -

구분	V _u (kN)			Sum
	합성전	장기합성	단기합성	
부재력	2386.957	962.827	0.000	3349.784

2) 전단강도 (KDS 14 31 10 : 2017, 4.3.3.1.9)
 i) 전단항복강도에 대한 전단좌굴응력의 비, C (KDS 14 31 10 : 2017, 4.3.3.1.9.3)
 • 복부판의 보강여부 판단
 수평보강재 배치 여부 : 배치되지 않음
 수직보강재 배치 여부 : 배치되지 않음
 중간 수직보강재의 배치간격 검토 (d_s) = 0.0 mm < 3 D = 5506.9 mm
 따라서, 이 복부판은 비보강된 복부판 로 구분됨

- 비보강 웹의 전단좌굴계수 산정
 $k = 5.000$

$$\frac{D}{t_w} = \frac{1835.647}{14.000} = 131.118$$

$$1.40 \sqrt{\frac{E_s k}{F_{yw}}} = 1.40 \times \sqrt{\frac{205000 \times 5.000}{355.000}} = 75.227$$

$\frac{D}{t_w} > 1.40 \sqrt{\frac{E_s k}{F_{yw}}}$ 이므로,

$$C = \frac{1.57}{\left(\frac{D}{t_w}\right)^2} \cdot \left(\frac{E_s k}{F_{yw}}\right) = \frac{1.57}{(131.118)^2} \times \left(\frac{205000 \times 5.000}{355.000}\right) = 0.264$$

ii) 비보강된 복부판의 공칭강도 산정 (KDS 14 31 10 : 2017, 4.3.3.1.9.2)
 $V_p = 0.58 F_{yw} \cdot D \cdot t_w = 0.58 \times 355.000 \times 1835.647 \times 14.000 = 5291.436$
 $V_n = V_p \cdot C = 0.264 \times 5291.436 = 1395.232$ kN

• 전단검토
 $V_u \leq \Phi_v \cdot V_n$
 $V_u = 1708.957$ kN
 $\Phi_v \cdot V_n = 1.000 \times 1395.232 = 1395.232$ kN
 $V_u > \Phi_v \cdot V_n$ ∴ NG (Ratio = 1.225)

조밀단면의 휨저항 강도 검토

2) 전단강도 (KDS 14 31 10 : 2017, 4.3.3.1.9)
 i) 전단항복강도에 대한 전단좌굴응력의 비, C (KDS 14 31 10 : 2017, 4.3.3.1.9.3)
 • 복부판의 보강여부 판단
 수평보강재 배치 여부 : 배치
 수직보강재 배치 여부 : 배치
 중간 수직보강재의 배치간격 검토 (d_s) = 150.0 mm < 1.5 D = 2753.5 mm
 따라서, 이 복부판은 보강된 복부판 로 구분됨

- 보강 웹의 전단좌굴계수 산정
 $k = 5 + \frac{5}{\left(\frac{d_s}{D}\right)^2} = 5 + \frac{5}{\left(\frac{150.000}{1835.647}\right)^2} = 753.800$

$$\frac{D}{t_w} = \frac{1835.647}{18.000} = 101.980$$

$$1.12 \sqrt{\frac{E_s k}{F_{yw}}} = 1.12 \sqrt{\frac{205000 \times 753.800}{355.000}} = 738.939$$

$\frac{D}{t_w} \leq 1.12 \sqrt{\frac{E_s k}{F_{yw}}}$ 이므로, C = 1.000

ii) 보강된 복부판의 공칭강도 산정 (KDS 14 31 10 : 2017, 4.3.3.1.9.3)
 $V_p = 0.58 F_{yw} \cdot D \cdot t_w = 0.58 \times 355.000 \times 1835.647 \times 18.000 = 6803.275$ kN
 $2D \cdot t_w = 2 \times 1835.6 \times 18.0 = 6606.24$
 $(b_1 t_1 + b_2 t_2) = (360.0 \times 20.0 + 400.0 \times 18.0) = 12000$
 $\frac{2D \cdot t_w}{(b_1 t_1 + b_2 t_2)} = \frac{6606.24}{12000} = 0.550 < 2.5$
 따라서,

$$V_n = V_p \left[C + \frac{0.87(1-C)}{\sqrt{\left(1 + \left(\frac{d_s}{D}\right)^2\right) + \frac{d_s}{D}}} \right] = 6803.275 \times \left[1.0 + \frac{0.87 \times (1 - 1.0)}{\sqrt{\left(1 + \left(\frac{150.0}{1835.6}\right)^2\right) + \frac{150.0}{1835.6}}} \right]$$

$$V_n = 6803.275$$
 kN

• 전단검토
 $V_u \leq \Phi_v \cdot V_n$
 $V_u = 1719.009$ kN
 $\Phi_v \cdot V_n = 1.000 \times 6803.275 = 6803.275$ kN
 $V_u \leq \Phi_v \cdot V_n$ ∴ OK (Ratio = 0.253)

비조밀 단면의 휨저항 강도 검토

3) 플랜속으로 필지지된 압축플랜지 (KDS 14 31 10 : 2017, 4.3.3.1.3.2(i))
 • 복부판의 극부좌굴에 따른 플랜지 응력 감소계수, R_b (KDS 14 31 10 : 2017, 4.3.3.1.10(2))
 시공성 검토 시, (KDS 14 31 10 : 2017, 4.3.3.1.3.2)
 R_b = 1.000

• 소성거동률 보장하는 비지지깊이의 관계, L_p (KDS 14 31 10 : 2017, 4.3.3.1.8.2(3))
 $L_p = 1.0 r_t \sqrt{\frac{E}{F_{yc}}} = 1.0 \times 150.857 \times \sqrt{\frac{205000.000}{355.000}} = 3625.174$ mm

여기서,
 $r_t = \sqrt{\frac{I_x}{A_g}} = \sqrt{\frac{600.000}{150.857}} = 63.095$ mm
 $I_x = \frac{1}{12} \left(1 + \frac{1}{3} \frac{D_c t_w}{b_1 t_1} \right) \left(\frac{1}{3} \frac{D_c t_w}{b_1 t_1} \right) = \frac{1}{12} \left(1 + \frac{1}{3} \frac{1063.776 \times 14.000}{600.000 \times 26.000} \right) \left(\frac{1}{3} \frac{1063.776 \times 14.000}{600.000 \times 26.000} \right) = 150.857$ mm⁴

• 모멘트 구배 수정계수, C_b (KDS 14 31 10 : 2017, 4.3.3.1.8.2)
 응력계산 (KDS 14 31 10 : 2017, 4.3.3.1.1.6)
 - 검토단면의 비지지깊이 중앙에서 휨방향 휨모멘트를 고려하지 않은 플랜지 응력 (f_{max})
 $f_{max} = -83.958$ MPa
 - 검토단면의 비지지깊이 양단에서 휨방향 휨모멘트를 고려하지 않은 플랜지 응력 (f₁, f₂)
 $f_1 = -66.424$ MPa (단부에서의 응력)
 $f_2 = -96.260$ MPa (반대편 단부에서의 응력)
 - 검토단면의 비지지깊이 내 플랜지 최대 응력 (f₁)
 $f_1 = \max(2f_{max} - f_2, f_1) = -71.657$ MPa
 $f_2 = \frac{f_1 - f_2}{2} = \frac{-83.958 - (-96.260)}{2} = 0.872 < 1.0$ 이므로,
 $C_b = 1.75 - 1.05 \left(\frac{f_1}{f_2} \right) + 0.3 \left(\frac{f_1}{f_2} \right)^2 \leq 2.3$
 $C_b = 1.75 - 1.05 \left(\frac{-71.657}{-96.260} \right) + 0.3 \left(\frac{-71.657}{-96.260} \right)^2 = 1.135 \leq 2.3$ ∴ C_b = 1.135

• 플랜지 휨방향 휨응력 (KDS 14 31 10 : 2017, 4.3.3.1.1.6)
 i. 플랜속적으로 필지지된 플랜지이므로, (극선교에 대하여)
 $f_t = \frac{M_u}{S_x} = 0.006$ MPa

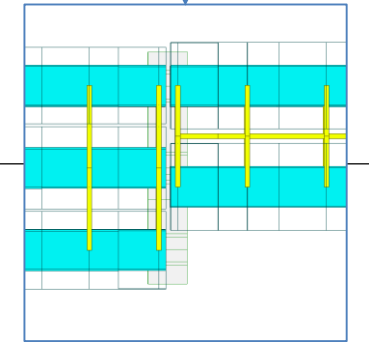
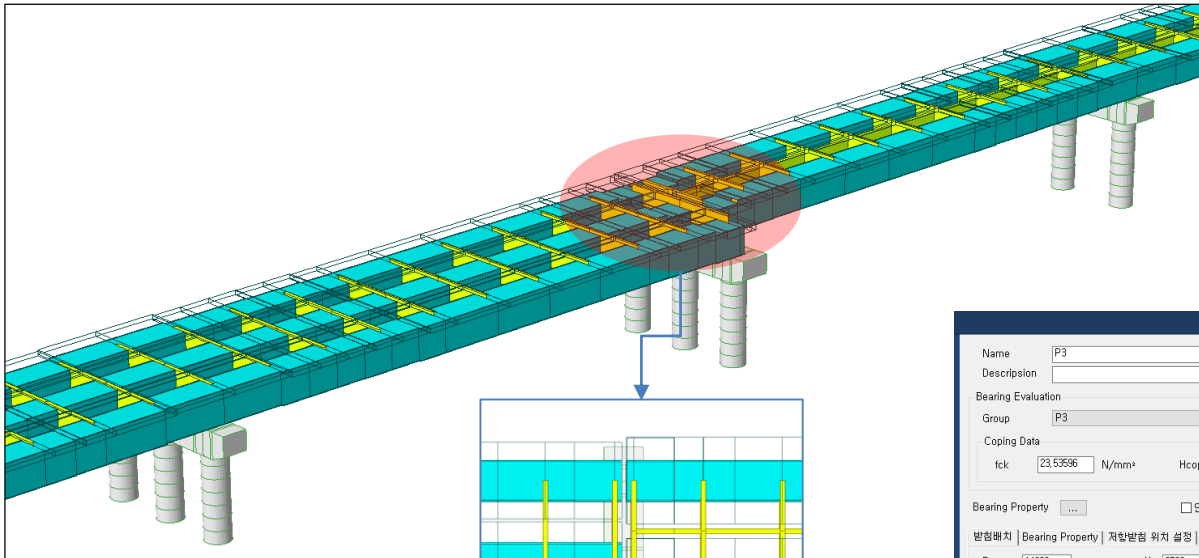
ii. 플랜지 휨방향 휨모멘트 최대 검토
 $L_b \leq L_p$ 이므로, ∴ 모멘트 최대 필요 없음
 $\therefore f_t = f_{1t} = -0.030$ MPa

$f_t = f_{1t} + f_{1w} = -0.030$ MPa ∴ OK

3. Seismic Performance Evaluation : 교량 접속부 및 확폭 구간 받침 배치 개선

- 교량 접속부/확폭 구간에 각 교각별 자유로운 받침 간격 및 종류 고려 가능
- 받침열에 대한 배치 정보를 각각 입력하도록 개선

▪ **Seismic Perform. > Evaluation Type > Bearing Eval. > Bearing Evaluation > Anchor Evaluation**



교량 확폭 구간 교각의 예시

Anchor Evaluation Guide

Name: P3
Description:

Bearing Evaluation
Group: P3

Coping Data
fck: 23.53696 N/mm² Hcop: 1604 mm

Bearing Property 인장 행커 검토

받침배치 | Bearing Property | 저항받침 위치 설정 |
 B: 14800 mm H: 2500 mm 상대각도: -90 [deg]
 Coping Angle: [deg] Guide e1: [deg] e2: [deg]

Layer	D1 (mm)	Sax (mm)	Say (mm)	D1 (mm)	D2 (mm)	D2 (mm)	θ (deg)
1	1400.00	1600, 3600, 1600, 3	-600.000	1400.00	-	650.000	0.0000
2	5400.00	1600, 4800, 1600	600.000	1400.00	650.000	-	0.0000
*							

받침 보강 철근 바뀜

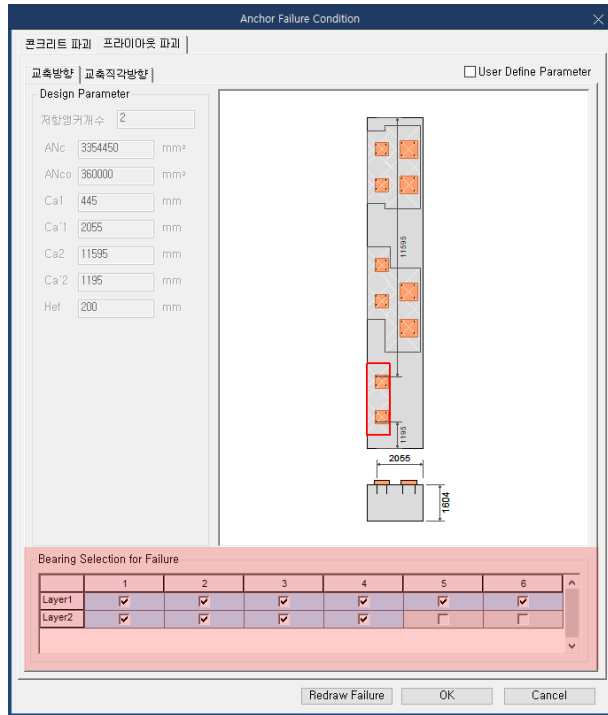
콘크리트 파괴/프라이 아웃 파괴 할상

교량 확폭 구간 교각의 받침 배치 상태

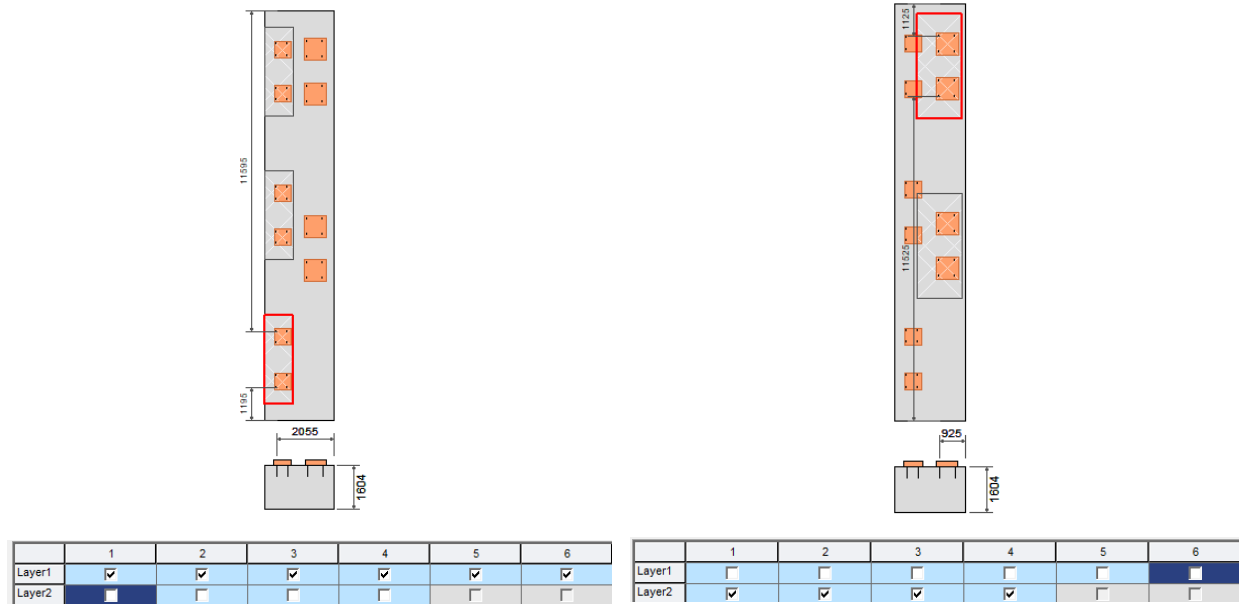
4. Seismic Performance Evaluation : 전단방향의 양방향 받침 검토

- 전단방향의 코핑부 양방향을 모두 검토하여 가장 불리한 저항 그룹을 선정하여 평가하도록 개선
- Bearing Selection for Failure 기능을 활용한 임의 저항 받침 적용 가능

▪ **Seismic Perform. > Evaluation Type > Bearing Eval. > Bearing Evaluation > Anchor Evaluation**



임의 저항 받침 선택 가능



임의 저항 받침 상태에 따른 최대 불리한 저항 그룹 선정

5. Moving Load Analysis to French Former Standard: FASCICULE N° 61 TITRE II

- 전 프랑스 국가 기준 (Former French national standard)에 대한 차량 라이브러리가 추가되었습니다.
- Fascicule N° 61, Conception, Calcul et Epreuves des Ouvrages d'art, Titre II - Programmes de Charges et Epreuves des Ponts-Routes (in French)

▪ **Load > Moving Load > Moving Load Code > France**

Define Standard Vehicular Load

Standard Name: Load System A

Vehicular Load Properties
 Vehicular Load Name: Load System A
 Vehicular Load Type: Load System A

$A = a1 \times a2 \times A(L)$

$A(L) = 2.3 + 360/(L+12) \text{ kN/m}^2$

$A(L) \times a1 \geq (4 - 0.002L) \text{ kN/m}^2$

Coefficient a1

Number of Loaded Lanes		1	2	3	4	≥5
Bridge Class	First Class	1	1	0.9	0.75	0.7
	Second Class	1	0.9	-	-	-
	Third Class	0.9	0.8	-	-	-

Lane Width Coefficient a2 = v0/v v = Loadable Width/Number of Lanes

Nominal Width (m)		v0
Bridge Class	First Class	3.5
	Second Class	3
	Third Class	2.75

OK Cancel Apply

Load System A

Define Standard Vehicular Load

Standard Name: Load System Bc

Vehicular Load Properties
 Vehicular Load Name: Load System Bc
 Vehicular Load Type: Load System Bc

No	Load(kN)	Spacing(m)	Distance Between two Vehedes Min = 4.5m Max = Infinite
1	60	4.5	
2	120	1.5	
3	120	end	

Coefficient bc

Number of Loaded Lanes		1	2	3	4	≥5
Bridge Class	First Class	1.2	1.1	0.95	0.8	0.7
	Second Class	1	1	-	-	-
	Third Class	1	0.8	-	-	-

Apply Dynamic Factor

OK Cancel Apply

Load System Bc

Define Standard Vehicular Load

Standard Name: Military Load

Vehicular Load Properties
 Vehicular Load Name: System Mc 80
 Vehicular Load Type: System Mc 80

Min. Distance Between Two Vehicles: 35.4 m

P: 720 kN D: 4.9 m

Apply Dynamic Factor

OK Cancel Apply

Military Load Mc 80

5. Moving Load Analysis to French Former Standard: FASCICULE N° 61 TITRE II

- 개별 차선이 아닌 차선 정의에서 도로 폭을 정의 합니다.

- **Load > Moving Load > Moving Load Code > France**

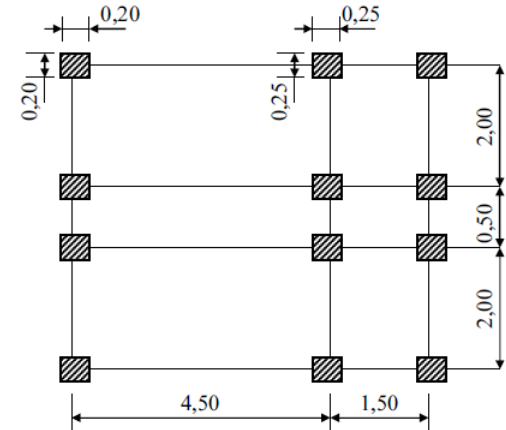
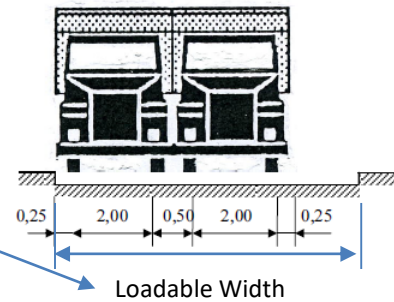
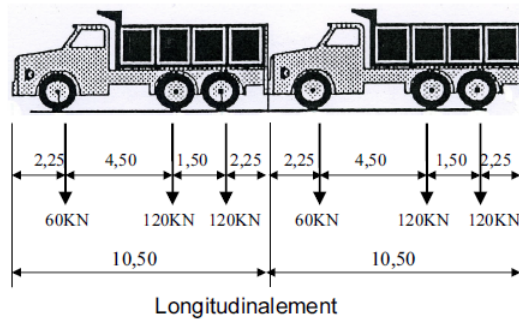
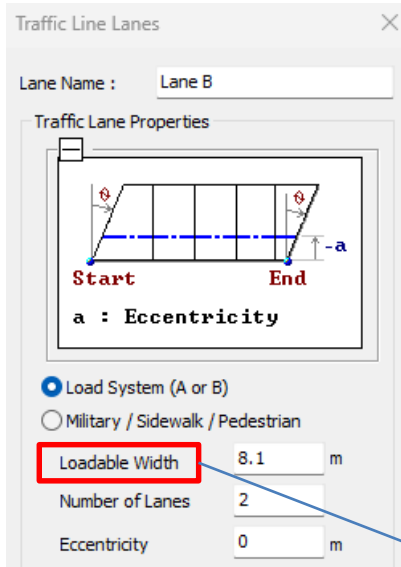


Figure 4.1 : Système B.

5. Moving Load Analysis to French Former Standard: FASCICULE N° 61 TITRE II

- 각 스패의 스패 길이와 무게를 입력하여 동적 계수(δ)를 계산합니다.
- 각 스패에 대한 Bc 하중 체계의 최대 하중은 프로그램에 의해 결정됩니다.

▪ **Load > Moving Load > Moving Load Code > France**

```

MIDAS/Text Editor - [MVmaxBcFz62_DetailResult]
File Edit View Window Help
00001 ** midas Civil France Moving Load Data **
00002 * Moving Load Cases : MVmaxBc
00003 * Key Element : Bc
00004 * Components : Fz
00005 * Maximum Value : 5.0809e+02
-----
00006
00007
00008
00009 [Lane1 ]
00010
00011
00012 * Multiple Lane Factor(bc), 1st Vehicle : 1.100
00013 * Multiple Lane Factor(bc), 2nd Vehicle : 1.100
00014 * Dynamic Factor for Each Axle : 1.241, 1.161, 1.161, 1.161, 1.161, 1.161
00015
00016 [Lane2 ]
00017
00018 * Multiple Lane Factor(bc), 1st Vehicle : 1.100
00019 * Multiple Lane Factor(bc), 2nd Vehicle : 1.100
00020 * Dynamic Factor for Each Axle : 1.241, 1.161, 1.161, 1.161, 1.161, 1.161
00021
00022
Ready Ln 0 / 21.
    
```

• Dynamic Factor

$$\delta = 1 + \frac{0,4}{1 + 0,2.L} + \frac{0,6}{1 + 4 \frac{G}{S}}$$

Traffic Line Lanes

Lane Name : Lane B

Traffic Lane Properties

a : Eccentricity

Load System (A or B)

Military / Sidewalk / Pedestrian

Loadable Width : 8.1 m

Number of Lanes : 2

Eccentricity : 0 m

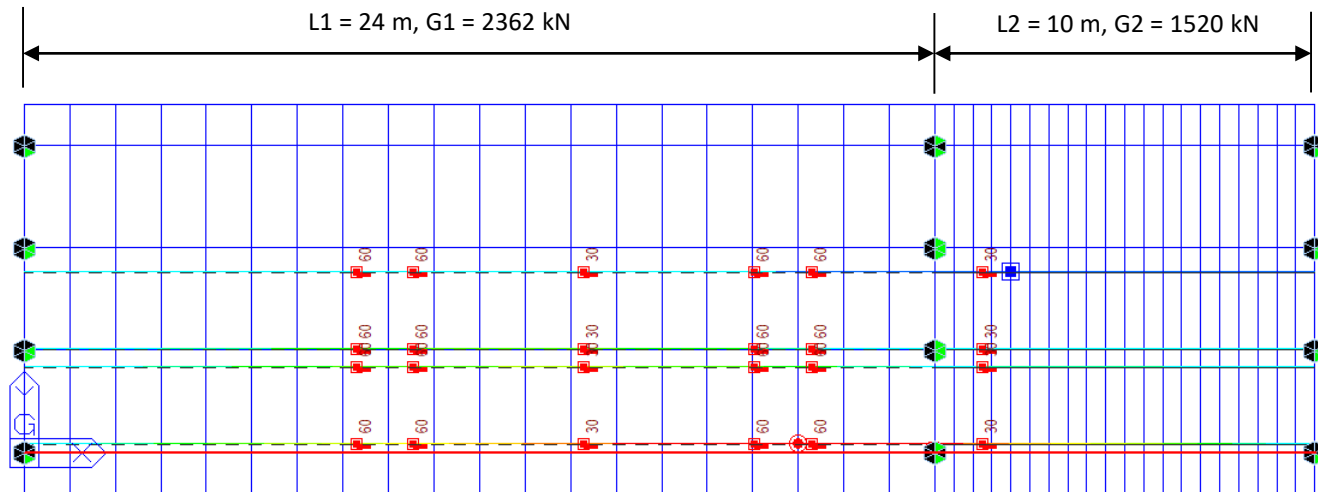
Dynamic Factor for System B

L (Span Length) : 24 m

G (Span Weight) : 2362 kN

Centrifugal Force

Left Wheel of Vehicle Moving Forward : 0.0 W



No	Elem	Eccen. (m)	L (m)	G (kN)	Span Start
1	82	-4.05	24	2362	☑
2	83	-4.05	24	2362	☐

No	Elem	Eccen. (m)	L (m)	G (kN)	Span Start
40	121	-4.05	10	980.	☐

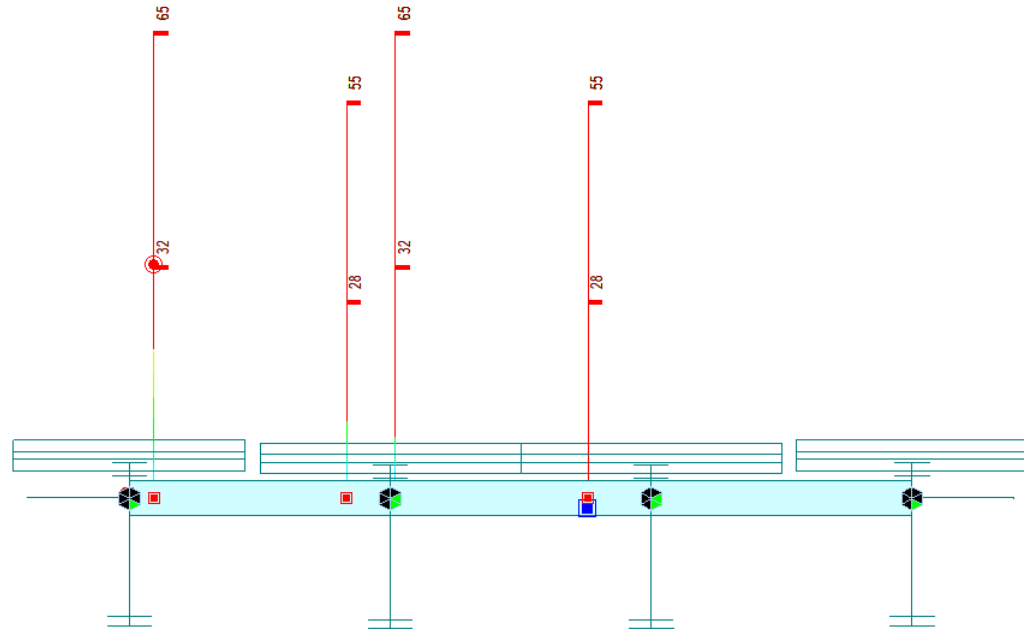
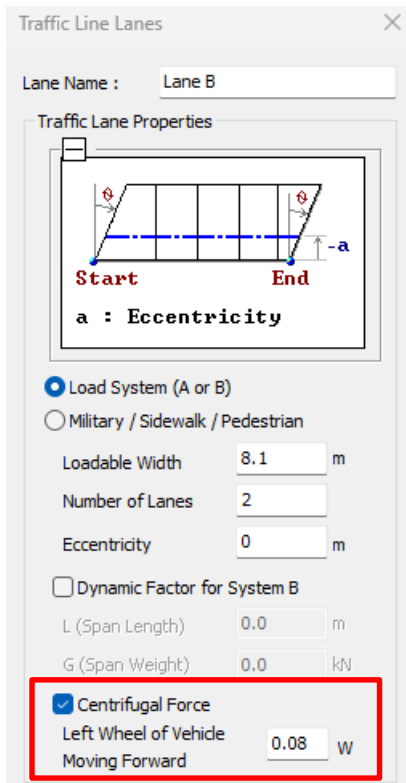
5. Moving Load Analysis to French Former Standard: FASCICULE N° 61 TITRE II

- 원심력 효과는 수직 하중의 효과에 추가될 수 있습니다.

- Load > Moving Load > Moving Load Code > France

- The ratio for the increase of left wheel load to consider the centrifugal forces

$$\frac{R + 150}{6R + 350} \quad \text{if } R < 400\text{m} \qquad \frac{80}{R} \quad \text{if } R \geq 400\text{m}$$



Vertical Loads with Centrifugal Forces

6. French National Annex to Eurocode 2, 3, 4

- Eurocode 2, 3 및 4에 대한 프랑스 국가 부록이 추가되었습니다.

Design > RC Design, Steel Design, Composite Design PSC > PSC Design

The image displays four overlapping dialog boxes from a software application, set against a background image of a French standard document titled "Norme NF EN 1992-1-1/NA Mars 2016 P18-711-1/NA".

- Composite Steel Girder Design Parameters:** Shows design code "EN 1994-2" and National Annex "France". It includes sections for Partial Factor (Concrete, Reinforcing Steel, Structural Steel), Shear Resistance, Fatigue Strength, and Ultimate Limit States (Bending Resistance, Resistance to Vertical Shear, etc.).
- PSC Design Parameters:** Shows design code "Eurocode2-2:05" and National Annex "France". It includes Input Parameters (Moment resistance, Shear resistance, Prestressing steel type) and Output parameters (Ultimate limit states, Serviceability).
- Steel Design Code:** Shows design code "Eurocode3-2:05" and National Annex "France". It includes options for All Beams/Girders are Laterally Braced, Check Beam/Column Deflection, and Biaxial moments for buckling resistance.
- Concrete Design Code:** Shows design code "Eurocode2-2:05" and National Annex "France". It includes Moment Resistance (Moment Redistribution Factor for Beam), Column Design (Axial load plus biaxial bending), and Shear Resistance (Strut Angle for Shear Resistance).

At the bottom of the dialog boxes, there are buttons for "Composite Steel Girder Design", "Prestressed Girder Design", "Steel Design", and "Concrete Design".

7. Eurocode Design Report in French

- Eurocode의 디자인 보고서를 이제 프랑스로 생성할 수 있습니다.

- **Design > RC Design, Steel Design, Composite Design**
- **PSC > PSC Design**

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■ NOM DU MEMBRE : Slab-BC

1. Informations de l'élément

- 1) Code de conception
EN 1992-2: 2005 (NA:France)
- 2) Propriété de section
10 (ID : 10)
- 3) Propriété matérielle
 $f_{ck} = 30.000\text{MPa}$, $f_y = 500.000\text{MPa}$
- 4) Longueur
 $L = 0.914\text{m}$
- 5) Données de ferrailage
Bot-Dir.1 : P16@300
Top-Dir.1 : P16@300
Bot-Dir.2 : P13@300
Top-Dir.2 : P13@300

2. Capacité de Moment (Dir-x, Négatif)

Moment Nég.	Memb No.	740	
	Nœud No.	777	
	LCB	cLCB2	
	M_{Ed} / M_{Rd}	-56.696kN-m/m / -59.070kN-m/m = 0.960	OK
	$\rho_{min} , \rho , \rho_{max}$	$\rho_{min} = 0.00151 < \rho = 0.00319 < \rho_{max} = 0.04000$	OK

* cLCB2 : (1.350)SW+(1.350)EHmax+(1.350)LS+(1.350)MVL1+(1.350)EV

- 1) Paramètre de conception
 $f_{ck} = 30.000\text{MPa}$, $f_{yk} = 500.000\text{MPa}$
 $b_w = 1,000.000\text{mm}$, $h = 260.000\text{mm}$
 $d = 210.000\text{mm}$
 $A_{st} = 670.200\text{mm}^2$
 $\alpha_{cc} = 1.000$
 $\gamma_c = 1.500$, $\gamma_s = 1.150$
 $f_{cd} = \alpha_{cc} f_{ck} / \gamma_c = 20.000\text{MPa}$
 $\bar{f}_{yd} = f_{yk} / \gamma_s = 434.783\text{MPa}$

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG
1																																	
2	Číslo prvku		16																														
3	Position Information		J																														
4																																	
5	1.Nastavení posudku																																
6	1.1 Návrhové parametry																																
7	- Dílčí součinitele pro mezní stav únosnosti (EN 1992-1-1:2004, 2.4.2.4)																																
8	Návrhové situace		γ_c beton				γ_s betonářská výztuž				γ_s předpjatá výztuž																						
9	Trvalé & Dočasné		1.500				1.150				1.150																						
10	Mimořádné		1.200				1.000				1.000																						
11																																	
12	- součinitel α_{cc} , α_{ct} : Součinitel pro dlouhodobé účinky únosnosti v tlaku a tahu.																																
13	$\alpha_{cc} =$		0.850				(pro únosnost betonu v tlaku)																										
14	$\alpha_{ct} =$		1.000				(pro únosnost betonu v tahu)																										
15																																	
16	1.2 Průřezy																																
17	b_w		8500.0 mm				I_y		7.8668E+12 mm ⁴				A_{sl}		0.000 mm ²																		
18	h		3000.0 mm				I_z		2.9574E+13 mm ⁴				A_{sc}		0.000 mm ²																		
19	d_c		0.0 mm				C_y		4250.0 mm				A_{sw}		0.000 mm ²																		
20	d_t		0.0 mm				C_z		1790.6 mm				A_{wt}		0.000 mm ²																		
21	A		6208720.000 mm ²										A_{it}		0.000 mm ²																		
22																																	
23	1.3 Materiály																																
24	- Beton																																
25	$f_{ck} =$		40.000 MPa				$E_c =$		35220.000 MPa																								
26																																	
27	- Výztuž																																
28	$f_{yk} =$		400.000 MPa				$E_s =$		200000.000 MPa																								
29																																	
30	1.4 Předpjaté kabely																																
31	Typ		Název kabelu				Pozice (mm)		Plocha (mm ²)		Pevnost (MPa)				E_p (MPa)																		
32											f_{ck}		$f_{p0.1k}$																				
33	1		S_A2L				500.0		2635.300		1900.000		1600.000		200000.000																		
34	2		S_A3L				700.0		2635.300		1900.000		1600.000		200000.000																		
35	3		S_A4R				900.0		2635.300		1900.000		1600.000		200000.000																		
36	4		S_A4L				900.0		2635.300		1900.000		1600.000		200000.000																		

8. Eurocode Design Report in Word Format

- Eurocode의 디자인 보고서는 이제 Excel 형식보다 더 빠른 Word 형식으로 생성되며, 사용자는 보고서 스타일을 쉽게 변경할 수 있습니다.
- 이 버전에서 PSC 디자인 보고서는 여전히 Excel 형식으로 유지됩니다.

■ Design > RC Design, Steel Design, Composite Design

The image displays three overlapping screenshots of Microsoft Word documents generated from Civil 2023, showing design reports for different member types:

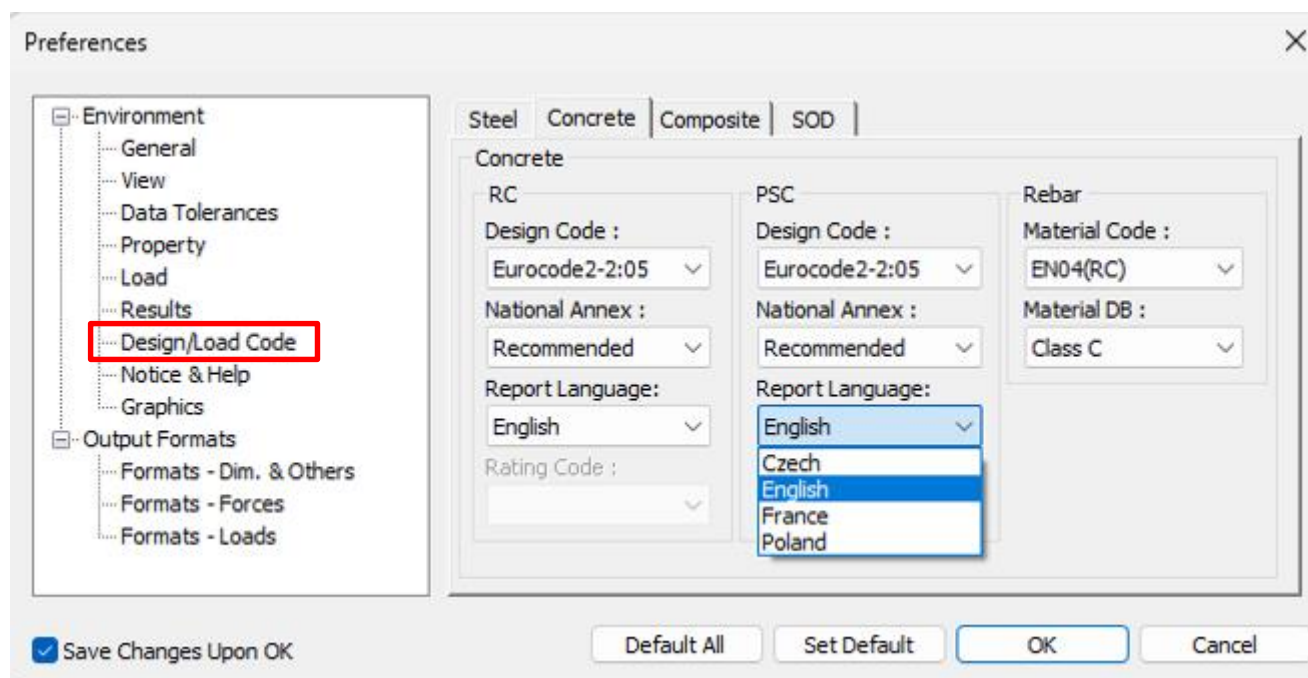
- Left Window (RC Design):**
 - Member Name: 500x300 (Section ID : 1, Element No.1)
 - 1. Member Information:
 - Design Code: EN 1992-2: 2005 (NA/Italy)
 - Section Property: 500x300 (ID : 1)
 - Material: Concrete ($f_c = 25.00\text{MPa}$, $E_{cm} = 31.475\text{MPa}$), Reinforcement ($f_{yk} = 430\text{MPa}$, $E_s = 206.000\text{MPa}$)
 - Length: $L = 6.000\text{m}$
 - Reinforcement Data: Top 2-P24, Bottom 2-P24, Stirrups 2-P14@200
 - 2. Moment Capacity (Negative) (Sector I, 0.25L):
 - Memb No.: 1
 - Neg. LCB: LCB1
 - Moment: $M_{Ed} / M_{Rd} = 0.000\text{kNm} / 136\text{kNm} = 0.000$
- Middle Window (Steel Design):**
 - Member Name: Column 7 W8x35 (ID : 1)
 - 1. Member Information:
 - Design Code: EN 1993-2: 2006 (NA-Recommended)
 - Material: $f_y = 1,711.357\text{MPa}$, $E_s = 199,948.024\text{MPa}$
 - Length: $L = 3.658\text{m}$
 - Partial factors: $\gamma_{M0} = 1.000$, $\gamma_{M1} = 1.000$, $\gamma_{M2} = 1.250$
 - Section Properties: Table with properties for A, C_y, C_z, W_{pl,y}, W_{pl,z}, I_y, I_z, I_{xy}
 - 2. Check Axial Resistance:
 - Axial LCB: sLCB1
 - Check: $N_{Ed} / N_{Rd} = 287.283\text{kN} / 2,325.666\text{kN} = 0.124$ (OK)
- Right Window (Composite Design):**
 - Member Name: Steel Composite : 1 - j
 - 1. Member Information:
 - Design Code: EN 1994-2 (NA - Recommended)
 - Section Property: Comp
 - Material: Steel ($f_y = 345.000\text{MPa}$, $E_s = 210,000.000\text{MPa}$), Concrete ($f_{ck} = 30.000\text{MPa}$, $E_{cm} = 33,000.000\text{MPa}$), Reinforcement ($f_{yk} = 500.000\text{MPa}$, $E_s = 200,000.000\text{MPa}$)
 - Length: $L = 1.000\text{m}$
 - Partial factors: Table with factors for concrete, reinforcing steel, structural steel, headed stud, constant amplitude stress range, fatigue strength, and studs in shear.
 - 6) Section Properties:
 - Diagram showing a composite section with dimensions: 400mm width, 200mm slab thickness, 12.5mm stud height, and 200mm stud spacing.
 - Table:

	Steel Section	Composite Section(Positive)	Composite Section(Negative)
Area	34,687.500mm ²	155,867.976mm ²	43,132.020mm ²

9. Preference Setting for Design Report Language

- 디자인 보고서의 선호 언어를 이제 Eurocode와 AASHTO LRFD의 설정에서 선택할 수 있습니다.
- 디자인 보고서의 선호 단위 체계를 이제 AASHTO LRFD의 설정에서 선택할 수 있습니다.

▪ *Tools > Setting > Preferences > Design/Load Code*

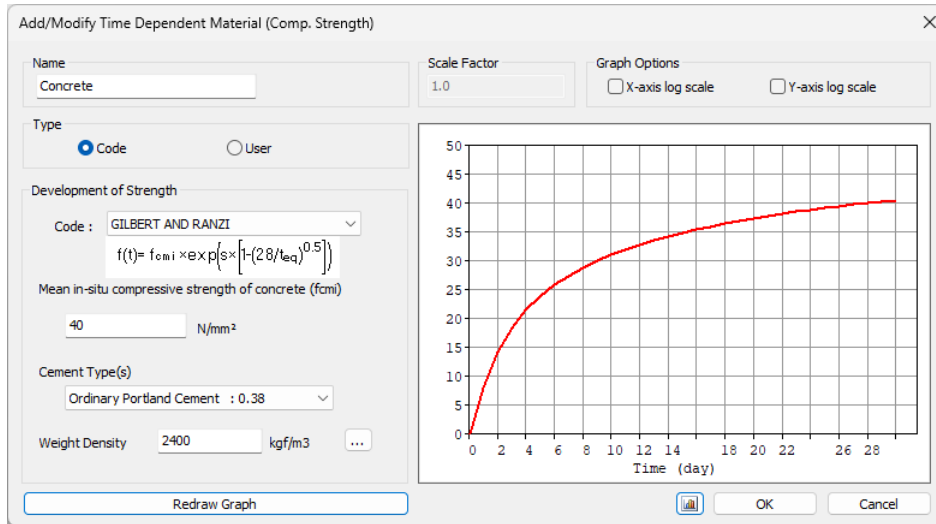


Report Language of Preference

10. Time Dependent Material: Modulus of Elasticity Suggested by Gilbert and Ranzi

- Gilbert와 Ranzi가 제안한 시간에 따라 변화하는 탄성률이 추가되었습니다.
- Time-dependent behavior of concrete structures by Raymond Ian Gilbert and Gianluca Ranzi, 2010

▪ Properties > Time Dependent Material > Comp. Strength > GILBERT AND RANZI



Development of Compressive Strength

- Modulus of elasticity

For $f_{cmi} \leq 40$ MPa:

$$E_c = \rho^{1.5} 0.043 \sqrt{f_{cmi}} \text{ (in MPa)}$$

For $40 < f_{cmi} \leq 100$ MPa:

$$E_c = \rho^{1.5} [0.024 \sqrt{f_{cmi}} + 0.12] \text{ (in MPa)}$$

- Modulus of elasticity with time

$$E_c(t) = \left(e^{s(1-\sqrt{28/t})} \right)^{0.5} E_c(28)$$

11. PSC Design: User Input of Torsion Parameters, Ak and uk

- PSC-Value 유형, PSC-Composite 유형 및 General-Composite 유형 단면의 비틀림 설계에 대한 면적 및 둘레를 사용자가 정의할 수 있습니다.

▪ Properties > Section > Section Manager > Reinforcements

Section Manager

Mode: Reinforcements

Target Section & Element

- Section : 3
 - 1 : T1-2 1500
 - 2 : Super T End
 - 3 : Super T Mid

Grid : 100 mm

Longitudinal Reinforcement | Shear Reinforcement

Same Rebar Data at i & j-end

Diagonal Reinforcement

Pitch: 150 mm
 Angle: 90 [deg]
 Aw: 402.2 mm²

Steel Bar for Web

Pitch: 0 mm
 Angle: 90 [deg]
 Ap: 0 mm²
 Pe: 0 N

Shear Reduction Factor: 1

Torsional Reinforcement

Pitch: 100 mm
 Awt: 201.1 mm²
 Alt: 1963.6 mm²

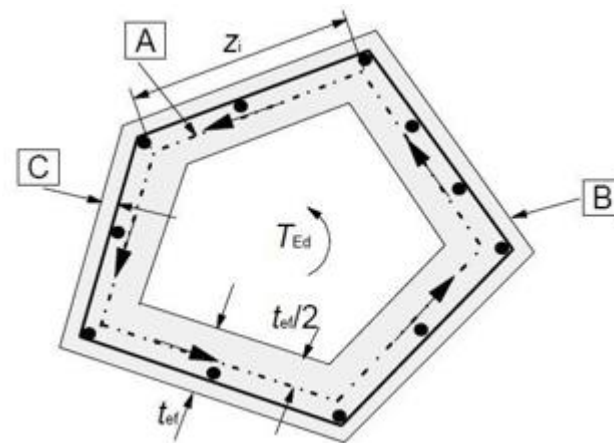
Enclosing Stirrup

Auto Calculation User Input

Ak_centerline	1304467	mm ²
uk_centerline	4820	mm
Ak_outside	1539582	mm ²
uk_outside	5707	mm

Copy Reinforcements to... | Super T End | G : 1088.6, -781.67 | VIEW

Apply | Close



- A - centre-line
- B - outer edge of effective cross-section, circumference u ,
- C - cover

Shear Reinforcement of Section Manager

12. Equivalent Beam Stress Results for Construction Stage Analysis

- 건설단계해석에서 Steel 보의 단면의 폰 미세스 응력 (von-Mises Stresses)을 포함한 등가보 응력을 제공 합니다.

Results > Stresses > Beam Stresses (Equivalent) or Beam Stresses Diagram (Equivalent)

Main Control Data

Auto Rotational DOF Constraint for Truss/Plane Stress/Solid Elements

Auto Normal Rotation Constraint for Plate Elements

Tension / Compression Truss Element (Elastic Link / Inelastic Spring)

Number of Iterations/Load Case: 20

Convergence Tolerance: 0.001

Consider Section Stiffness Scale Factor for Stress Calculation

Transfer Reactions of Slave Nodes to the Master Node

Calculate Equivalent Beam Stresses (Von-Mises and Max-Shear)

Consider Reinforcement for Section Stiffness Calculation

Change Local Axis of Tapered Section for Force/stress Calculation

React... Deform... Forces Stres... Strains

Beam Stresses(Equivalent)

Load Cases: CS: Summation

Step: Last Step

Stresses:

Normal Von-Mises

Tau_xy Max-Shear

Tau_xz Princ. (max)

Princ. (min)

Position:

Maximum

1 (-y, +z)

2 (+y, +z)

3 (+y, -z)

4 (-y, -z)

5 (N.A. -y)

6 (N.A. +y)

7 (N.A. -z)

8 (N.A. +z)

Type of Display:

Contour Deform

Values Legend

Animate Undeformed

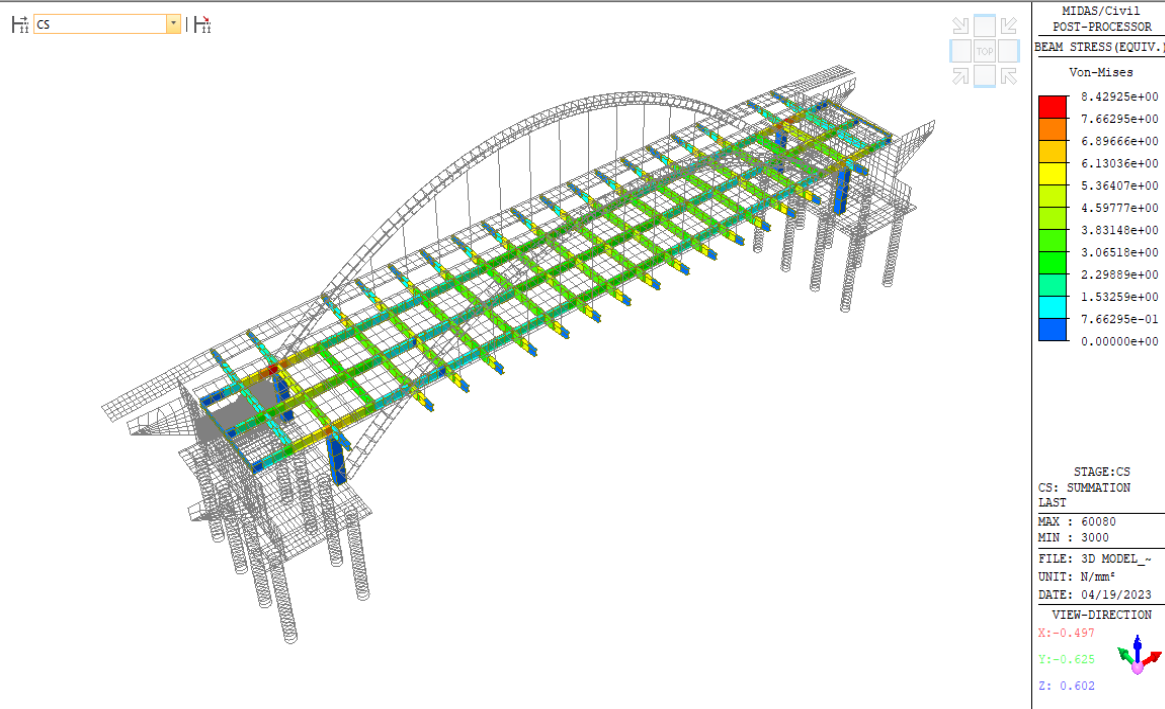
Mirrored

Output Section Location:

I Center J

Max All

Apply Close



Von-Mises Stresses at Centroid of Steel Beam

13. GSD Excel Report: Print Results of All Load Combinations

- GSD 보고서에서 모든 하중 결합에 대한 디자인 결과가 이제 함께 생성됩니다.

Tools > Generator > General Section Designer

Define Load Combination

No.	Load Combination	P (kN)	My (kNxm)	Mz (kNxm)	Vy (kN)	Vz (kN)	T (kNxm)
1	lcb1	0.00	2880.00	0.00	0.00	0.00	0.00
2	lcb2	10000.00	1550.00	0.00	0.00	0.00	0.00
3	lcb3	5000.00	1350.00	1120.00	0.00	0.00	0.00
4	lcb4	7540.00	-2415.00	2640.00	0.00	0.00	0.00
5	lcb5	3590.00	-1450.00	3400.00	0.00	0.00	0.00

Close

Section View: Section1 Interaction Curve Stress Contour

Mode: My-Mz 3D

Mode: Angle: 0.000000 Dea: P-My P-Mz Load Combination: lcb1

Code: Eurocode2:04 Hoop Type: Tie Spiral

Checking Ratio: Keep M/P constant Keep M constant Keep P constant

	P (kN)	My (kNxm)	Mz (kNxm)
1	18618.363	0.000	-0.000
2	13854.348	2844.186	-0.000
3	13259.834	3088.594	-0.000
4	12671.983	3308.460	-0.000
5	12091.494	3500.334	-0.000
6	11519.309	3670.993	-0.000
7	10956.736	3820.881	-0.000
8	10405.647	3949.762	-0.000
9	9868.821	4061.678	-0.000
10	9350.626	4158.444	-0.000
11	8858.537	4235.074	-0.000
12	8407.673	4299.348	-0.000
13	8056.967	4343.774	-0.000
14	7846.246	4321.414	-0.000
15	7113.378	4271.786	-0.000
16	6522.025	4185.485	-0.000
17	5889.170	4059.685	-0.000
18	5223.550	3889.404	-0.000
19	4530.596	3670.616	-0.000
20	3814.054	3399.924	-0.000
21	3076.679	3074.359	-0.000
22	2320.593	2690.837	-0.000
23	1547.484	2245.082	-0.000
24	503.778	1558.325	-0.000
25	-1707.374	0.000	-0.000

Report All Report Close

P-M Curve

Mode: Load Combination = lcb1
Checking Ratio = 2.384 (Keep M/P Constant)

Pu(kN)	Mn(kNxm)
18618.363	0.000
13854.348	2844.186
13259.834	3088.594
12671.983	3308.460
12091.494	3500.334
11519.309	3670.993
10956.736	3820.881
10405.647	3949.762
9868.821	4061.678
9350.626	4158.444
8858.537	4235.074
8407.673	4299.348
8056.967	4343.774
7846.246	4321.414
7113.378	4271.786
6522.025	4185.485
5889.170	4059.685
5223.550	3889.404
4530.596	3670.616
3814.054	3399.924
3076.679	3074.359
2320.593	2690.837
1547.484	2245.082
503.778	1558.325
-1707.374	0.000

Mode: Load Combination = lcb2
Checking Ratio = 0.677 (Keep M/P Constant)

Pu(kN)	Mn(kNxm)
18618.363	0.000
13854.348	2844.186
13259.834	3088.594
12671.983	3308.460
12091.494	3500.334
11519.309	3670.993
10956.736	3820.881
10405.647	3949.762
9868.821	4061.678
9350.626	4158.444
8858.537	4235.074
8407.673	4299.348
8056.967	4343.774
7846.246	4321.414
7113.378	4271.786
6522.025	4185.485
5889.170	4059.685
5223.550	3889.404
4530.596	3670.616
3814.054	3399.924
3076.679	3074.359
2320.593	2690.837
1547.484	2245.082
503.778	1558.325
-1707.374	0.000

Mode: Load Combination = lcb3
Checking Ratio = 1.198 (Keep M/P Constant)

Pu(kN)	Mn(kNxm)
18618.363	0.000
15710.463	1047.896
14919.966	1155.320
14103.774	1232.297
13293.674	1314.675
12495.936	1394.606

Mode: Load Combination = lcb4
Checking Ratio = 3.388 (Keep M/P Constant)

Pu(kN)	Mn(kNxm)
18618.363	0.000
15473.694	978.839
14670.085	1069.599
13888.355	1148.447
13118.117	1228.088

Mode: Load Combination = lcb5
Checking Ratio = 6.686 (Keep M/P Constant)

Pu(kN)	Mn(kNxm)
18618.363	0.000
14822.449	841.783
14096.620	935.683
13379.695	1019.282
12662.163	1096.550
11979.869	1145.635
11289.743	1194.251
10613.982	1232.493
9967.001	1263.977
9331.757	1284.925
8728.384	1298.148
8175.284	1305.567
7738.030	1308.730
7196.163	1295.125
6466.592	1270.877
5658.242	1235.319
4791.853	1187.060
3908.743	1107.766
2963.610	1013.575
2006.083	915.062
1018.217	766.886
-16.058	634.672
-869.623	468.636
-1564.498	89.669
-1707.374	0.000



14. Concrete & Rebar Material Database to South Africa: TMH7

- South Africa TMH7을 위한 콘크리트 및 강재 재료 데이터베이스가 추가되었습니다.

Properties > Material > Concrete > TMH7



Material Data

General
Material ID: 2 Name: Grade 40

Elasticity Data
Type of Design: Concrete
Steel Standard: DB
Concrete Standard: TMH7(RC)
Code: Grade 40
DB: DB

Type of Material
 Isotropic Orthotropic

Steel
Modulus of Elasticity: 0.0000e+00 N/mm²
Poisson's Ratio: 0
Thermal Coefficient: 0.0000e+00 1/[C]
Weight Density: 0 N/mm³
 Use Mass Density: 0 N/mm³/g

Concrete
Modulus of Elasticity: 3.1000e+04 N/mm²
Poisson's Ratio: 0.2
Thermal Coefficient: 1.2000e-05 1/[C]
Weight Density: 2.3e-05 N/mm³
 Use Mass Density: 2.345e-09 N/mm³/g

Plasticity Data
Plastic Material Name: NONE

Inelastic Material Properties for Fiber Model
Concrete: None Rebar: None

Thermal Transfer
Specific Heat: 0 Btu/N-[C]
Heat Conduction: 0 Btu/mm-hr-[C]
Damping Ratio: 0.05

OK Cancel Apply

Concrete Material

Modify Concrete Materials

Material List

ID	Name	fc fck R	Chk	Lambda	Main-bar	Sub-bar
1	Grade 40	40	X	1		

Concrete Material Selection
Code: TMH7(RC) Grade: Grade 40
Specified Compressive Strength (fc|fck): 40 N/mm²
 Light Weight Concrete Factor (Lambda): 1

Rebar Selection
Code: TMH7(RC)
Grade of Main Rebar: Type C Fy: 450 N/mm²
Grade of Sub-Rebar: Type A Fys: 450 N/mm²

Modify Close

Reinforcement Material

Rebar Material Property

Rebar Material Code: TMH7(RC)
Rebar Grade: Type C
Rebar fy: 450 N/mm²
Modulus of Elasticity: 200000 N/mm²
Stress Strain Curve: Park Strain Hardening

OK Close

Reinforcement Material

Material Data

General
Material ID: 2 Name: Grade 40

Elasticity Data
Type of Design: RC
Steel Standard: DB
Concrete Standard: TMH7(RC)
Code: Grade 40
DB: DB

Type of Material
 Isotropic Orthotropic

Steel
Strength: 0 N/mm²
Modulus of Elasticity: 0.0000e+00 N/mm²
Poisson's Ratio: 0
Thermal Coefficient: 0.0000e+00 1/[T]
Weight Density: 0 N/mm³
 Use Mass Density: 0 N/mm³/g

Concrete
Strength: 40 N/mm²
Modulus of Elasticity: 3.1000e+04 N/mm²
Poisson's Ratio: 0.2
Thermal Coefficient: 1.2000e-05 1/[T]
Weight Density: 2.3e-05 N/mm³
 Use Mass Density: 2.345e-09 N/mm³/g

Define Nonlinear Properties

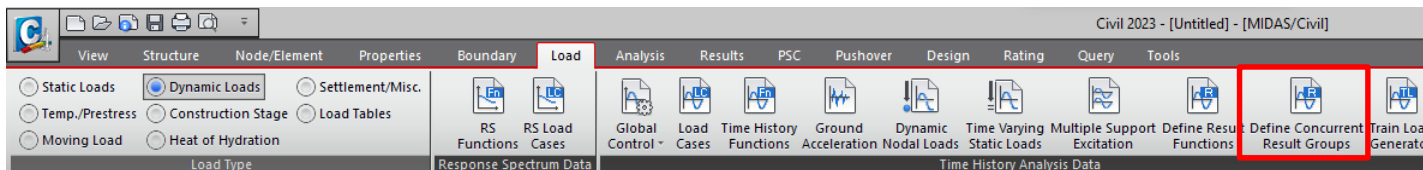
OK Close Apply

Concrete Material

15. Concurrent Disp./Vel./Accel. for Time History Analysis

선형/비선형 시간 이력 분석에서 동시에 여러노드의 변위를 동시에 적용할 수 있습니다.

- **Load > Load Type > Dynamic Loads > Time History Analysis Data > Define Concurrent Result Groups**
- **Results > Result Tables > Time History Analysis > Displ./Vel./Accel. (Concurrent)**



Time History Analysis Data

Time History Concurrent Result Group: G1

Group Name: G1

Master Node: 72

Sub Nodes: 70 73

Type of Result: Displ. Vel. Accel.

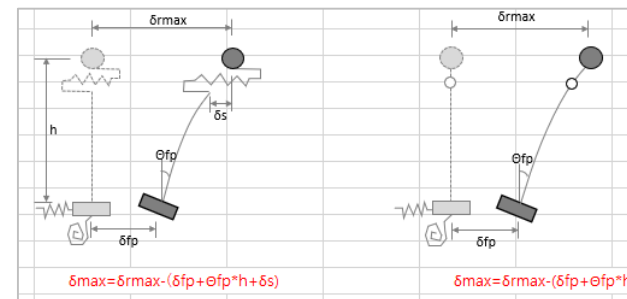
Component: DX

Name	Master Node	Type
G1	72	Displ.
G2	1	Displ.

Operations: Add, Modify, Delete

Define Node Groups

- Reaction
 - Concurrent(Max/Min) Reaction
 - Concurrent(Max/Min) Joint Force
- Displacements
 - Truss
 - Cable
 - Beam
 - Plate
 - Plane Stress
 - Plane Strain
 - Axissymmetric
 - Solid
- Elastic Link
- General Link
- Resultant Forces
- Vibration Mode Shape
- Buckling Mode Shape
- Effective Span Length
- Nodal Results of RS
- Inelastic Hinge
 - Time History Analysis **Displ./Vel./Accel**
 - Heat of Hydration Analysis **Displ./Vel./Accel(Concurrent)**
- Tendon
- Composite Section For C.S.
- Construction Stage
- Equilibrium Element Nodal Force
- Initial Element Force



Group	Load	Node	DX (mm)	DY (mm)	DZ (mm)	RX ([rad])	RY ([rad])	RZ ([rad])
G1	EX(max)	Master Node(72)	97.009600	0.000547	-0.205912	-0.000000	0.001684	-0.000033
		Sub Node(70)	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
G1	EX(min)	Master Node(72)	24.129700	-0.000193	-0.077511	0.000001	0.001782	-0.000050
		Sub Node(70)	-77.893400	-0.003365	0.440000	0.000013	-0.001365	0.000019
G2	EX(max)	Master Node(70)	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
		Sub Node(73)	-23.230400	0.000922	0.170059	-0.000003	-0.001508	0.000049
G2	EX(min)	Master Node(1)	131.728000	-0.012116	-0.319860	0.000002	0.000950	-0.000054
		Sub Node(70)	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
G2	EX(max)	Master Node(72)	96.609000	0.000783	-0.228289	-0.000001	0.001692	-0.000032
		Sub Node(73)	24.106900	-0.000252	-0.086362	0.000001	0.001773	-0.000049
		Master Node(1)	-112.312000	-1.110280	0.590966	0.000043	-0.001041	0.000030
G2	EX(min)	Master Node(70)	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
		Sub Node(72)	-77.818700	-0.003272	0.432113	0.000013	-0.001381	0.000019
		Sub Node(73)	-22.805700	0.000893	0.167061	-0.000003	-0.001495	0.000046

Concurrent Displacements of Multiple Nodes

16. Transmission Zone Design of Pretensioned Beam to AASHTO LRFD

- 프리텐션 빔 설계는 전송 길이(Transmission length) 및 철근의 정착길이(Development length)로 정의된 이중선형 관계를 따르는 텐던의 응력 발생을 고려하여 수행됩니다.
- 철근의 정착길이(Development length)를 고려하여 ULS에서의 휨 저항력이 철근의 정착길이(Development length) 내에서 계산됩니다.

■ PSC > Design Parameter > AASHTO LRFD

No.	Tendon Name	k	f_{ps}	$T_{ps} = A_{ps} f_{ps}$	$A_{ps} f_{ps} (d_p - c)$
1	S_Span1-263	0.374	44,509	9,658	541,010
2	S_Span1-253	0.374	44,510	9,659	541,027
3	S_Span1-243	0.374	44,204		
4	S_Span1-233	0.374	43,899		

(See 5.6.3.1)

No.	Tendon name	l_1 (in)	l_2 (in)	l_{ps} (in)	f_{ps} (ksi)
1	S_Span1-263	31.50	152.65	15.75	44.51
2	S_Span1-253	31.50	152.65	15.75	44.51
3	S_Span1-243	31.50	153.15		
4	S_Span1-233	31.50	153.65		

* The section is located within the transfer length

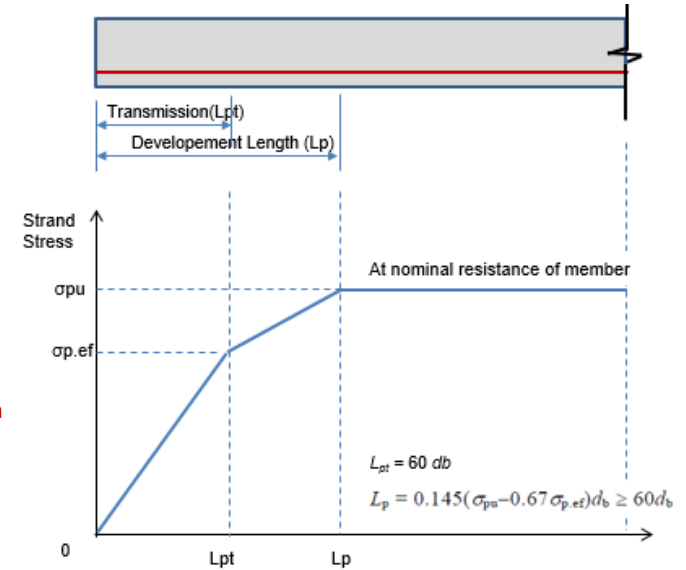
Tendon stress at ULS within development length

Transfer Length & Development Length

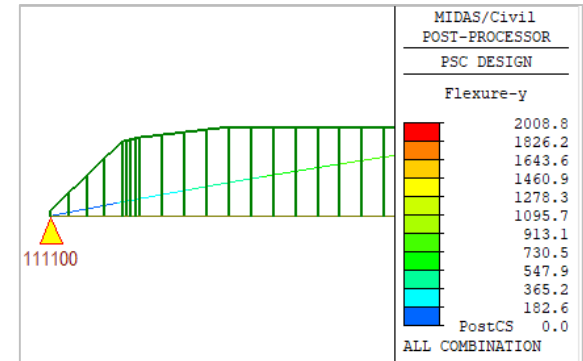
Development Length in Report



Flexural Resistance Diagram



Stresses in the Tendon at ULS



17. SNIp/SP PSC Design: Crack Opening Coefficient by Tendon Material

- SNIp/SP PSC 디자인을 위해 다른 텐던 재료에 대한 균열 개방 계수가 추가되었습니다.

▪ PSC > Design Parameter > CSP 35.13330.2011

PSC Design Parameters

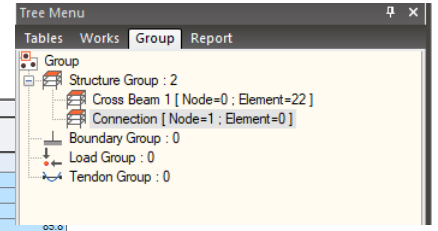
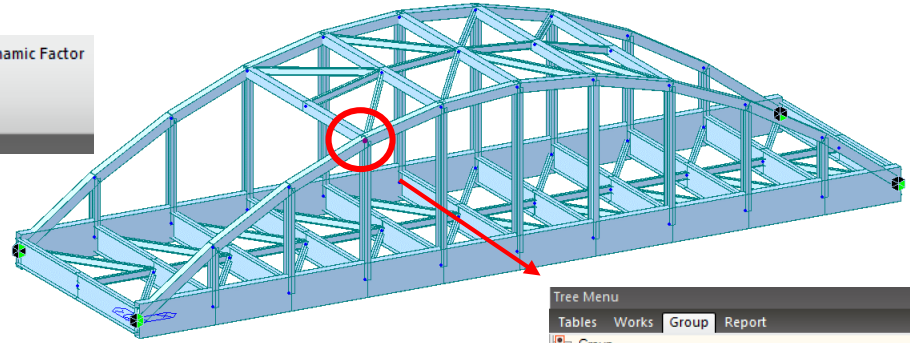
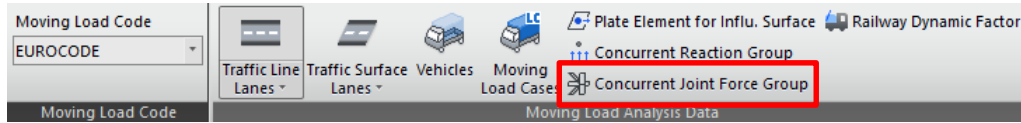
Material (GOST-SP)	Crack Opening Coefficient, Ψ
A600	1,5sqrt(Rr)
A800	1,5sqrt(Rr)
AT600	1,5sqrt(Rr)
AT800	1,5sqrt(Rr)
AT1000	1,5sqrt(Rr)
V1500	0,35(Rr)
V1400	0,35(Rr)
V1400 (Group S)	0,35(Rr)
V1400 (Group Zh)	0,35(Rr)
V1300	0,35(Rr)
V1200	0,35(Rr)
Vp1500	1,5sqrt(Rr)
Vp1400	1,5sqrt(Rr)
Vp1200	1,5sqrt(Rr)
K7-1500	1,5sqrt(Rr)
K7-1400	1,5sqrt(Rr)

Crack Opening Coefficients

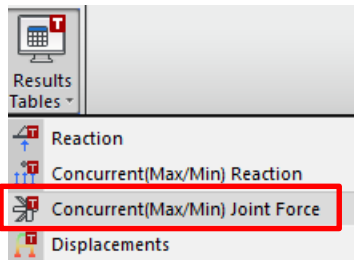
18. Concurrent Joint Forces

- 이동하중 분석 및 침하분석을 위해 조인트에서 교차하는 요소들의 동시 작용력이 제공됩니다.
- 이번 출시에서는 유로코드에만 적용이 가능합니다.

- **Load > Moving Load Analysis Data > Concurrent Joint Force Group**
- **Results > Result Tables > Concurrent (Max/Min) Joint Force**



Select Nodes and Assign Structure Group



Elem.	Load	Elem.	3[U]						4[I]										
			Component	Fx (kN)	Fy (kN)	Fz (kN)	Mx (kN-m)	My (kN-m)	Mz (kN-m)	Fx (kN)	Fy (kN)	Fz (kN)	Mx (kN-m)						
111111	Node:4	Apply																	
3[U]	LM1-U(max)	Fx	0.0	0.0	-0.0	-0.0	-0.0	-0.0	0.0	-0.0	-0.0	-0.0	0.0						
		Fy	-596.7	10.3	2.4	-9.3	-11.2	-87.2	-538.0	-14.8	-2.3	37.8							
		Fz	-1011.8	-4.7	28.5	5.1	80.0	39.7	-913.1	5.4	21.6	-9.3							
		Mx	-787.0	-8.6	-5.5	16.4	71.0	70.9	-647.3	7.4	14.0	-21.4							
		My	-1282.5	-7.4	-17.8	7.8	297.7	61.8	-1119.2	8.4	33.9	-11.9							
		Mz	-1282.0	-11.3	-13.6	12.4	211.7	94.2	-1130.5	12.8	25.1	-21.1							
4[I]	LM1-U(max)	Fx	0.0	0.0	-0.0	-0.0	-0.0	-0.0	0.0	-0.0	-0.0	0.0							
		Fy	-1143.7	-11.1	13.1	11.4	149.2	93.0	-1017.1	13.0	19.4	-23.2	161.3						
		Fz	-1064.8	-7.7	-14.8	9.1	277.2	64.6	-936.8	8.7	38.6	-16.0	285.6						
		Mx	-787.8	9.6	0.9	-10.7	-13.9	-81.6	-713.5	-13.8	-6.1	40.2	-30.2						
		My	-1251.5	-7.3	-17.6	7.9	297.4	60.9	-1108.5	8.2	34.2	-12.1	303.1						
		Mz	-1101.6	-11.2	13.4	12.1	150.9	93.6	-977.3	13.0	20.3	-24.3	164.0						
13[I]	LM1-U(max)	Fx	-1967.4	-6.1	-22.1	5.0	214.2	51.1	-1761.1	6.4	21.3	-0.3	214.1						
		Fy	-1186.4	-7.4	13.6	7.5	219.2	61.9	-1061.8	8.6	25.8	-13.8	229.5						
		Fz	-678.2	-6.9	9.2	15.9	37.0	57.4	-571.1	5.3	11.7	-21.1	57.0						
		Mx	-1246.5	-11.1	-13.3	13.7	213.0	92.7	-1096.2	12.3	25.9	-22.8	222.9						
		My	-764.5	-8.5	-5.6	16.4	72.0	69.9	-644.9	7.3	14.1	-21.4	87.1						
		Mz	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						
111[I]	LM1-U(max)	Fx	-1018.2	1.5	-1.6	6.4	-4.0	-13.8	-881.0	-6.1	-5.3	8.8	5.1						
		Fy	-1461.5	-10.7	-14.7	12.9	200.7	89.1	-1290.5	11.6	22.9	-19.2	209.5						
		Fz	-670.1	-7.3	9.2	16.0	36.3	61.0	-565.2	6.0	11.9	-21.9	55.7						
		Mx	-644.6	-4.3	10.4	12.9	37.0	35.9	-543.2	2.3	9.8	-16.1	58.3						
		My	-668.0	-7.4	9.3	16.0	36.2	61.1	-563.4	6.0	11.9	-21.9	55.5						
		Mz	-1299.0	-11.0	-13.5	13.7	211.0	92.1	-1143.0	12.1	25.0	-22.2	220.9						
125[I]	LM1-U(max)	Fx	0.0	0.0	-0.0	-0.0	-0.0	-0.0	0.0	-0.0	-0.0	0.0							
		Fy	-1474.2	-7.5	-18.5	6.5	277.3	62.5	-1315.5	8.5	26.5	-7.8	277.9						
		Fz	-1420.0	-7.5	-18.7	7.7	291.4	62.9	-1261.3	8.4	31.3	-10.4	295.9						
		Mx	-602.7	-4.5	3.0	11.4	-92.0	36.6	-509.6	2.4	-1.8	-9.1	-82.1						
		My	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						
		Mz	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						

Concurrent Forces of Members Connected at Joints