

AUTOSTRADA (A14) : BOLOGNA-BARI-TARANTO

TRATTO: BOLOGNA BORGO PANIGALE - BOLOGNA SAN LAZZARO

POTENZIAMENTO IN SEDE DEL SISTEMA AUTOSTRADALE E TANGENZIALE DI BOLOGNA

"PASSANTE DI BOLOGNA"

PROGETTO DEFINITIVO

TANGENZIALE NORD E SUD

82T - VIADOTTO NAVILE-BATTIFERRO AMPL. TANG.

AMPLIAMENTO NORD E SUD

RELAZIONE TECNICA DI CALCOLO
IMPALCATO ESISTENTE - ADEGUAMENTO

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PROGETTAZIONE NUOVE OPERE AUTOSTRADALI

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DIPARTIMENTO PER LE INFRASTRUTTURE, GLI AFFARI GENERALI ED IL PERSONALE
STRUTTURA DI VIGILANZA SULLE CONCESSIONARIE AUTOSTRADALI

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1 GENERALITA'

1.1. OGGETTO E SCOPO

La seguente relazione di calcolo è relativa all'analisi dell'impalcato esistente del ponte sui canali Battiferro e Navile previste nell'ambito del progetto esecutivo di potenziamento in sede del sistema autostradale/tangenziale nodo di Bologna.

Il ponte in oggetto, che è stato realizzato nel 1964, scavalca due canali idrici ed è costituito in realtà da due opere separate strutturalmente e sostenenti ciascuna una carreggiata della Autostrada A14, Bologna - Taranto, e una carreggiata della Tangenziale di Bologna.

Gli impalcati dei due ponti sono articolati in 3 campate semplicemente appoggiate, su pile a telaio aventi interasse pari a 26.05 m e disposte in obliquo di 16.2° rispetto all'asse stradale.

Ciascuna campata è costituita da 8 travi in C.A.P. con cavi di post-tensione, aventi luci nette di 24.05 m, e da 4 traversi lunghi 21.00 m, quelli intermedi precompressi. La struttura è completata da una soletta gettata in opera avente uno spessore di 20 cm. La soletta è interrotta da due giunti trasversali presso ogni pila e spalla, posti in asse agli appoggi, ed il piccolo varco di circa 2.00 m tra le solette di due campate contigue viene coperto da una soletta appoggiata ai traversi di estremità degli impalcati stessi.

La sottostruttura a telaio è costituita da un pulvino sorretto da quattro colonne in C.A. del diametro di 1.20 m e poggianti su un unico plinto a sua volta fondato su pali di tipo Franki. Le spalle, anch'esse in C.A. e fondate su pali Franki, sono completate da due muri andatori.

L'opera in oggetto è stata soggetta a un primo intervento di ampliamento nel 2004 che consiste nell'allargamento della piattaforma stradale sul lato esterno - lato tangenziale - per una misura di 1.32 m, sufficiente a consentire l'inserimento di tre corsie sia per l'autostrada che per la tangenziale.

L'allargamento della piattaforma comporta una struttura in allargamento per ciascuna delle due carreggiate ottenuta mediante l'aggiunta di una trave in struttura mista acciaio-calcestruzzo a fianco di quelle esistenti in C.A.P. ed un ampliamento anche delle sottostrutture, comportante la continuazione strutturale del pulvino e del plinto con l'inserimento di una nuova colonna dello stesso diametro delle esistenti.

La parte in allargamento del 2004 dell'impalcato è stata collegata strutturalmente a quella esistente tramite la continuazione dei traversi di testata, realizzati in C.A., ed il collegamento delle solette mediante demolizione della parte a sbalzo esistente con preservazione delle armature e conglobamento di queste nel nuovo getto.

Inoltre, durante l'intervento di allargamento del 2004 è stata prevista l'applicazione, ad intradosso delle travi in c.a.p., di 3 lamelle in carbonio di dimensioni 100 mm x 1.2 mm. Tali lamelle vengono pre-tese con forza di coazione pari a 120 kN per ciascuna lamella. È stata anche consolidata la spalla esistente mediante l'introduzione di tiranti passivi realizzati in micropali armati e mediante un intervento di placcaggio.

La presente relazione riporta le analisi svolte per la verifica dell'impalcato esistente.

Di seguito si riportano le principali geometrie dell'opera. Per ulteriori dettagli si rimanda agli elaborati grafici di progetto.

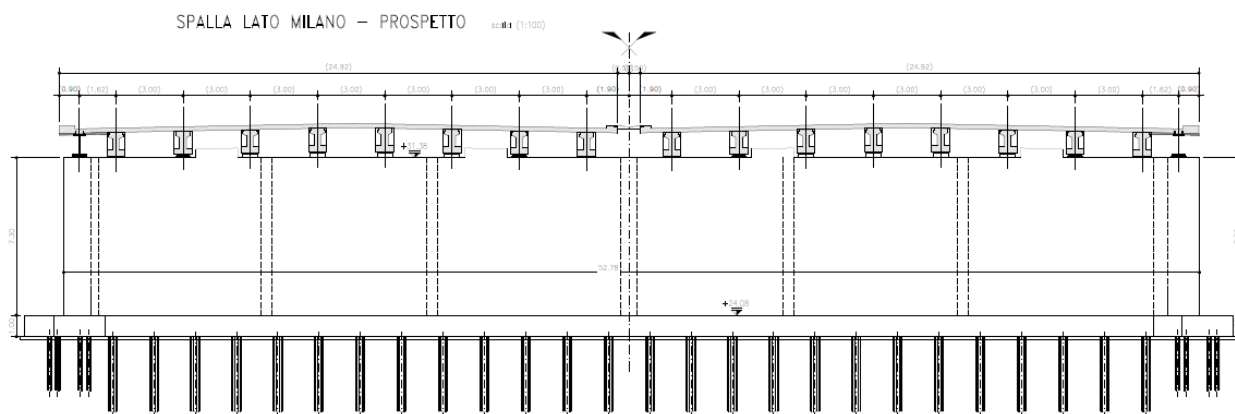


Figura 1.1: Sezione trasversale spalla lato Milano

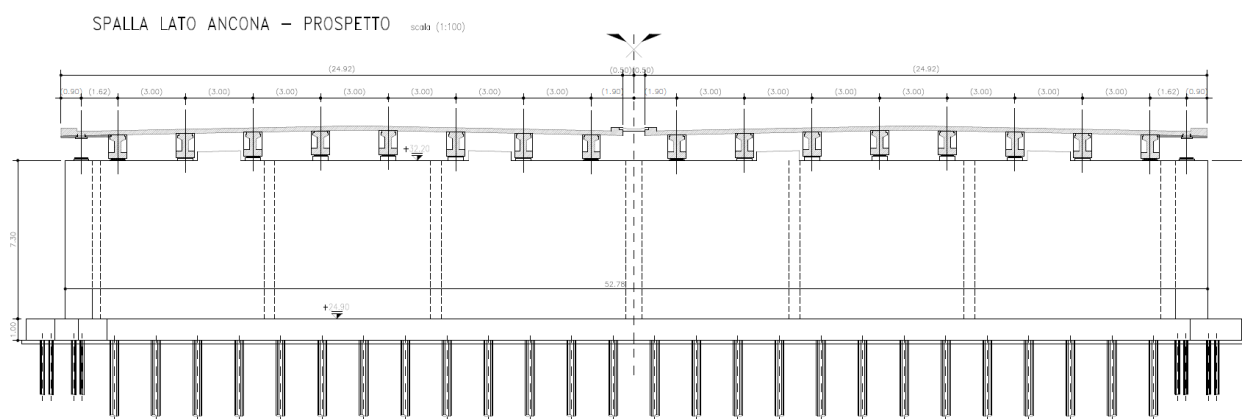


Figura 1.2: Sezione trasversale Spalla lato Ancona

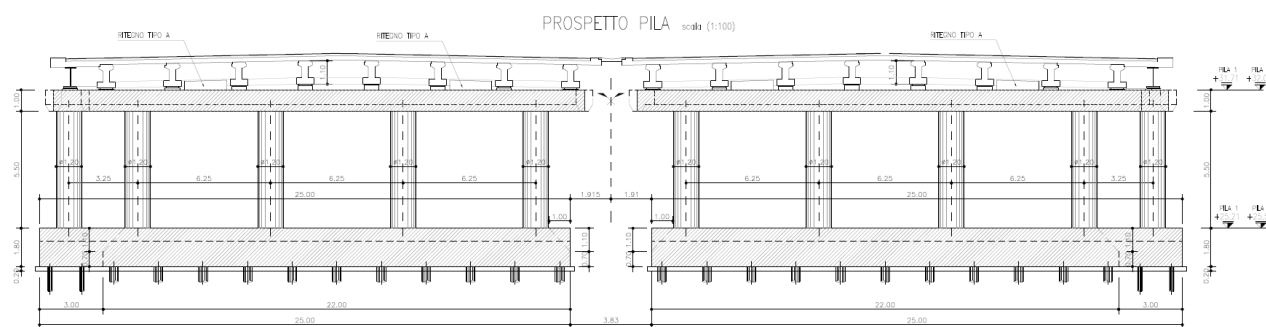


Figura 1.3: Sezione trasversale impalcato su pila

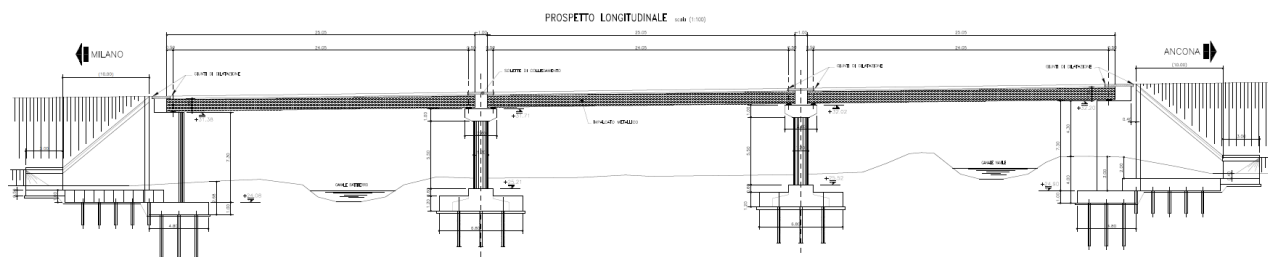


Figura 1.4: Sezione longitudinale impalcato

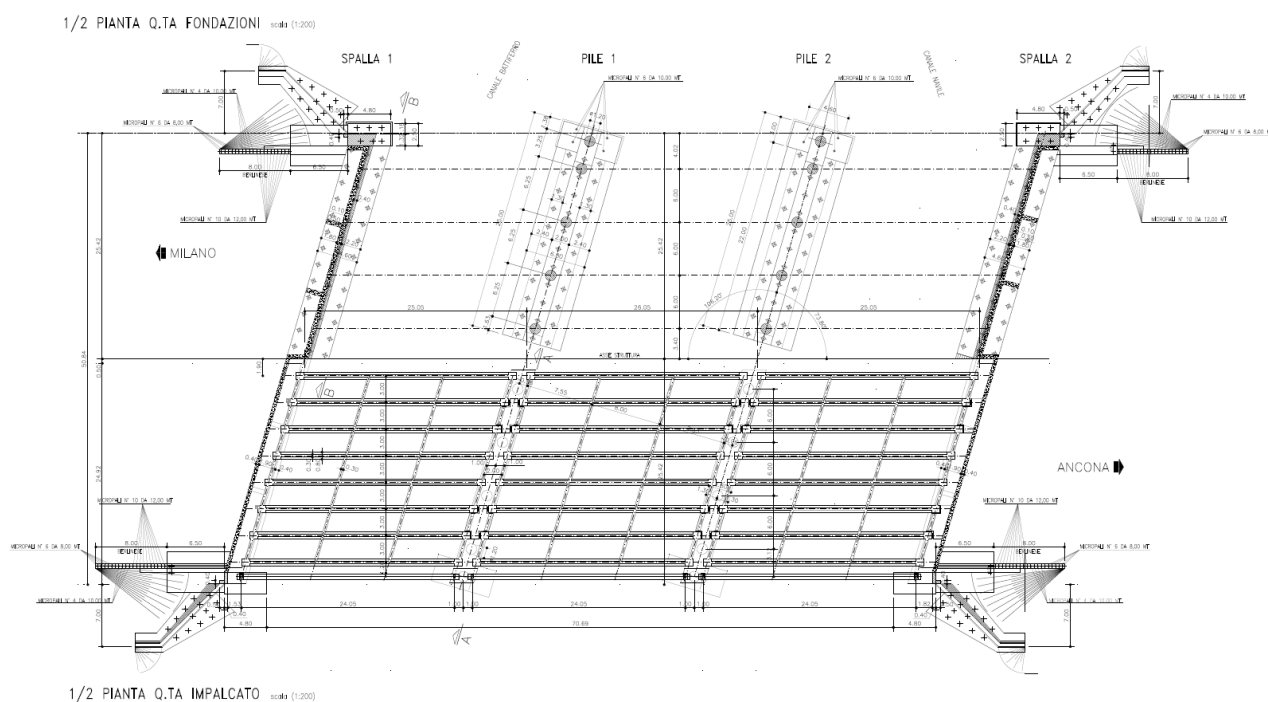


Figura 1.5: *Pianta impalcato*

1.2. NORMATIVA DI RIFERIMENTO

Le analisi e le verifiche di seguito documentate sono state svolte nel rispetto della Normativa vigente di seguito richiamata:

- Legge 5 Novembre 1971 N° 1086 – “*Norme per la disciplina delle opere in calcestruzzo cementizio, normale e precompresso ed a struttura metallica*”;
- Legge 2 Febbraio 1974 n.64: “*Provvedimenti per le costruzioni, con particolari prescrizioni per le zone sismiche*”;
- D.M. 17/01/2018: Aggiornamento delle “*Norme Tecniche per le Costruzioni*” - GU n°42 del 20/2/2018 (di seguito indicata con la sigla “NTC”)
- Circolare 21 Gennaio 2019, n.7 C.S.LL.PP. - Istruzioni per l'applicazione dell'«Aggiornamento delle “Norme tecniche per le costruzioni”» di cui al decreto ministeriale 17 gennaio 2018;
- CNR DT 207/2008 “*Istruzioni per la valutazione delle azioni e degli effetti del vento sulle costruzioni*”.
- CNR UNI 10011/88: “*Costruzioni di acciaio. Istruzioni per il calcolo, l'esecuzione, il collaudo e la manutenzione*”.
- CNR 10016/85: “*Travi composte di acciaio e calcestruzzo. Istruzioni per l'impiego nelle costruzioni*”.
- CNR 10030/87: “*Anime irrigidite di travi a parete piena*”.
- CNR 10024/86: “*Analisi di strutture mediante elaboratore: impostazione e redazione delle relazioni di calcolo*”.
- CNR 10012/85: “*Istruzioni per la valutazione delle azioni sulle costruzioni*”.

Per quanto non definito dalle sopra citate norme, nella stesura dei calcoli è stata consultata anche la seguente normativa internazionale:

- UNI ENV 1090-1:2001: *Esecuzione di strutture in acciaio – Parte 1: Regole generali e regole per gli edifici*.
- UNI EN 1991-2:2003 Eurocodice 1- *Azioni sulle strutture – Parte 2: Carichi da traffico sui ponti*
- UNI ENV 1992-1-1:2005: Eurocodice 2 – *Progettazione delle strutture in calcestruzzo – Parte 1-1: Regole generali e regole per gli edifici*.
- UNI ENV 1993-1-1:1994: Eurocodice 3 – *Progettazione delle strutture in acciaio – Parte 1-1: Regole generali e regole per gli edifici*.
- UNI EN 1993-1-1:2005: Eurocodice 3 – *Progettazione delle strutture in acciaio – Parte 1-1: Regole generali e regole per gli edifici*.
- UNI EN 1993-1-5:2007: Eurocode 3 – *Design of steel structures – Part 1-5: Plated structural element*.
- UNI ENV 1993-1-6:2002: Eurocodice 3 – *Progettazione delle strutture in acciaio – Parte 1-6: Regole generali – Regole supplementari per le strutture a guscio*.
- UNI EN 1993-1-8:2005: Eurocodice 3 – *Progettazione delle strutture in acciaio – Parte 1-8: Progettazione dei collegamenti*.

- UNI EN 1993-1-11:2005: Eurocode 3 – *Design of steel structures – Part 1-11: Design of structures with tension components.*
- UNI ENV 1994-1-1:2004: Eurocode 4 – *Design of composite steel and concrete structures – Part 1-1: General rules and rules for buildings.*
- UNI ENV 1994-2:2005: Eurocode 4 – *Design of composite steel and concrete structures – Part 2: General rules and rules for bridges*

Inoltre si è fatto riferimento a:

- Linee guida per la classificazione e gestione del rischio, la valutazione della sicurezza ed il monitoraggio dei ponti esistenti del Consiglio Superiore dei Lavori Pubblici n88/2019 – Ministero delle Infrastrutture – 17.04.2020

1.3. PRINCIPI DI PROGETTAZIONE

1.3.1. Metodi di Calcolo

Tutti i calcoli di verifica vengono svolti secondo i metodi comprovati derivanti dalla scienza e dalla tecnica delle costruzioni, ricavati dalla letteratura e dalla normativa vigente.

La presente relazione strutturale di calcolo illustra il progetto nei suoi aspetti generali. Data la notevole mole di dati elaborati e di calcoli svolti per verificare tutti i componenti e tener conto delle possibili situazioni di progetto, vengono di seguito riportati solo i principali risultati ed una parte dei calcoli strutturali. In allegato si riporta un estratto dei tabulati di input dati e i relativi dati di output per la condizione di massime sollecitazioni sulle nuove travi in acciaio e sulle travi esistenti secondo la configurazione di carico definite dalle attuali norme.

1.3.2. Unità di Misura

Nel seguito della relazione si adotteranno le seguenti unità di misura:

- per le masse \Rightarrow kg, t
- per i carichi \Rightarrow kN, kN/m, kN/m²
- per le azioni di calcolo \Rightarrow kN, kNm
- per le tensioni \Rightarrow N/mm², MPa, daN/cm²

1.3.3. Stati Limite e Situazioni di Progetto

Stati Limite

Per la progettazione e verifica delle strutture in oggetto viene adottato il metodo degli Stati Limite; per le verifiche che seguono sono stati presi in considerazione, direttamente od indirettamente, le seguenti categorie di Stati Limite:

- Stati Limite Ultimi (SLU).
- Stati Limite di Servizio (SLS).

Per la progettazione e verifica della struttura in oggetto sono stati presi in considerazione, direttamente od indirettamente, i seguenti Stati Limite Ultimi significativi:

- Stato limite di equilibrio come corpo rigido (EQU).
- Stato limite di resistenza della struttura compresi gli elementi di fondazione (STR).

Situazioni di Progetto

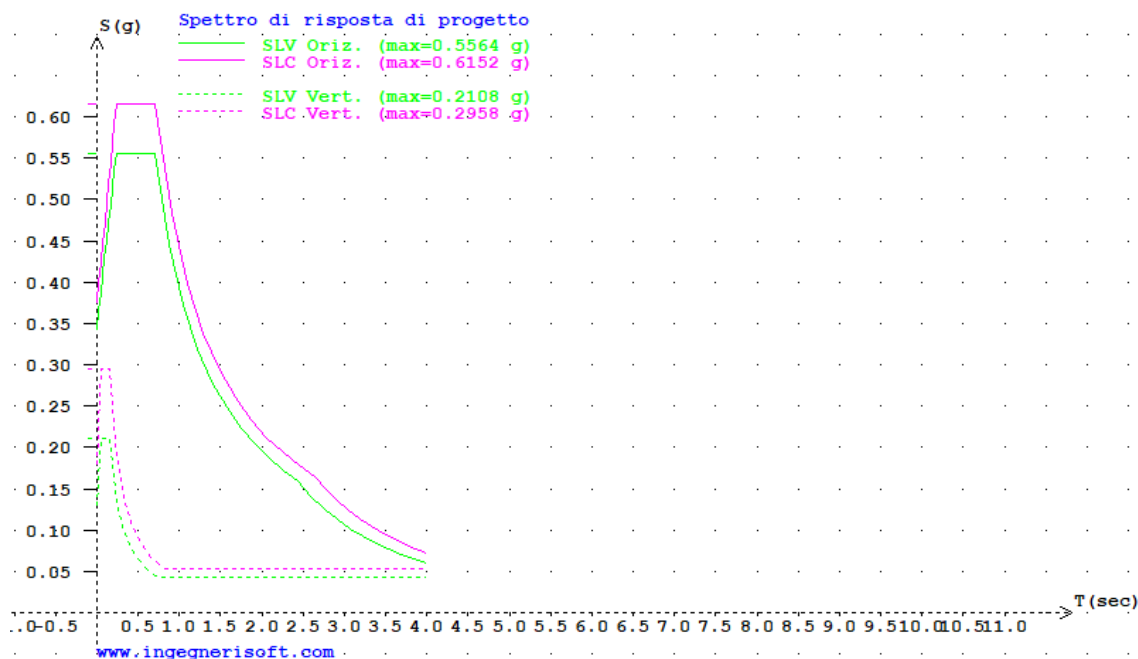
Poiché la costruzione in oggetto rientra nelle tipologie strutturali ordinarie, vengono prese in considerazione le seguenti situazioni di progetto pertinenti:

- Situazioni di Progetto Persistenti: sono le condizioni progettuali corrispondenti alle normali condizioni d'uso della struttura.
- Situazioni di Progetto Sismiche: sono le condizioni progettuali applicabili quando la struttura è soggetta all'evento sismico.
- Situazioni di Progetto Eccezionali: sono le condizioni progettuali applicabili quando la struttura è soggetta ad azioni eccezionali di progetto.

1.4. INQUADRAMENTO SISMICO

Si richiama di seguito l'inquadramento sismico del sito di intervento.

Vita nominale:	50anni
Classe d'uso:	IV \rightarrow Cu = 2.0
Vita di riferimento:	100anni
Accelerazione massima su suolo tipo A:	$a_g = 0.210g$
Categoria topografica:	T1
Tipo di suolo:	D (pk da 10+200 a 18+500) C (pk da 8+900 a 10+200 e da 18+500 a 22+300)
Coeff. di amplificazione topografica S_T :	1.00
Coeff. di amplificazione stratigrafica S_s :	1.635 (suolo tipo D) 1.394 (suolo tipo C)
Accelerazione massima al sito:	$a_{max} = 0.3434g$ (suolo tipo D) $a_{max} = 0.2927g$ (suolo tipo C)



Nel seguito, la trattazione sismica non verrà sviluppata in quanto ha condotto a risultati minori in termini di sollecitazioni, rispetto alla combinazione SLU.

2 MATERIALI

2.1 CARATTERIZZAZIONE MECCANICA DEI MATERIALI DI STRUTTURE ESISTENTI

Secondo quanto definito dalle NTC2018, le resistenze di progetto sono ottenute a partire dalle resistenze medie riducendole con i coefficienti sui materiali, secondo quanto definito dalle NTC2018, e assumendo comunque un valore non maggiore di quello caratteristico per tenere in conto dell'entità della dispersione dei risultati.

Inoltre, in accordo alle Linee guida dei Ponti (paragrafo 6.3.4), per la resistenza di progetto si sceglie il minimo fra i due seguenti valori:

$$f_d = \min (f_m/FC * \gamma_m ; f_k/FC)$$

dove:

- f_m : valore medio a partire dai dati delle prova
- f_k : valore caratteristico al frattile 5% stimato a partire dai dati delle prove
- γ_m : fattore parziale di sicurezza, definito in accordo alle NTC2018
- FC: fattore di confidenza che varia da 1 a 1,35, che riduce i valori medi dei materiali che a loro volta sono ridotti del valore di γ_m .

Il fattore di confidenza FC è definito con riferimento a tre livelli di conoscenza (LC) crescenti:

LC1	livello di conoscenza limitato	FC	=	1,35
LC2	livello di conoscenza adeguato	FC	=	1,20
LC3	livello di conoscenza accurato	FC	=	1

Il livello di conoscenza è definito sulla base degli approfondimenti effettuati inerenti a:

- geometria della struttura;
- proprietà dei materiali;
- connessioni tra i diversi elementi e loro presumibili modalità di collasso

Per maggiori dettagli si rimanda alle NTC2018 e alle Linee Guida dei ponti.

Nel caso in esame, essendo nota la geometria e essendo disponibili i risultati di indagini diagnostiche (riportate nel paragrafo successivo), si assume:

- un livello di conoscenza LC3 (livello di conoscenza LC3), per cui il fattore di confidenza è assunto pari a 1.

Per la determinazione delle resistenze di progetto dei materiali, si fa riferimento a quanto definito dalle NTC2018, ossia le resistenze di progetto sono ottenute a partire dalle resistenze medie riducendole con i coefficienti sui materiali:

$$\gamma_c = 1,50$$

$$\gamma_s = 1,15$$

2.2 RISULTATI DELLE INDAGINI

Si riportano di seguito i risultati delle prove sperimentali effettuate nel 2020 con riferimento al solettone e alle travi esistenti.

- SOLETTA

Prova	Elemento	Carotaggio	R _{ck}
[anno]	[-]	[ID]	[MPa]
2020	soletta	C 40	54.41
2020	soletta	C 41	51.04
2020	soletta	C 42	46.22
2020	soletta	C 43	46.27
2020	soletta	C 44	55.11
2020	soletta	C 46	40.39
2020	soletta	C 52	33.9
2020	soletta	C 54	56.81
2020	soletta	C 56	51.59
2020	soletta	C 59	45.34
2020	soletta	C 61	21.73
2020	soletta	C 62	50.82
2020	soletta	C 64	40.35
2020	soletta	C 65	48.17
2020	soletta	C 66	45.66
2020	soletta	C 67	47.06
2020	soletta	C 68	36.22
2020	soletta	C 69	34.23
2020	soletta	C 70	47.37

- TRAVI

Prova	Elemento	Carotaggio	R _{ck}
[anno]	[-]	[ID]	[MPa]
2020	travi	C 39	44.93
2020	travi	C 45	58.04
2020	travi	C 53	59.21
2020	travi	C 57	51.75
2020	travi	C 58	49.75
2020	travi	C 60	56.2

Con riferimento a quanto definito nel paragrafo 2.1, si riportano di seguito i valori delle resistenze di progetto del calcestruzzo

Elaborazione Dati Prove

dev standard	8.72	[MPa]	Deviazione standard campionaria dei valori
μ	3.782	[MPa]	Media campionaria dei logaritmi
σ	0.228	[MPa]	Deviazione standard campionaria dei logaritmi
$\mu_{0.16}$	3.730	[MPa]	Sedicesimo percentile della distribuzione media campionaria
FC	1.00	[-]	Fattore di confidenza

R_{cm}	44.9	[MPa]	Valore resistenza media dei valori
$R_{ck'}$	28.7	[MPa]	Resistenza cubica caratteristica - frattile 5%

Calcolo resistenze di progetto

γ_c	1.50	[-]	fattore di sicurezza materiale - NTC2018
$R_{cd_NTC2018}$ (DUTTILI)	38.1	[MPa]	$= \alpha_{cc} \times R_{cm} / FC$
$f_{cd_NTC2018}$ (DUTTILI)	31.7	[MPa]	$= 0.83 \times R_{cd_NTC2018}$
$R_{cd_NTC2018}$ (FRAGILI)	25.4	[MPa]	$= \alpha_{cc} \times R_{cm} / (\gamma_c \times FC)$
$f_{cd_NTC2018}$ (FRAGILI)	21.1	[MPa]	$= 0.83 \times R_{cd_NTC2018}$

Resistenza di progetto adottata

R_{cd_MIN}	25.4	[MPa]	$= \min(R_{cd_NTC2018(DUTTILI)}; R_{cd_NTC2018(FRAGILI)})$
f_{cd_MIN}	21.1	[MPa]	$= \min(f_{cd_NTC2018(DUTTILI)}; f_{cd_NTC2018(FRAGILI)})$

CLS equivalente - SOLETTA. C37/45

Elaborazione Dati Prove

N	6	[-]	Numero Campioni
dev standard	5.49	[MPa]	Deviazione standard campionaria dei valori
μ	3.972	[MPa]	Media campionaria dei logaritmi
σ	0.106	[MPa]	Deviazione standard campionaria dei logaritmi
$\mu_{0.16}$	3.928	[MPa]	Sedicesimo percentile della distribuzione media campionaria
FC	1.00	[-]	Fattore di confidenza

R_{cm}	53.3	[MPa]	Valore resistenza media dei valori
$R_{ck'}$	42.7	[MPa]	Resistenza cubica caratteristica - frattile 5%
α_{cc}	0.85	[-]	Coefficiente effetti a lungo termine e durata di applicazione del carico

Calcolo resistenze di progetto

γ_c	1.50	[-]	fattore di sicurezza materiale - NTC2018
$R_{cd_NTC2018}$ (DUTTILI)	45.3	[MPa]	$= \alpha_{cc} \times R_{cm} / FC$
$f_{cd_NTC2018}$ (DUTTILI)	37.6	[MPa]	$= 0.83 \times R_{cd_NTC2018}$
$R_{cd_NTC2018}$ (FRAGILI)	30.2	[MPa]	$= \alpha_{cc} \times R_{cm} / (\gamma_c \times FC)$
$f_{cd_NTC2018}$ (FRAGILI)	25.1	[MPa]	$= 0.83 \times R_{cd_NTC2018}$

Resistenza di progetto adottata

R_{cd_MIN}	30.2	[MPa]	$= \min(R_{cd_NTC2018(DUTTILI)}; R_{cd_NTC2018(FRAGILI)})$
f_{cd_MIN}	25.1	[MPa]	$= \min(f_{cd_NTC2018(DUTTILI)}; f_{cd_NTC2018(FRAGILI)})$

CLS equivalente - trave. C44/53

Cautelativamente nelle verifiche riportate nella presente relazione sono stati utilizzate resistenze di progetto minori rispetto a quelle ottenute dalle indagini, in particolare si riportano di seguito le caratteristiche dei materiali utilizzate.

2.3 CARATTERIZZAZIONE MECCANICA DEI MATERIALI DELLE STRUTTURE DEL PRIMO AMPLIAMENTO (2014)

I materiali per le strutture in cemento armato sono in accordo con le Norme Tecniche per le Costruzioni (NTC 2018 – D.M. 17/01/2018), UNI EN 206:2006 e UNI 11104:2004 “Classi di esposizione per calcestruzzo strutturale”.

Il calcestruzzo ha le seguenti caratteristiche generali:

Coefficiente di Poisson $\nu = 0,2$

Coefficiente di espansione termica $\alpha = 1,00 \times 10^{-5} \text{ } 1/^{\circ}\text{C}$

Peso specifico (compresa l'armatura) $\rho = 25 \text{ kN/m}^3$

Di seguito sono elencate le caratteristiche specifiche del calcestruzzo per i diversi tipi di impiego.

Calcestruzzo per solette

Calcestruzzo a ritiro compensato con espansivo a base di ossido di calcio con ritiro $\leq 100 \text{ microm/m}$ a 28 gg

Classe di resistenza C35/45

Resistenza caratteristica cubica $R_{ck} \geq 45 \text{ N/mm}^2$

Resistenza caratteristica cilindrica $f_{ck} \geq 37,35 \text{ N/mm}^2$

Modulo elastico secante $E = 34.625 \text{ N/mm}^2$

Classe di esposizione XF4

Classe di consistenza S4

Diametro massimo dell'aggregato 32 mm

Copriferro nominale 35 mm

Calcestruzzo per coppelle

Classe di resistenza C35/45

Resistenza caratteristica cubica $R_{ck} \geq 45 \text{ N/mm}^2$

Resistenza caratteristica cilindrica $f_{ck} \geq 37,35 \text{ N/mm}^2$

Modulo elastico secante $E = 34.625 \text{ N/mm}^2$

Classe di esposizione XF4

Classe di consistenza S4

Diametro massimo dell'aggregato 32 mm

Copriferro nominale 35 mm

Acciaio per armatura lenta

L'acciaio ha le seguenti caratteristiche generali:

Modulo elastico	$E = 210.000 \text{ N/mm}^2$
Coefficiente di Poisson	$\nu = 0,3$
Coefficiente di espansione termica	$\alpha = 1,20 \times 10^{-5} \text{ 1/}^\circ\text{C}$
Peso specifico	$\rho = 78,50 \text{ kN/m}^3$

Di seguito sono elencate le caratteristiche dell'acciaio per armatura lenta sono:

Barre

Tipo di acciaio	B450C
Tensione caratteristica di snervamento	$f_{yk} \geq 450 \text{ N/mm}^2$
Tensione caratteristica di rottura	$f_{tk} \geq 540 \text{ N/mm}^2$
Rapporto tensioni caratteristiche	$1,15 \leq (f_t/f_y)_k < 1,35$
Rapporto tensioni di snervamento	$(f_y/f_{y,nom})_k < 1,25$
Allungamento a carico massimo	$(A_{gt})_k \geq 7,5\%$

Acciaio per carpenteria

I materiali per le strutture in carpenteria metallica sono in accordo con le Norme Tecniche per le Costruzioni (NTC 2018 – D.M. 17/01/2018). Si riportano per ogni tipologia le norme di riferimento europee.

La struttura metallica è quindi definita, con riferimento alle UNI EN 1090, come:

Categoria di conseguenza:	CC2
Categoria di servizio:	SC2
Categoria di produzione:	PC2
CLASSE DI ESECUZIONE:	EX C3

I profili metallici sia saldati sia laminati ed il piastrame sono realizzati con l'impiego di acciaio strutturale per carpenteria nelle qualità sotto indicate, in accordo con la norma UNI EN 10025.

Le giunzioni saranno effettuate con saldature o bullonature in conformità alle prescrizioni del paragrafo 11.3.4 delle NTC.

Le modalità di accettazione ed i controlli verranno effettuati in accordo alle prescrizioni del paragrafo 11.3.4 delle NTC.

Tensione caratteristica di rottura ($t < 40\text{mm}$) , f_{tk}	510	MPa
Tensione caratteristica di snervamento ($t < 40\text{mm}$), f_{yk}	355	MPa
Resilienza, KV	$\geq 27 \text{ J}$	
Allungamento percentuale a rottura, ϵ_t	$\geq 20\%$	
Modulo elastico, E_s	210'000	MPa
Coefficiente di contrazione trasversale, ν	0.3	ν

Modulo di elasticità tagliante, G	80'769	MPa
Coefficiente di espansione termica lineare, α	1,20E-05	°C-1
Densità, ρ	7850	kg/m ³

Stato limite ultimo elastico (S.L.U.)

Coefficiente di sicurezza per la resistenza, γ_{M0}	1,05	
Resistenza di progetto per tensioni normali, f_d	338	MPa
Resistenza di progetto per tensioni tangenziali, $\tau_d = f_d/\sqrt{3}$	195,2	MPa
Resistenza all'instabilità delle membrature, γ_{M1}	1,1	
Resistenza, nei riguardi della frattura, delle sezioni tese, γ_{M2}	1,25	

Unioni bullonate

Secondo NTC, UNI 3740 e 20898 parte I e II

Giunzioni a taglio:

Viti classi 10.9 (UNI5712)

Dadi classe 10 (UNI 5713)

Rosette in acciaio C50 EN10083 (HRC 32-40) (UNI5714)

Giunzioni ad attrito:

Viti classi 10.9 (UNI5712)

Dadi classe 10 (UNI 5713)

Rosette in acciaio C50 EN10083 (HRC 32-40) (UNI5714)

Precarico e coppia di serraggio: secondo UNI EN 1993-1-8 e UNI ENV 1090

I bulloni devono essere disposti in opera con una rosetta posta sotto il dado ed una sotto la testa della vite.

$\gamma_{M2} = 1,25$ coefficiente parziale di sicurezza relativo alla resistenza dei bulloni

Saldature

Tutte le saldature sono a piena penetrazione, eseguite come previsto dal D.M. 14.01.2008 ai p.ti 4.2.1.3, 4.2.8.2 ed 11.3.4.5. Secondo NTC e UNI ENV 1090 (cfr. [24]) – Calcolo secondo EC3

$\gamma_{M2} = 1,25$ coefficiente parziale di sicurezza relativo alla resistenza delle saldature a parziale penetrazione e a cordone d'angolo

Connettori a piolo

I connettori a piolo, con testa a tipo Nelson, conforme a quanto prescritto al paragrafo 11.3.4.7 delle NTC.

Secondo UNI EN ISO 13918

Pioli tipo NELSON F=19 - H=0,170m

Acciaio ex ST 37-3K (S235J2G3+C450)

$f_y > 350$ MPa

$f_u > 450$ MPa

2.4 CARATTERISTICHE STRUTTURE ESISTENTI

Calcestruzzo spalle

Classe di resistenza	C20/25
Resistenza caratteristica cubica	$R_{ck} \geq 25 \text{ N/mm}^2$
Resistenza caratteristica cilindrica	$f_{ck} \geq 20,75 \text{ N/mm}^2$

Calcestruzzo traversi

Classe di resistenza	C25/30
Resistenza caratteristica cubica	$R_{ck} \geq 30 \text{ N/mm}^2$
Resistenza caratteristica cilindrica	$f_{ck} \geq 24,90 \text{ N/mm}^2$

Soletta esistente

Classe di resistenza	C25/30
Resistenza caratteristica cubica	$R_{ck} \geq 30 \text{ N/mm}^2$
Resistenza caratteristica cilindrica	$f_{ck} \geq 24,90 \text{ N/mm}^2$

Travi in c.a.p. esistente

Classe di resistenza	C35/45
Resistenza caratteristica cubica	$R_{ck} \geq 45 \text{ N/mm}^2$
Resistenza caratteristica cilindrica	$f_{ck} \geq 37,35 \text{ N/mm}^2$

Barre

Tipo di acciaio	GS ad aderenza migliorata
Tensione caratteristica di snervamento	$f_{yk} \geq 230 \text{ N/mm}^2$
Tensione caratteristica di rottura	$f_{tk} \geq 400 - 440 \text{ N/mm}^2$
Allungamento a carico massimo	$(A_{gt})_k \geq 20\%$

Acciaio per c.a.p.

Cavi del tipo trafilato a freddo	
Struttura	18 Ø 7 mm
Guaina	Ø 44 mm
Tensione di rottura	$\sigma_{f,r} \geq 1670 \text{ N/mm}^2$
Tensione caratteristica all'0,2% di deformazione residua	$\sigma_{f,s/0,2} \geq 1470 \text{ N/mm}^2$

Coefficiente	$\mu = 0,21$
Ancoraggi a testina rifollata	
Distanza dal bordo dell'ancoraggio	156 mm
Distanza dall'asse dell'ancoraggio	264 mm
Slittamento per ogni estremità	1,00 mm

3 ANALISI DEI CARICHI

Si riportano di seguito le analisi dei carichi agenti sulle strutture esistenti del ponte in esame.

3.1 PESO PROPRIO IMPALCATO (G_1) E CARICHI PERMANENTI (G_2)

- Peso proprio travi

Il peso proprio della struttura viene assegnato automaticamente dal programma di calcolo in funzione dell'area degli elementi e dei rispettivi pesi specifici:

- Calcestruzzo armato $\gamma_{cls} = 25 \text{ kN/m}^3$
- Acciaio da carpenteria $\gamma_{acc} = 78.5 \text{ kN/m}^3$

- Peso proprio solaio travi esistenti

Il peso totale della soletta, pari a $25.0 \times 0.20 = 5.00 \text{ kN/m}^2$, viene schematizzato come di seguito come carico lineare agente sulle aste di soletta. Quindi il carico agente su ogni asta di soletta è pari a $g_{1b} = 5.00 \times 0.962 = 4.81 \text{ kN/m}$.

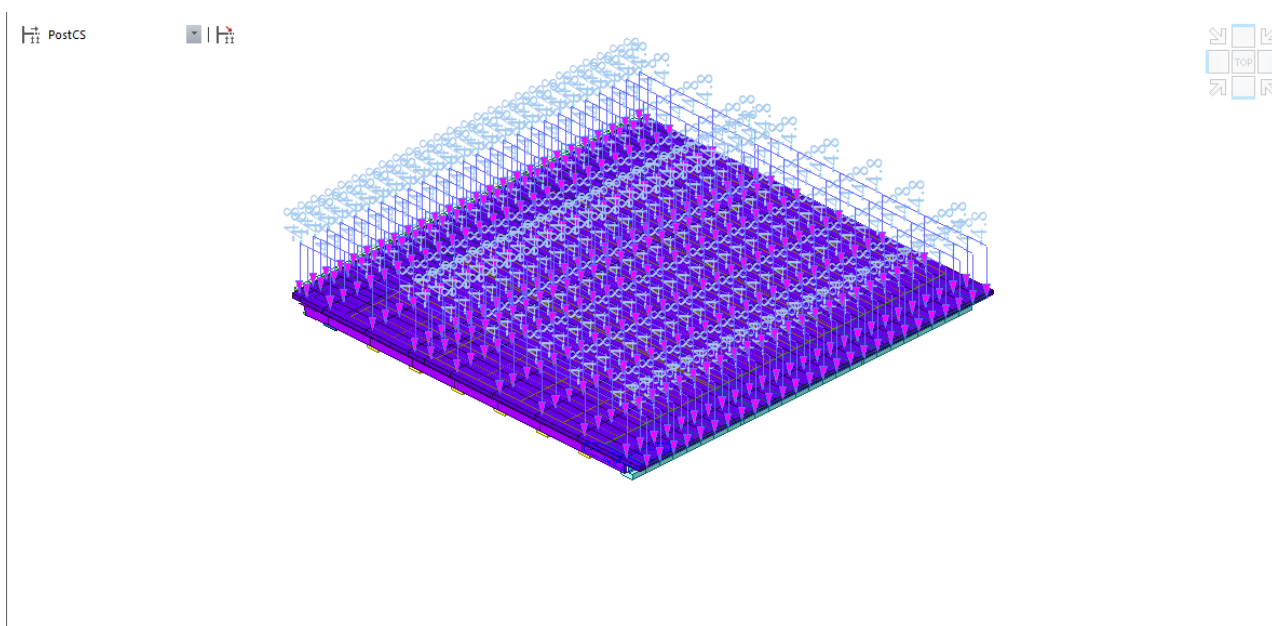
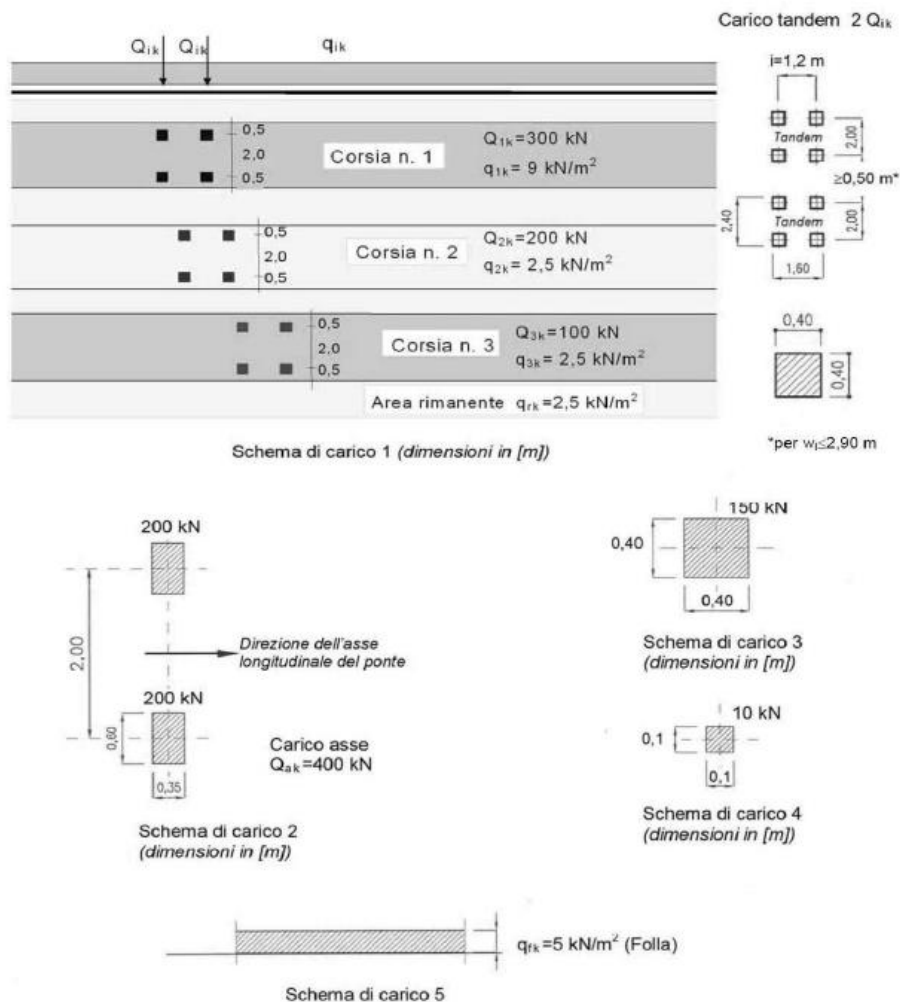


Figura 3.1: Carico soletta su travi esistenti

- Cordolo destro: 1.65 kN/m
- Cordolo centrale: 3.15 kN/m
- Peso pavimentazione bituminosa: $p = 3,00 \text{ kN/m}^2 \times 0.962 = 2.886 \text{ kN/m}$
- Sicurvia destro: 0.70 kN/m
- Sicurvia centrale: 1.40 kN/m

3.2 AZIONI VARIABILI DA TRAFFICO

I carichi mobili sono stati considerati in base alle indicazioni previste per i ponti stradali indicati al punto 5.1.3.3 delle NTC 2018. In particolare, si è considerato lo schema di carico 1 per le verifiche globali.



Data la larghezza della carreggiata si sono assegnate 3 corsie di carico di larghezza pari a 3.0 m secondo lo Schema di Carico 1, come mostrato in figura.

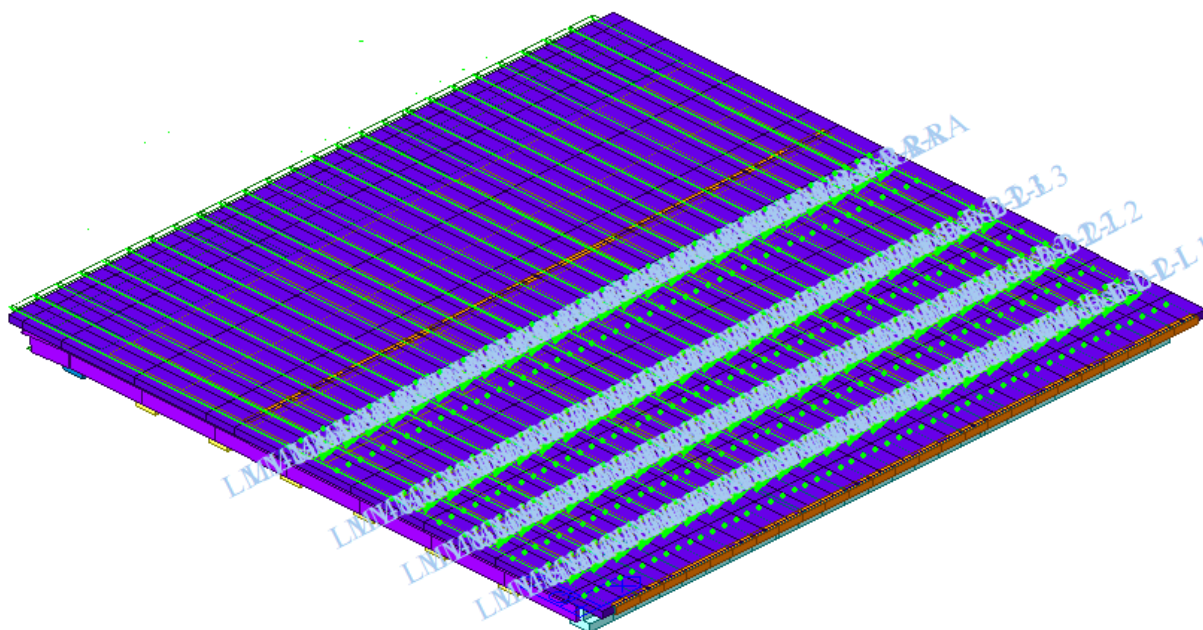


Figura 3.2: Scenario 2 - Massimizzazione sollecitazioni trave in cap di bordo

Tale disposizioni prevedono l'accostamento delle 3 corsie convenzionali sul bordo della carreggiata oltre alle aree rimanenti, consentendo di massimizzare le sollecitazioni delle travi principali poste sui bordi. Si è poi eseguita l'analisi di tipo "Moving Load" disponibile sul codice di calcolo Midas Civil in base alla quale il programma determina di volta in volta l'effetto più gravoso (sollecitazioni, deformazioni, reazioni vincolari) che le varie configurazioni di carichi mobili provocano sui vari elementi finiti costituenti il modello di calcolo secondo la teoria delle linee di influenza.

Tab. 5.1.II - Intensità dei carichi Q_{ik} e q_{ik} per le diverse corsie

Posizione	Carico asse Q_{ik} [kN]	q_{ik} [kN/m ²]
Corsia Numero 1	300	9,00
Corsia Numero 2	200	2,50
Corsia Numero 3	100	2,50
Altre corsie	0,00	2,50

Pertanto, l'impalcato ha le seguenti caratteristiche geometriche:

- Numero delle corsie parte autostradale 3
- Numero delle corsie parte tangenziale 3
- Larghezza corsia 3,00 m
- Larghezza zona rimanente parte autostradale 5,00 m

- Larghezza zona rimanente parte tangenziale 8,75 m

Quindi i treni di carico sono divisi in:

1^a colonna di carico

Q_{ik} = mezzo convenzionale da 300 kN a due assi (4 carichi concentrati da 150 kN)

q_{ik} = carico ripartito da 9,00 kN/m² disposto lungo l'asse di una corsia d'ingombro da 3,00m

2^a colonna di carico

Q_{ik} = mezzo convenzionale da 200 kN a due assi (4 carichi concentrati da 100 kN)

q_{ik} = carico ripartito da 2,50 kN/m² disposto lungo l'asse di una corsia d'ingombro da 3,00m

3^a colonna di carico

Q_{ik} = mezzo convenzionale da 100 kN a due assi (4 carichi concentrati da 50 kN)

q_{ik} = carico ripartito da 2,50 kN/m² disposto lungo l'asse di una corsia d'ingombro da 3,00m

parte rimanente

q_{ik} = carico ripartito da 2,50 kN/m²

3.3 AZIONE LONGITUDINALE DI FRENAMENTO O ACCELERAZIONE

Per i ponti di 1^a categoria la forza di frenamento o di accelerazione q_3 è funzione del carico totale agente sulla corsia convenzionale n°1 è pari a:

$$q_3 = 0,6 \cdot (2 \cdot Q_{1k}) + 0,10 \cdot q_{1k} \cdot w_1 \cdot L$$

Il limite inferiore regolamentare per l'intensità delle forze di frenata è 180,0 kN, mentre quella superiore è di 900,0 kN.

Nel caso in esame si hanno i seguenti parametri:

- $Q_{1k} = 300$ kN
- $q_{1k} = 9,00$ kN/m²
- $w_1 = 3,00$ m
- $L = 25,05$ m

Quindi il valore dell'azione è pari a:

$$q_3 = 0,6 \times (2 \times 300) + 0,10 \times 9,00 \times 3,00 \times 25,05 = 427,64 \text{ kN}$$

Lo scarico alla spalla vale:

$$H_f = 427,64/2 = 213,82 \text{ kN}$$

3.4 AZIONE CENTRIFUGA

Il ponte è in rettilineo per cui sono assenti gli effetti di forza centrifuga.

3.5 VARIAZIONE TERMICA (ϵ_3)

In base alle NTC si tiene conto della variazione termica considerando un $\Delta T = \pm 25^\circ\text{C}$ uniforme.

Quindi la variazione di lunghezza dell'impalcato vale:

$$\Delta l = \alpha \cdot \Delta T \cdot L = 1,20 \times 10^{-5} \times 25 \times 25.050 = 7,52 \text{ mm}$$

Per il calcolo delle escursione totale del giunto si considera la tipologia di appoggi in gomma con distribuzione delle dilatazione metà per parte e quindi si incrementa la variazione di temperatura del 50%.

$$\Delta l_{giunta\text{tot}} = 1,5 \cdot (\Delta l / 2) = 1,5 \times (7,52 / 2) = 5,64 \text{ mm}$$

Per il giunto tra impalcato e spalla si adotta una tipologia con una escursione di $\Delta l_{giunto} = \pm 5,00 \text{ mm}$

3.6 RITIRO E VISCOSITÀ DEL CALCESTRUZZO

La deformazione da ritiro vale: $\epsilon_{cs}(t, t_0) = \epsilon_{cs0} \beta_s(t, t_0)$

ϵ_{cs0} coefficiente nominale di ritiro

$\beta_s(t, t_0)$ coeff. di ritiro nel tempo

$t_0 = 1$ g

$t = 36500$ g

L'analisi degli effetti del ritiro viene gestita dal programma di calcolo eseguendo un'analisi nel tempo.

Gli effetti della viscosità sono stati valutati sulla base dell'evoluzione nel tempo del coefficiente di viscosità $\phi(t, t_0)$:

$t_0 = 28$ g per carichi permanenti; $t_0 = 1$ g per il ritiro; $t = 36500$ g

Il coeff. di viscosità $\phi(t, t_0)$ assume nel nostro caso i valori riportati nelle tabelle.

Figura 3.3 : Andamento della viscosità cls 25/30

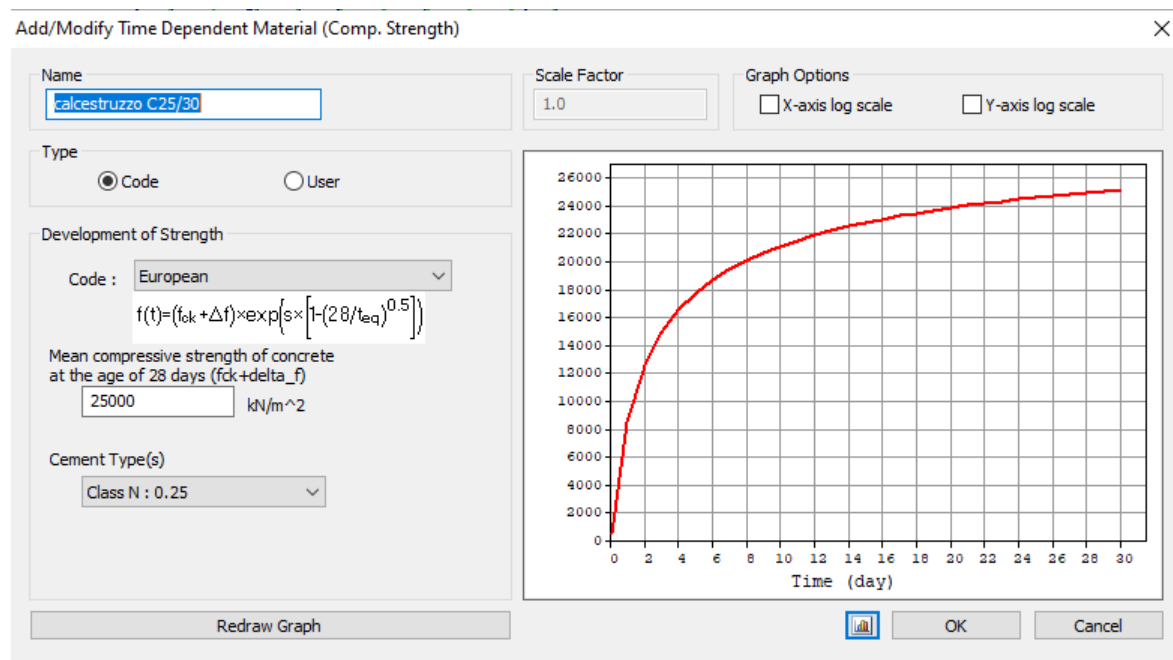


Figura 3.4 : Andamento della viscosità cls 25/30

3.7 PRECOMPRESSIONE

Nella trave esistente sono presenti cavi da 18 ϕ 7. Il carico è stato applicato in due fasi: inizialmente è stato applicato un primo tiro alla tensione di 9000 kg/cm² esercitando la precompressione sulla sola nervatura. Successivamente al getto e al consolidamento della soletta, che interviene con il suo peso a modificare le tensioni della nervatura, si ha il tiro dei cavi sino alla tensione di 11000 kg/cm².

Infine eseguito il grouting, si considerano avvenire le perdite di tensione.

Il percorso cavi e l'azione di precompressione è stata definita all'interno del programma di calcolo mediante la specifica funzione "*Tendon Prestressed Loads*" e impostando i seguenti parametri:

Struttura	18 Ø 7 mm
Guaina	Ø 44 mm
Tensione di rottura	$\sigma_{f,r} \geq 1670 \text{ N/mm}^2$
Tensione caratteristica all'0,2% di deformazione residua	$\sigma_{f,s/0,2} \geq 1470 \text{ N/mm}^2$
Coefficiente di attrito	$\mu = 0,21$
Distanza dal bordo dell'ancoraggio	156 mm
Distanza dall'asse dell'ancoraggio	264 mm
Slittamento per ogni estremità	1,00 mm

Add/Modify Tendon Profile

Tendon Name : 1 Group : gh

Tendon Property : cavo precompressione

Assigned Elements : 176to200 1087 1095

Input Type : ☐ 2-D ☒ 3-D

Curve Type : ☒ Spline ☐ Round

Straight Length of Tendon : Begin : 0 m End : 0 m

☐ Typical Tendon No. of Tendons : 1

Transfer_Length : User defined Length Begin : 0 End : 0 m

Profile Reference Axis : ☐ Straight ☐ Curve ☒ Element

Y 1.53667
-0.46333
-2.46333
0 2 4 6 8 10 14 18 22 x

Z 1.53667
-0.46333
-2.46333
0 2 4 6 8 10 14 18 22 x

	x(m)	y(m)	z(m)	fix	Ry[deg]	Rz[deg]
1	0.0000	-0.1000	-0.5733	<input checked="" type="checkbox"/>	0.00	0.00
2	12.025	-0.3500	-0.6533	<input checked="" type="checkbox"/>	0.00	0.00
3	24.050	-0.1000	-0.5733	<input checked="" type="checkbox"/>	0.00	0.00
4				<input type="checkbox"/>		

Point of Sym.: ☐ First ☒ Last Make Symmetric Tendon

Profile Insertion Point : ☒ End-I ☐ End-J of Elem. 176

x Axis Direction : ☒ I -> J ☐ J -> I of Elem. 176

x Axis Rot. Angle : 0 [deg] ☒ Projection

Offset y : 0 m z : 0 m

OK Cancel Apply

Figura 3.5: Metodo di definizione del percorso cavi

Figura 3.6 : Input parametri trefoli nel programma di calcolo

PostCS

11

TOP

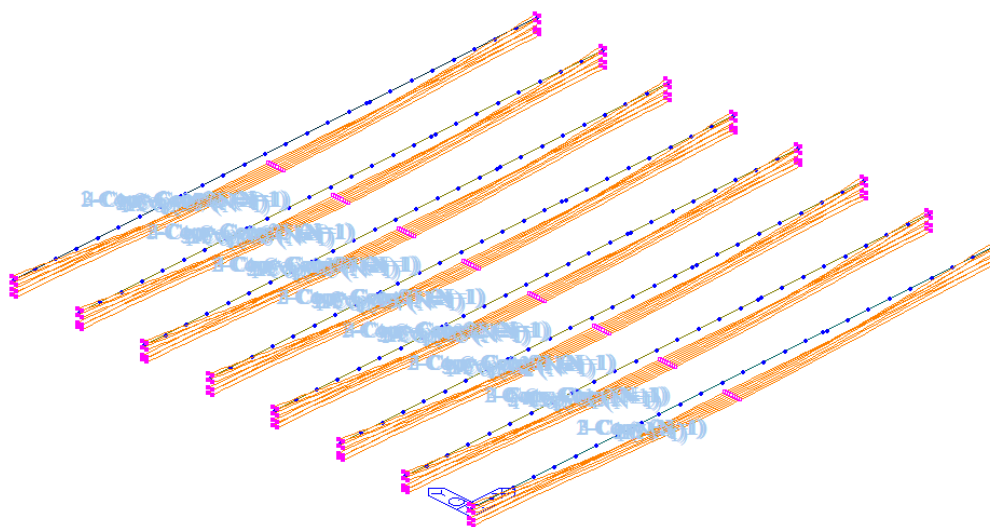


Figura 3.7 : Disposizioni cavi all'interno del programma di calcolo

Le perdite di carico vengono valutate dal programma di calcolo tenendo conto di

Come si evince dalle tabelle sottoriportate il massimo rapporto tra tensione totale nel cavo dopo tutte le perdite e tensione nel cavo dopo le perdite immediate è stato stimato in ragione di 90%.

	Elem	Part	Stress (After Immediate Loss) : A (kN/m ²)	Elastic Deform. Loss : B (kN/m ²)	Stress(Elastic Loss)/ Stress(Immediate Loss)	Creep/Shrinkage Loss (kN/m ²)	Relaxation Loss (kN/m ²)	Stress(After All Loss)/ Stress(After Immediate Loss)	Effective Num.
The Loss of tendon group [ab] at the stage of [FASE 3]									
	Tendon Group		ab	Stage	FASE 3				
	26	I	1034341.933	2228.6156	1.0022	-24684.6655	-70709.8349	0.9099	2
	26	J	1036140.799	2600.475	1.0025	-21233.2788	-71161.1051	0.9133	2
	27	I	1036140.799	2723.167	1.0026	-21108.4151	-71161.1051	0.9136	2
	27	J	1038216.803	3558.3446	1.0034	-17424.8926	-71685.2117	0.9176	2
	28	I	1038216.803	3660.3599	1.0035	-17320.5853	-71685.2117	0.9178	2
	28	J	1040568.342	4858.8348	1.0047	-13511.7224	-72283.1947	0.9222	2
	29	I	1040568.342	4938.3034	1.0047	-13432.5833	-72283.1947	0.9224	2
	29	J	1043193.721	6390.1509	1.0061	-9610.8034	-72956.269	0.927	2
	30	I	1043193.721	6448.3488	1.0062	-9556.655	-72956.269	0.9271	2
	30	J	1046091.132	8041.29	1.0077	-5834.1309	-73705.8203	0.9317	2
	31	I	1046091.132	8080.8921	1.0077	-5802.5539	-73705.8203	0.9317	2
	31	J	1049258.612	9708.382	1.0093	-2285.6944	-74533.3972	0.936	2
	32	I	1049258.612	9731.1855	1.0093	-2273.8874	-74533.3972	0.9361	2
	32	J	1052693.995	11301.8409	1.0107	941.2629	-75440.7007	0.94	2
	33	I	1052693.995	11310.6995	1.0107	936.0904	-75440.7007	0.94	2
	33	J	1056394.852	12749.1435	1.0121	3766.6175	-76429.5684	0.9433	2
	34	I	1056394.852	12747.0849	1.0121	3748.7635	-76429.5684	0.9433	2
	34	J	1056124.553	12960.3272	1.0123	4185.6792	-76356.9396	0.9439	2
	35	I	1052715.018	14255.672	1.0135	6104.6988	-75446.2843	0.9477	2
	35	J	1048491.939	15420.1265	1.0147	7985.0726	-74332.3001	0.9514	2
	36	I	1048491.939	15402.2633	1.0147	7949.0331	-74332.3001	0.9514	2
	36	J	1044013.05	16233.3332	1.0155	9264.9261	-73167.5075	0.9543	2
	37	I	1044013.05	16208.4241	1.0155	9221.9323	-73167.5075	0.9543	2
	37	J	1039282.676	16678.6161	1.016	9923.018	-71955.6874	0.9564	2
	38	I	1039282.676	16648.1618	1.016	9875.7857	-71955.6874	0.9563	2
	38	J	1039282.676	16838.9062	1.0162	9917.5914	-71955.6874	0.9565	2
	39	I	1039282.676	16804.8415	1.0162	9869.1909	-71955.6874	0.9564	2
	39	J	1044013.05	16710.9277	1.016	9250.381	-73167.5075	0.9548	2
	40	I	1044013.05	16675.3241	1.016	9203.8359	-73167.5075	0.9547	2
	40	J	1048491.939	16205.3486	1.0155	7965.9404	-74332.3001	0.9522	2
	41	I	1048491.939	16170.5076	1.0154	7924.3918	-74332.3001	0.9521	2
	41	J	1052715.018	15342.4563	1.0146	6114.0519	-75446.2843	0.9487	2
	42	I	1052715.018	15311.2674	1.0145	6081.4293	-75446.2843	0.9487	2
	42	J	1056124.553	14345.3428	1.0136	4182.3483	-76356.9396	0.9452	2
	43	I	1056394.852	14193.7517	1.0134	3730.3871	-76429.5684	0.9446	2
	43	J	1052693.995	13185.7454	1.0125	946.7367	-75440.7007	0.9418	2
	44	I	1052693.995	13167.1868	1.0125	941.7414	-75440.7007	0.9417	2
	44	J	1049258.612	11929.0974	1.0114	-2280.4097	-74533.3972	0.9382	2
	45	I	1049258.612	11916.3986	1.0114	-2270.4871	-74533.3972	0.9382	2

	45	J	1046091.132	10505.72	1.01	-5864.6568	-73705.8203	0.934	2
	46	I	1046091.132	10498.1689	1.01	-5839.5522	-73705.8203	0.934	2
	46	J	1043193.721	8980.1831	1.0086	-9727.2905	-72956.269	0.9293	2
	47	I	1043193.721	8975.2247	1.0086	-9689.4157	-72956.269	0.9294	2
	47	J	1040568.342	7434.3244	1.0071	-13782.3922	-72283.1947	0.9244	2
	48	I	1040568.342	7427.1532	1.0071	-13736.9313	-72283.1947	0.9245	2
	48	J	1038216.803	5953.1395	1.0057	-17939.7435	-71685.2117	0.9194	2
	49	I	1038216.803	5938.5308	1.0057	-17893.4782	-71685.2117	0.9194	2
	49	J	1036140.799	4620.9441	1.0045	-22106.6005	-71161.1051	0.9144	2
	50	I	1036140.799	4594.9724	1.0044	-22066.2168	-71161.1051	0.9145	2
	50	J	1034341.933	3518.1584	1.0034	-26188.3055	-70709.8349	0.9097	2
	51	I	1034341.933	2108.4859	1.002	-24752.8662	-70709.8349	0.9097	2
	51	J	1036140.799	2539.9946	1.0025	-21372.81	-71161.1051	0.9131	2
	52	I	1036140.799	2569.9653	1.0025	-21322.7123	-71161.1051	0.9132	2
	52	J	1038216.803	3596.6468	1.0035	-17628.6255	-71685.2117	0.9174	2
	53	I	1038216.803	3619.5351	1.0035	-17584.8507	-71685.2117	0.9175	2
	53	J	1040568.342	5079.7172	1.0049	-13712.834	-72283.1947	0.9222	2
	54	I	1040568.342	5095.1496	1.0049	-13677.43	-72283.1947	0.9223	2
	54	J	1043193.721	6821.884	1.0065	-9766.9826	-72956.269	0.9272	2
	55	I	1043193.721	6829.8028	1.0065	-9741.1722	-72956.269	0.9273	2
	55	J	1046091.132	8661.2202	1.0083	-5927.4783	-73705.8203	0.9322	2
	56	I	1046091.132	8662.2291	1.0083	-5911.6486	-73705.8203	0.9322	2
	56	J	1049258.612	10450.8857	1.01	-2318.8986	-74533.3972	0.9367	2
	57	I	1049258.612	10445.5199	1.01	-2312.8824	-74533.3972	0.9367	2
	57	J	1052693.995	12068.6477	1.0115	950.6403	-75440.7007	0.9407	2
	58	I	1052693.995	12058.9098	1.0115	947.9107	-75440.7007	0.9407	2
	58	J	1056394.852	13420.5108	1.0127	3792.3621	-76429.5684	0.9439	2
	59	I	1056394.852	13409.1455	1.0127	3783.9115	-76429.5684	0.9439	2
	59	J	1056124.553	13589.4611	1.0129	4219.5555	-76356.9396	0.9446	2
	60	I	1052715.018	14983.399	1.0142	6183.8497	-75446.2843	0.9484	2
	60	J	1048491.939	16311.1222	1.0156	8095.2671	-74332.3001	0.9524	2
	61	I	1048491.939	16304.0608	1.0156	8082.8308	-74332.3001	0.9524	2
	61	J	1044013.05	17199.4914	1.0165	9419.2653	-73167.5075	0.9554	2
	62	I	1044013.05	17194.9319	1.0165	9404.8889	-73167.5075	0.9554	2
	62	J	1039282.676	17624.433	1.017	10109.2439	-71955.6874	0.9574	2
	63	I	1039282.676	17622.7451	1.017	10093.61	-71955.6874	0.9574	2
	63	J	1039282.676	17664.3788	1.017	10116.8594	-71955.6874	0.9575	2
	64	I	1039282.676	17666.1207	1.017	10101.2128	-71955.6874	0.9575	2
	64	J	1044013.05	17315.4844	1.0166	9440.9352	-73167.5075	0.9555	2
	65	I	1044013.05	17321.2186	1.0166	9426.861	-73167.5075	0.9555	2
	65	J	1048491.939	16491.8634	1.0157	8127.285	-74332.3001	0.9526	2
	66	I	1048491.939	16502.0322	1.0157	8116.5589	-74332.3001	0.9526	2
	66	J	1052715.018	15220.0921	1.0145	6229.9189	-75446.2843	0.9487	2
	67	I	1052715.018	15234.7631	1.0145	6224.2877	-75446.2843	0.9487	2
	67	J	1056124.553	13821.769	1.0131	4255.8018	-76356.9396	0.9448	2
	68	I	1056394.852	13622.9898	1.0129	3819.7145	-76429.5684	0.9442	2

	68	J	1052693.995	12072.907	1.0115	959.3577	-75440.7007	0.9407	2
	69	I	1052693.995	12087.2896	1.0115	960.0833	-75440.7007	0.9407	2
	69	J	1049258.612	10275.8518	1.0098	-2332.2131	-74533.3972	0.9365	2
	70	I	1049258.612	10280.054	1.0098	-2335.2589	-74533.3972	0.9365	2
	70	J	1046091.132	8311.0273	1.0079	-5968.7204	-73705.8203	0.9318	2
	71	I	1046091.132	8298.8424	1.0079	-5978.8867	-73705.8203	0.9318	2
	71	J	1043193.721	6306.8101	1.006	-9841.0042	-72956.269	0.9267	2
	72	I	1043193.721	6272.7901	1.006	-9861.4273	-72956.269	0.9266	2
	72	J	1040568.342	4429.1122	1.0043	-13820.2863	-72283.1947	0.9215	2
	73	I	1040568.342	4369.203	1.0042	-13853.4974	-72283.1947	0.9214	2
	73	J	1038216.803	2866.5736	1.0028	-17762.3612	-71685.2117	0.9166	2
	74	I	1038216.803	2780.0969	1.0027	-17808.8003	-71685.2117	0.9165	2
	74	J	1036140.799	1823.1293	1.0018	-21513.331	-71161.1051	0.9123	2
	75	I	1036140.799	1714.9337	1.0017	-21569.4873	-71161.1051	0.9122	2
	75	J	1034341.933	1506.4281	1.0015	-24918.2271	-70709.8349	0.909	2
	76	I	1034341.933	2093.0612	1.002	-24787.7097	-70709.8349	0.9097	2
	76	J	1036140.799	2537.3488	1.0024	-21357.363	-71161.1051	0.9132	2
	77	I	1036140.799	2554.6642	1.0025	-21336.0198	-71161.1051	0.9132	2
	77	J	1038216.803	3613.4125	1.0035	-17619.1683	-71685.2117	0.9175	2
	78	I	1038216.803	3626.1535	1.0035	-17599.5625	-71685.2117	0.9175	2
	78	J	1040568.342	5159.7971	1.005	-13719.7401	-72283.1947	0.9223	2
	79	I	1040568.342	5168.1027	1.005	-13702.6243	-72283.1947	0.9223	2
	79	J	1043193.721	7026.2306	1.0067	-9788.6945	-72956.269	0.9274	2
	80	I	1043193.721	7029.5979	1.0067	-9775.2689	-72956.269	0.9274	2
	80	J	1046091.132	9060.9715	1.0087	-5954.0789	-73705.8203	0.9325	2
	81	I	1046091.132	9059.1589	1.0087	-5945.3549	-73705.8203	0.9325	2
	81	J	1049258.612	11121.4151	1.0106	-2335.2478	-74533.3972	0.9373	2
	82	I	1049258.612	11114.358	1.0106	-2331.8296	-74533.3972	0.9373	2
	82	J	1052693.995	13083.1988	1.0124	962.237	-75440.7007	0.9417	2
	83	I	1052693.995	13072.4355	1.0124	960.7239	-75440.7007	0.9417	2
	83	J	1056394.852	14846.7885	1.0141	3849.6832	-76429.5684	0.9453	2
	84	I	1056394.852	14834.7496	1.014	3845.6405	-76429.5684	0.9453	2
	84	J	1056124.553	15093.6911	1.0143	4290.5312	-76356.9396	0.9461	2
	85	I	1052715.018	16455.6986	1.0156	6273.7577	-75446.2843	0.9499	2
	85	J	1048491.939	17727.3429	1.0169	8184.8429	-74332.3001	0.9538	2
	86	I	1048491.939	17718.9529	1.0169	8181.8624	-74332.3001	0.9538	2
	86	J	1044013.05	18558.9776	1.0178	9508.2469	-73167.5075	0.9568	2
	87	I	1044013.05	18551.7311	1.0178	9504.474	-73167.5075	0.9568	2
	87	J	1039282.676	18934.8763	1.0182	10193.7591	-71955.6874	0.9588	2
	88	I	1039282.676	18928.5273	1.0182	10188.7209	-71955.6874	0.9588	2
	88	J	1039282.676	18938.5918	1.0182	10194.9677	-71955.6874	0.9588	2
	89	I	1039282.676	18933.389	1.0182	10188.8895	-71955.6874	0.9588	2
	89	J	1044013.05	18570.0264	1.0178	9511.5566	-73167.5075	0.9568	2
	90	I	1044013.05	18566.6646	1.0178	9505.306	-73167.5075	0.9568	2
	90	J	1048491.939	17745.5244	1.0169	8189.2718	-74332.3001	0.9538	2
	91	I	1048491.939	17745.0467	1.0169	8184.2362	-74332.3001	0.9538	2

	91	J	1052715.018	16491.2739	1.0157	6280.8832	-75446.2843	0.95	2
	92	I	1052715.018	16494.8221	1.0157	6278.6593	-75446.2843	0.95	2
	92	J	1056124.553	15121.045	1.0143	4294.6447	-76356.9396	0.9461	2
	93	I	1056394.852	14898.2404	1.0141	3851.6776	-76429.5684	0.9454	2
	93	J	1052693.995	13144.978	1.0125	962.1042	-75440.7007	0.9417	2
	94	I	1052693.995	13153.8878	1.0125	963.0612	-75440.7007	0.9417	2
	94	J	1049258.612	11204.1562	1.0107	-2331.0028	-74533.3972	0.9374	2
	95	I	1049258.612	11210.983	1.0107	-2333.7523	-74533.3972	0.9374	2
	95	J	1046091.132	9164.6186	1.0088	-5942.2064	-73705.8203	0.9326	2
	96	I	1046091.132	9165.9609	1.0088	-5951.0015	-73705.8203	0.9326	2
	96	J	1043193.721	7146.4518	1.0069	-9767.2873	-72956.269	0.9276	2
	97	I	1043193.721	7139.2511	1.0068	-9784.4658	-72956.269	0.9275	2
	97	J	1040568.342	5288.5226	1.0051	-13687.8435	-72283.1947	0.9225	2
	98	I	1040568.342	5268.6052	1.0051	-13716.1405	-72283.1947	0.9224	2
	98	J	1038216.803	3738.9104	1.0036	-17576.371	-71685.2117	0.9176	2
	99	I	1038216.803	3701.7334	1.0036	-17618.3985	-71685.2117	0.9175	2
	99	J	1036140.799	2646.8809	1.0026	-21302.0427	-71161.1051	0.9133	2
	100	I	1036140.799	2588.8054	1.0025	-21358.8898	-71161.1051	0.9132	2
	100	J	1034341.933	2155.507	1.0021	-24736.9587	-70709.8349	0.9098	2
	101	I	1034341.933	2088.8879	1.002	-24813.7052	-70709.8349	0.9097	2
	101	J	1036140.799	2526.8854	1.0024	-21295.5004	-71161.1051	0.9132	2
	102	I	1036140.799	2538.8153	1.0025	-21291.0316	-71161.1051	0.9132	2
	102	J	1038216.803	3550.1444	1.0034	-17535.0379	-71685.2117	0.9175	2
	103	I	1038216.803	3559.9493	1.0034	-17530.7397	-71685.2117	0.9175	2
	103	J	1040568.342	5037.1224	1.0048	-13645.2678	-72283.1947	0.9223	2
	104	I	1040568.342	5044.8934	1.0048	-13641.0814	-72283.1947	0.9223	2
	104	J	1043193.721	6866.2931	1.0066	-9739.8873	-72956.269	0.9273	2
	105	I	1043193.721	6871.5542	1.0066	-9736.2542	-72956.269	0.9273	2
	105	J	1046091.132	8908.8785	1.0085	-5932.7817	-73705.8203	0.9324	2
	106	I	1046091.132	8911.2811	1.0085	-5930.2097	-73705.8203	0.9324	2
	106	J	1049258.612	11037.6367	1.0105	-2332.3778	-74533.3972	0.9373	2
	107	I	1049258.612	11036.8836	1.0105	-2331.2905	-74533.3972	0.9373	2
	107	J	1052693.995	13134.8366	1.0125	962.5761	-75440.7007	0.9417	2
	108	I	1052693.995	13131.7716	1.0125	962.0643	-75440.7007	0.9417	2
	108	J	1056394.852	15100.6392	1.0143	3865.4754	-76429.5684	0.9456	2
	109	I	1056394.852	15095.6383	1.0143	3863.6018	-76429.5684	0.9456	2
	109	J	1056124.553	15396.5354	1.0146	4312.6077	-76356.9396	0.9464	2
	110	I	1052715.018	16688.5021	1.0159	6291.6453	-75446.2843	0.9502	2
	110	J	1048491.939	17867.9917	1.017	8188.7112	-74332.3001	0.954	2
	111	I	1048491.939	17860.2208	1.017	8184.7932	-74332.3001	0.9539	2
	111	J	1044013.05	18636.6605	1.0179	9494.8306	-73167.5075	0.9569	2
	112	I	1044013.05	18627.9633	1.0178	9489.8637	-73167.5075	0.9568	2
	112	J	1039282.676	18985.981	1.0183	10166.2802	-71955.6874	0.9588	2
	113	I	1039282.676	18976.7772	1.0183	10160.3947	-71955.6874	0.9588	2
	113	J	1039282.676	19005.7416	1.0183	10161.1355	-71955.6874	0.9588	2
	114	I	1039282.676	18996.6883	1.0183	10154.7457	-71955.6874	0.9588	2

	114	J	1044013.05	18696.35	1.0179	9480.4946	-73167.5075	0.9569	2
	115	I	1044013.05	18688.3083	1.0179	9474.2822	-73167.5075	0.9569	2
	115	J	1048491.939	17968.7149	1.0171	8168.3231	-74332.3001	0.954	2
	116	I	1048491.939	17962.6058	1.0171	8163.1171	-74332.3001	0.954	2
	116	J	1052715.018	16838.2836	1.016	6272.9877	-75446.2843	0.9503	2
	117	I	1052715.018	16834.8413	1.016	6269.5443	-75446.2843	0.9503	2
	117	J	1056124.553	15582.3326	1.0148	4295.3933	-76356.9396	0.9465	2
	118	I	1056394.852	15301.8911	1.0145	3847.1835	-76429.5684	0.9458	2
	118	J	1052693.995	13390.3549	1.0127	958.244	-75440.7007	0.942	2
	119	I	1052693.995	13391.5492	1.0127	958.1199	-75440.7007	0.942	2
	119	J	1049258.612	11335.6971	1.0108	-2321.3014	-74533.3972	0.9376	2
	120	I	1049258.612	11336.9234	1.0108	-2321.6143	-74533.3972	0.9376	2
	120	J	1046091.132	9231.8426	1.0088	-5905.9306	-73705.8203	0.9327	2
	121	I	1046091.132	9229.4532	1.0088	-5908.542	-73705.8203	0.9327	2
	121	J	1043193.721	7189.2984	1.0069	-9699.6231	-72956.269	0.9277	2
	122	I	1043193.721	7179.1606	1.0069	-9707.5312	-72956.269	0.9276	2
	122	J	1040568.342	5331.0074	1.0051	-13596.0957	-72283.1947	0.9226	2
	123	I	1040568.342	5307.5891	1.0051	-13613.2467	-72283.1947	0.9226	2
	123	J	1038216.803	3786.952	1.0036	-17481.8821	-71685.2117	0.9178	2
	124	I	1038216.803	3744.5289	1.0036	-17512.4609	-71685.2117	0.9177	2
	124	J	1036140.799	2690.2866	1.0026	-21239.4391	-71161.1051	0.9134	2
	125	I	1036140.799	2625.2083	1.0025	-21286.0729	-71161.1051	0.9133	2
	125	J	1034341.933	2175.9561	1.0021	-24749.7	-70709.8349	0.9098	2
	126	I	1034341.933	2056.0693	1.002	-24854.1529	-70709.8349	0.9096	2
	126	J	1036140.799	2500.5684	1.0024	-21325.8389	-71161.1051	0.9132	2
	127	I	1036140.799	2493.3908	1.0024	-21347.6617	-71161.1051	0.9131	2
	127	J	1038216.803	3513.0867	1.0034	-17576.8106	-71685.2117	0.9174	2
	128	I	1038216.803	3508.2028	1.0034	-17594.9092	-71685.2117	0.9174	2
	128	J	1040568.342	4993.7705	1.0048	-13690.1991	-72283.1947	0.9222	2
	129	I	1040568.342	4991.4944	1.0048	-13703.9595	-72283.1947	0.9222	2
	129	J	1043193.721	6818.8328	1.0065	-9780.2417	-72956.269	0.9272	2
	130	I	1043193.721	6818.7475	1.0065	-9789.7296	-72956.269	0.9272	2
	130	J	1046091.132	8856.9953	1.0085	-5961.9878	-73705.8203	0.9323	2
	131	I	1046091.132	8858.6195	1.0085	-5967.507	-73705.8203	0.9323	2
	131	J	1049258.612	10978.749	1.0105	-2345.4238	-74533.3972	0.9372	2
	132	I	1049258.612	10981.4101	1.0105	-2347.4383	-74533.3972	0.9372	2
	132	J	1052693.995	13064.5575	1.0124	968.8547	-75440.7007	0.9417	2
	133	I	1052693.995	13068.259	1.0124	969.7709	-75440.7007	0.9417	2
	133	J	1056394.852	15014.7887	1.0142	3892.16	-76429.5684	0.9455	2
	134	I	1056394.852	15018.4962	1.0142	3895.0445	-76429.5684	0.9456	2
	134	J	1056124.553	15315.3655	1.0145	4347.0505	-76356.9396	0.9463	2
	135	I	1052715.018	16604.6825	1.0158	6346.4901	-75446.2843	0.9501	2
	135	J	1048491.939	17768.064	1.0169	8252.9785	-74332.3001	0.9539	2
	136	I	1048491.939	17769.9179	1.0169	8257.3941	-74332.3001	0.9539	2
	136	J	1044013.05	18520.5096	1.0177	9570.0975	-73167.5075	0.9568	2
	137	I	1044013.05	18521.7981	1.0177	9574.8987	-73167.5075	0.9568	2

	137	J	1039282.676	18842.1739	1.0181	10246.7256	-71955.6874	0.9588	2
	138	I	1039282.676	18843.1707	1.0181	10251.6547	-71955.6874	0.9588	2
	138	J	1039282.676	18822.2392	1.0181	10240.4865	-71955.6874	0.9587	2
	139	I	1039282.676	18823.2451	1.0181	10245.3355	-71955.6874	0.9587	2
	139	J	1044013.05	18461.8879	1.0177	9552.6315	-73167.5075	0.9568	2
	140	I	1044013.05	18463.1979	1.0177	9557.2629	-73167.5075	0.9568	2
	140	J	1048491.939	17673.959	1.0169	8227.9243	-74332.3001	0.9538	2
	141	I	1048491.939	17675.7278	1.0169	8232.2006	-74332.3001	0.9538	2
	141	J	1052715.018	16476.7458	1.0157	6315.8634	-75446.2843	0.95	2
	142	I	1052715.018	16478.7445	1.0157	6319.48	-75446.2843	0.95	2
	142	J	1056124.553	15163.2797	1.0144	4323.0883	-76356.9396	0.9462	2
	143	I	1056394.852	14827.2088	1.014	3875.134	-76429.5684	0.9454	2
	143	J	1052693.995	12782.7613	1.0121	961.5538	-75440.7007	0.9414	2
	144	I	1052693.995	12782.1573	1.0121	962.3669	-75440.7007	0.9414	2
	144	J	1049258.612	10608.2468	1.0101	-2334.2107	-74533.3972	0.9369	2
	145	I	1049258.612	10602.9815	1.0101	-2336.6849	-74533.3972	0.9368	2
	145	J	1046091.132	8398.0013	1.008	-5926.0338	-73705.8203	0.9319	2
	146	I	1046091.132	8383.4175	1.008	-5934.5034	-73705.8203	0.9319	2
	146	J	1043193.721	6271.806	1.006	-9712.744	-72956.269	0.9268	2
	147	I	1043193.721	6243.0757	1.006	-9730.6272	-72956.269	0.9267	2
	147	J	1040568.342	4368.0517	1.0042	-13581.6784	-72283.1947	0.9217	2
	148	I	1040568.342	4320.343	1.0042	-13612.4624	-72283.1947	0.9216	2
	148	J	1038216.803	2839.0186	1.0027	-17410.9871	-71685.2117	0.9169	2
	149	I	1038216.803	2769.6826	1.0027	-17456.705	-71685.2117	0.9168	2
	149	J	1036140.799	1847.3995	1.0018	-21072.0121	-71161.1051	0.9128	2
	150	I	1036140.799	1758.7661	1.0017	-21131.1239	-71161.1051	0.9126	2
	150	J	1034341.933	1563.4831	1.0015	-24431.3	-70709.8349	0.9095	2
	151	I	1034341.933	2039.4021	1.002	-24893.1159	-70709.8349	0.9095	2
	151	J	1036140.799	2495.9799	1.0024	-21374.1664	-71161.1051	0.9131	2
	152	I	1036140.799	2470.2963	1.0024	-21426.1571	-71161.1051	0.913	2
	152	J	1038216.803	3526.5275	1.0034	-17655.8384	-71685.2117	0.9173	2
	153	I	1038216.803	3505.6907	1.0034	-17700.7659	-71685.2117	0.9173	2
	153	J	1040568.342	5056.7246	1.0049	-13785.3004	-72283.1947	0.9221	2
	154	I	1040568.342	5042.0221	1.0048	-13821.3107	-72283.1947	0.9221	2
	154	J	1043193.721	6965.9423	1.0067	-9873.7907	-72956.269	0.9273	2
	155	I	1043193.721	6957.5719	1.0067	-9899.9654	-72956.269	0.9272	2
	155	J	1046091.132	9122.4911	1.0087	-6034.8938	-73705.8203	0.9325	2
	156	I	1046091.132	9120.1933	1.0087	-6050.9334	-73705.8203	0.9325	2
	156	J	1049258.612	11392.4788	1.0109	-2379.166	-74533.3972	0.9376	2
	157	I	1049258.612	11395.4792	1.0109	-2385.2806	-74533.3972	0.9376	2
	157	J	1052693.995	13647.5041	1.013	990.0487	-75440.7007	0.9422	2
	158	I	1052693.995	13655.2891	1.013	992.8977	-75440.7007	0.9423	2
	158	J	1056394.852	15776.5763	1.0149	3979.0503	-76429.5684	0.9464	2
	159	I	1056394.852	15786.8974	1.0149	3988.7231	-76429.5684	0.9464	2
	159	J	1056124.553	16112.6092	1.0153	4451.8737	-76356.9396	0.9472	2
	160	I	1052715.018	17443.322	1.0166	6502.0762	-75446.2843	0.9511	2

	160	J	1048491.939	18608.077	1.0177	8442.6324	-74332.3001	0.9549	2
	161	I	1048491.939	18617.8888	1.0178	8460.4919	-74332.3001	0.9549	2
	161	J	1044013.05	19343.1468	1.0185	9791.3746	-73167.5075	0.9578	2
	162	I	1044013.05	19352.1993	1.0185	9812.7791	-73167.5075	0.9579	2
	162	J	1039282.676	19623.2322	1.0189	10486.4287	-71955.6874	0.9597	2
	163	I	1039282.676	19631.1493	1.0189	10510.6418	-71955.6874	0.9598	2
	163	J	1039282.676	19539.5003	1.0188	10484.2792	-71955.6874	0.9597	2
	164	I	1039282.676	19545.7475	1.0188	10510.0165	-71955.6874	0.9597	2
	164	J	1044013.05	19095.6555	1.0183	9785.1645	-73167.5075	0.9576	2
	165	I	1044013.05	19099.5855	1.0183	9810.6234	-73167.5075	0.9576	2
	165	J	1048491.939	18207.6677	1.0174	8433.1954	-74332.3001	0.9545	2
	166	I	1048491.939	18208.5421	1.0174	8456.1047	-74332.3001	0.9545	2
	166	J	1052715.018	16897.3016	1.0161	6477.1309	-75446.2843	0.9505	2
	167	I	1052715.018	16894.3788	1.016	6494.8221	-75446.2843	0.9505	2
	167	J	1056124.553	15482.2863	1.0147	4436.7201	-76356.9396	0.9466	2
	168	I	1056394.852	15123.5726	1.0143	3981.2026	-76429.5684	0.9457	2
	168	J	1052693.995	12922.4431	1.0123	982.0389	-75440.7007	0.9415	2
	169	I	1052693.995	12914.0855	1.0123	984.7129	-75440.7007	0.9415	2
	169	J	1049258.612	10627.9201	1.0101	-2368.5543	-74533.3972	0.9368	2
	170	I	1049258.612	10620.5541	1.0101	-2374.0963	-74533.3972	0.9368	2
	170	J	1046091.132	8364.7745	1.008	-5980.2881	-73705.8203	0.9318	2
	171	I	1046091.132	8358.3584	1.008	-5995.4016	-73705.8203	0.9318	2
	171	J	1043193.721	6267.4831	1.006	-9744.1717	-72956.269	0.9267	2
	172	I	1043193.721	6263.3639	1.006	-9769.8288	-72956.269	0.9267	2
	172	J	1040568.342	4466.6597	1.0043	-13545.174	-72283.1947	0.9218	2
	173	I	1040568.342	4464.8487	1.0043	-13581.438	-72283.1947	0.9218	2
	173	J	1038216.803	3083.6292	1.003	-17267.9592	-71685.2117	0.9173	2
	174	I	1038216.803	3083.2968	1.003	-17313.5916	-71685.2117	0.9172	2
	174	J	1036140.799	2218.4058	1.0021	-20804.0709	-71161.1051	0.9134	2
	175	I	1036140.799	2216.903	1.0021	-20856.4061	-71161.1051	0.9133	2
	175	J	1034341.933	1938.9497	1.0019	-24059.7178	-70709.8349	0.9103	2
	176	I	1034341.933	2071.4518	1.002	-24482.7938	-70709.8349	0.91	2
	176	J	1036140.799	2544.4374	1.0025	-21317.7894	-71161.1051	0.9132	2
	177	I	1036140.799	2535.2049	1.0024	-21299.7165	-71161.1051	0.9132	2
	177	J	1038216.803	3802.3145	1.0037	-17744.5034	-71685.2117	0.9175	2
	178	I	1038216.803	3788.9367	1.0036	-17731.6957	-71685.2117	0.9175	2
	178	J	1040568.342	5677.2506	1.0055	-13921.9253	-72283.1947	0.9226	2
	179	I	1040568.342	5660.6844	1.0054	-13914.3713	-72283.1947	0.9226	2
	179	J	1043193.721	7982.7629	1.0077	-9994.2379	-72956.269	0.9281	2
	180	I	1043193.721	7964.7137	1.0076	-9990.9956	-72956.269	0.9281	2
	180	J	1046091.132	10530.9068	1.0101	-6104.4895	-73705.8203	0.9338	2
	181	I	1046091.132	10513.4639	1.0101	-6104.0521	-73705.8203	0.9338	2
	181	J	1049258.612	13143.3778	1.0125	-2387.3333	-74533.3972	0.9392	2
	182	I	1049258.612	13128.3027	1.0125	-2387.9353	-74533.3972	0.9392	2
	182	J	1052693.995	15661.9111	1.0149	1036.5486	-75440.7007	0.9442	2
	183	I	1052693.995	15652.2227	1.0149	1037.1178	-75440.7007	0.9442	2

	183	J	1056394.852	17958.4658	1.017	4063.8575	-76429.5684	0.9485	2
	184	I	1056394.852	17955.8194	1.017	4068.0881	-76429.5684	0.9485	2
	184	J	1056124.553	18297.9756	1.0173	4536.2463	-76356.9396	0.9493	2
	185	I	1052715.018	19904.3191	1.0189	6629.213	-75446.2843	0.9535	2
	185	J	1048491.939	21378.3144	1.0204	8627.5598	-74332.3001	0.9577	2
	186	I	1048491.939	21393.7749	1.0204	8644.2597	-74332.3001	0.9578	2
	186	J	1044013.05	22319.0466	1.0214	10023.0596	-73167.5075	0.9609	2
	187	I	1044013.05	22342.3418	1.0214	10044.4882	-73167.5075	0.9609	2
	187	J	1039282.676	22685.7601	1.0218	10747.5559	-71955.6874	0.9629	2
	188	I	1039282.676	22714.8262	1.0219	10771.5793	-71955.6874	0.963	2
	188	J	1039282.676	22557.2032	1.0217	10750.8349	-71955.6874	0.9628	2
	189	I	1039282.676	22589.3148	1.0217	10774.9831	-71955.6874	0.9629	2
	189	J	1044013.05	21936.3572	1.021	10031.3771	-73167.5075	0.9605	2
	190	I	1044013.05	21968.4828	1.021	10053.2373	-73167.5075	0.9606	2
	190	J	1048491.939	20750.4582	1.0198	8636.9064	-74332.3001	0.9571	2
	191	I	1048491.939	20779.7638	1.0198	8654.5344	-74332.3001	0.9572	2
	191	J	1052715.018	19040.382	1.0181	6624.1236	-75446.2843	0.9527	2
	192	I	1052715.018	19064.7676	1.0181	6636.3596	-75446.2843	0.9527	2
	192	J	1056124.553	17234.5254	1.0163	4533.1257	-76356.9396	0.9483	2
	193	I	1056394.852	16887.8324	1.016	4072.6433	-76429.5684	0.9475	2
	193	J	1052693.995	14511.252	1.0138	1035.2436	-75440.7007	0.9431	2
	194	I	1052693.995	14525.2534	1.0138	1036.6684	-75440.7007	0.9431	2
	194	J	1049258.612	11968.2332	1.0114	-2397.842	-74533.3972	0.9381	2
	195	I	1049258.612	11981.9303	1.0114	-2399.0834	-74533.3972	0.9381	2
	195	J	1046091.132	9384.1472	1.009	-6127.312	-73705.8203	0.9327	2
	196	I	1046091.132	9404.6821	1.009	-6125.0031	-73705.8203	0.9327	2
	196	J	1043193.721	6926.9269	1.0066	-10030.2064	-72956.269	0.9271	2
	197	I	1043193.721	6967.0722	1.0067	-10014.5339	-72956.269	0.9271	2
	197	J	1040568.342	4776.9182	1.0046	-13970.8129	-72283.1947	0.9217	2
	198	I	1040568.342	4851.866	1.0047	-13930.0603	-72283.1947	0.9218	2
	198	J	1038216.803	3110.0075	1.003	-17808.9926	-71685.2117	0.9168	2
	199	I	1038216.803	3233.7529	1.0031	-17732.9608	-71685.2117	0.917	2
	199	J	1036140.799	2080.0924	1.002	-21411.3878	-71161.1051	0.9127	2
	200	I	1036140.799	2257.0325	1.0022	-21298.1242	-71161.1051	0.9129	2
	200	J	1034341.933	1797.0196	1.0017	-24666.1919	-70709.8349	0.9095	2
	214	I	1034341.933	3647.9883	1.0035	-21125.3663	-70709.8349	0.9147	2
	214	J	1036140.799	3686.2807	1.0036	-18631.9938	-71161.1051	0.9169	2
	215	I	1036140.799	4479.7478	1.0043	-17916.7222	-71161.1051	0.9184	2
	215	J	1038216.803	5111.2983	1.0049	-15179.7616	-71685.2117	0.9213	2
	216	I	1038216.803	5611.2228	1.0054	-14733.6035	-71685.2117	0.9222	2
	216	J	1040568.342	6848.1497	1.0066	-11803.9578	-72283.1947	0.9258	2
	217	I	1040568.342	7161.9697	1.0069	-11533.0771	-72283.1947	0.9263	2
	217	J	1043193.721	8991.8551	1.0086	-8465.0083	-72956.269	0.9306	2
	218	I	1043193.721	9185.1033	1.0088	-8309.581	-72956.269	0.9309	2
	218	J	1046091.132	11559.6245	1.0111	-5171.139	-73705.8203	0.9356	2
	219	I	1046091.132	11670.9649	1.0112	-5093.7119	-73705.8203	0.9358	2

	219	J	1049258.612	14511.7001	1.0138	-1966.2493	-74533.3972	0.9409	2
	220	I	1049258.612	14564.4456	1.0139	-1942.3461	-74533.3972	0.941	2
	220	J	1052693.995	17776.6472	1.0169	1084.954	-75440.7007	0.9463	2
	221	I	1052693.995	17787.3764	1.0169	1073.974	-75440.7007	0.9463	2
	221	J	1056394.852	21280.744	1.0201	3910.7411	-76429.5684	0.9515	2
	222	I	1056394.852	21271.8317	1.0201	3882.547	-76429.5684	0.9515	2
	222	J	1056124.553	21873.3146	1.0207	4338.2163	-76356.9396	0.9525	2
	223	I	1052715.018	23398.633	1.0222	6187.9656	-75446.2843	0.9564	2
	223	J	1048491.939	24609.0917	1.0235	7993.203	-74332.3001	0.9602	2
	224	I	1048491.939	24594.7942	1.0235	7957.5919	-74332.3001	0.9602	2
	224	J	1044013.05	25445.8381	1.0244	9208.8805	-73167.5075	0.9631	2
	225	I	1044013.05	25427.9492	1.0244	9176.6945	-73167.5075	0.9631	2
	225	J	1039282.676	25883.2419	1.0249	9834.6559	-71955.6874	0.9651	2
	226	I	1039282.676	25863.105	1.0249	9809.9185	-71955.6874	0.9651	2
	226	J	1039282.676	25993.1456	1.025	9835.5702	-71955.6874	0.9652	2
	227	I	1039282.676	25972.6769	1.025	9821.0317	-71955.6874	0.9652	2
	227	J	1044013.05	25770.9219	1.0247	9211.9128	-73167.5075	0.9634	2
	228	I	1044013.05	25752.4322	1.0247	9208.9966	-73167.5075	0.9634	2
	228	J	1048491.939	25135.6666	1.024	7999.1537	-74332.3001	0.9607	2
	229	I	1048491.939	25121.4719	1.024	8007.3947	-74332.3001	0.9607	2
	229	J	1052715.018	24114.0167	1.0229	6231.074	-75446.2843	0.9572	2
	230	I	1052715.018	24106.7439	1.0229	6247.6668	-75446.2843	0.9572	2
	230	J	1056124.553	22962.5403	1.0217	4366.0632	-76356.9396	0.9536	2
	231	I	1056394.852	22139.5622	1.021	3935.0802	-76429.5684	0.9523	2
	231	J	1052693.995	18585.2624	1.0177	1082.6476	-75440.7007	0.947	2
	232	I	1052693.995	18574.3977	1.0176	1092.1762	-75440.7007	0.947	2
	232	J	1049258.612	15284.7757	1.0146	-1945.8025	-74533.3972	0.9417	2
	233	I	1049258.612	15233.7451	1.0145	-1968.8652	-74533.3972	0.9416	2
	233	J	1046091.132	12302.3449	1.0118	-5097.1008	-73705.8203	0.9364	2
	234	I	1046091.132	12186.8171	1.0116	-5177.7757	-73705.8203	0.9362	2
	234	J	1043193.721	9718.2889	1.0093	-8300.7311	-72956.269	0.9314	2
	235	I	1043193.721	9504.9958	1.0091	-8471.7842	-72956.269	0.9311	2
	235	J	1040568.342	7592.5384	1.0073	-11501.2725	-72283.1947	0.9268	2
	236	I	1040568.342	7232.8211	1.007	-11808.7758	-72283.1947	0.9261	2
	236	J	1038216.803	5941.5474	1.0057	-14671.9039	-71685.2117	0.9225	2
	237	I	1038216.803	5364.4699	1.0052	-15181.4497	-71685.2117	0.9215	2
	237	J	1036140.799	4717.8252	1.0046	-17825.7411	-71161.1051	0.9187	2
	238	I	1036140.799	3822.074	1.0037	-18628.97	-71161.1051	0.917	2
	238	J	1034341.933	3800.9756	1.0037	-21015.4676	-70709.8349	0.915	2
	1087	I	1056124.553	17226.5028	1.0163	4535.4881	-76356.9396	0.9483	2
	1087	J	1056394.852	16869.1634	1.016	4065.9471	-76429.5684	0.9475	2
	1088	I	1056124.553	15473.5256	1.0147	4438.4535	-76356.9396	0.9466	2
	1088	J	1056394.852	15130.4874	1.0143	3971.0803	-76429.5684	0.9457	2
	1089	I	1056124.553	15140.0529	1.0143	4324.012	-76356.9396	0.9461	2
	1089	J	1056394.852	14825.8549	1.014	3872.7127	-76429.5684	0.9454	2
	1090	I	1056124.553	15592.9973	1.0148	4295.369	-76356.9396	0.9465	2

	1090	J	1056394.852	15302.571	1.0145	3848.5743	-76429.5684	0.9458	2
	1091	I	1056124.553	15145.9431	1.0143	4295.5482	-76356.9396	0.9461	2
	1091	J	1056394.852	14890.393	1.0141	3850.4205	-76429.5684	0.9454	2
	1092	I	1056124.553	13816.7116	1.0131	4257.1929	-76356.9396	0.9448	2
	1092	J	1056394.852	13605.2353	1.0129	3819.717	-76429.5684	0.9441	2
	1093	I	1056124.553	14351.7829	1.0136	4175.9615	-76356.9396	0.9452	2
	1093	J	1056394.852	14218.4906	1.0135	3749.6507	-76429.5684	0.9447	2
	1094	I	1056124.553	22747.5843	1.0215	4373.1706	-76356.9396	0.9534	2
	1094	J	1056394.852	22137.7867	1.021	3914.3633	-76429.5684	0.9523	2
	1095	I	1056124.553	18259.8377	1.0173	4536.2011	-76356.9396	0.9493	2
	1095	J	1052715.018	19897.9338	1.0189	6618.7016	-75446.2843	0.9535	2
	1096	I	1056124.553	16121.9064	1.0153	4453.7099	-76356.9396	0.9472	2
	1096	J	1052715.018	17433.0078	1.0166	6488.0925	-75446.2843	0.9511	2
	1097	I	1056124.553	15314.4264	1.0145	4347.9302	-76356.9396	0.9463	2
	1097	J	1052715.018	16601.9985	1.0158	6342.7087	-75446.2843	0.9501	2
	1098	I	1056124.553	15398.7396	1.0146	4311.9058	-76356.9396	0.9464	2
	1098	J	1052715.018	16695.0633	1.0159	6294.5517	-75446.2843	0.9502	2
	1099	I	1056124.553	15077.4574	1.0143	4289.0964	-76356.9396	0.946	2
	1099	J	1052715.018	16465.8419	1.0156	6276.9597	-75446.2843	0.9499	2
	1100	I	1056124.553	13562.7506	1.0128	4217.691	-76356.9396	0.9445	2
	1100	J	1052715.018	14992.8603	1.0142	6194.3044	-75446.2843	0.9485	2
	1101	I	1056124.553	13044.5689	1.0124	4182.635	-76356.9396	0.944	2
	1101	J	1052715.018	14265.7762	1.0136	6131.997	-75446.2843	0.9477	2
	1102	I	1056124.553	22128.7368	1.021	4329.4307	-76356.9396	0.9528	2
	1102	J	1052715.018	23409.3811	1.0222	6221.852	-75446.2843	0.9565	2

Elem	Part	Stress (After Immediate Loss) : A (kN/m^2)	Elastic Deform. Loss : B (kN/m^2)	Stress(Elastic Loss)/ Stress(Immediate Loss)	Creep/Shrinkage Loss (kN/m^2)	Relaxation Loss (kN/m^2)	Stress(After All Loss)/ Stress(After Immediate Loss)	Effective Num.
The Loss of tendon group [cd] at the stage of [FASE 3]								
Tendon Group	cd	Stage	FASE 3					
26	I	1036316.678	2957.7937	1.0029	-13884.1745	-71205.3697	0.9207	2
26	J	1038063.485	3866.916	1.0037	-11407.8441	-71646.3834	0.9237	2
27	I	1038063.485	3933.1651	1.0038	-11341.0033	-71646.3834	0.9238	2
27	J	1040002.403	5097.6141	1.0049	-8727.3143	-72138.8593	0.9271	2
28	I	1040002.403	5150.6132	1.005	-8675.32	-72138.8593	0.9272	2
28	J	1042132.361	6495.3621	1.0062	-5998.0293	-72683.4699	0.9307	2
29	I	1042132.361	6534.6128	1.0063	-5963.1473	-72683.4699	0.9308	2
29	J	1044452.229	7981.705	1.0076	-3298.6451	-73280.9692	0.9343	2
30	I	1044452.229	8008.2214	1.0077	-3280.3207	-73280.9692	0.9344	2
30	J	1046960.809	9481.0447	1.0091	-703.5987	-73932.1912	0.9378	2
31	I	1046960.809	9496.4491	1.0091	-700.1035	-73932.1912	0.9378	2
31	J	1049656.83	10925.141	1.0104	1718.9254	-74638.048	0.9409	2
32	I	1049656.83	10930.0394	1.0104	1709.4664	-74638.048	0.9409	2
32	J	1052538.925	12258.6576	1.0116	3909.0003	-75399.5262	0.9437	2
33	I	1052538.925	12255.045	1.0116	3888.5166	-75399.5262	0.9437	2
33	J	1055605.618	13439.6867	1.0127	5816.1367	-76217.6825	0.946	2
34	I	1055605.618	13430.2527	1.0127	5788.7264	-76217.6825	0.946	2
34	J	1056074.883	13600.5809	1.0129	6085.1364	-76343.6004	0.9464	2
35	I	1056192.88	14705.2573	1.0139	7376.516	-76375.293	0.9486	2
35	J	1052761.988	15666.9507	1.0149	8655.9472	-75458.7608	0.9514	2
36	I	1052761.988	15647.0382	1.0149	8616.9075	-75458.7608	0.9514	2
36	J	1049151.849	16326.7201	1.0156	9513.059	-74505.3634	0.9536	2
37	I	1049151.849	16301.0377	1.0155	9468.9234	-74505.3634	0.9535	2
37	J	1045364.657	16689.3925	1.016	9951.3221	-73517.2162	0.9552	2
38	I	1045364.657	16658.8477	1.0159	9903.9563	-73517.2162	0.9551	2
38	J	1045364.657	16849.7463	1.0161	9945.8786	-73517.2162	0.9553	2
39	I	1045364.657	16815.5887	1.0161	9897.3412	-73517.2162	0.9552	2
39	J	1049151.849	16806.0023	1.016	9498.0814	-74505.3634	0.9541	2
40	I	1049151.849	16769.5645	1.016	9450.3018	-74505.3634	0.954	2
40	J	1052761.988	16459.8779	1.0156	8634.9795	-75458.7608	0.9522	2
41	I	1052761.988	16422.7482	1.0156	8589.9814	-75458.7608	0.9521	2
41	J	1056192.88	15816.8909	1.015	7386.9467	-76375.293	0.9497	2
42	I	1056192.88	15781.4789	1.0149	7347.6403	-76375.293	0.9496	2
42	J	1056074.883	15031.1825	1.0142	6077.905	-76343.6004	0.9477	2
43	I	1055605.618	14925.059	1.0141	5757.5526	-76217.6825	0.9474	2
43	J	1052538.925	14245.8092	1.0135	3907.5316	-75399.5262	0.9456	2
44	I	1052538.925	14220.7884	1.0135	3888.6521	-75399.5262	0.9456	2
44	J	1049656.83	13338.6829	1.0127	1732.6611	-74638.048	0.9433	2
45	I	1049656.83	13318.6695	1.0127	1724.1225	-74638.048	0.9432	2

45	J	1046960.809	12268.5521	1.0117	-696.0438	-73932.1912	0.9404	2
46	I	1046960.809	12253.9022	1.0117	-693.5567	-73932.1912	0.9404	2
46	J	1044452.229	11073.2872	1.0106	-3328.3028	-73280.9692	0.9373	2
47	I	1044452.229	11063.4875	1.0106	-3315.6869	-73280.9692	0.9373	2
47	J	1042132.361	9808.2764	1.0094	-6107.6172	-72683.4699	0.9338	2
48	I	1042132.361	9801.0443	1.0094	-6087.7268	-72683.4699	0.9338	2
48	J	1040002.403	8532.7837	1.0082	-8973.8502	-72138.8593	0.9302	2
49	I	1040002.403	8525.1711	1.0082	-8950.8928	-72138.8593	0.9302	2
49	J	1038063.485	7307.3526	1.007	-11864.6075	-71646.3834	0.9266	2
50	I	1038063.485	7296.6683	1.007	-11843.0574	-71646.3834	0.9266	2
50	J	1036316.678	6191.7616	1.006	-14715.8393	-71205.3697	0.9231	2
51	I	1036316.678	2845.6841	1.0027	-13922.5924	-71205.3697	0.9206	2
51	J	1038063.485	3987.9172	1.0038	-11482.2532	-71646.3834	0.9238	2
52	I	1038063.485	3995.5589	1.0038	-11455.4753	-71646.3834	0.9238	2
52	J	1040002.403	5433.6295	1.0052	-8828.3251	-72138.8593	0.9274	2
53	I	1040002.403	5436.1659	1.0052	-8806.5508	-72138.8593	0.9274	2
53	J	1042132.361	7055.6034	1.0068	-6086.0307	-72683.4699	0.9312	2
54	I	1042132.361	7053.3897	1.0068	-6070.4798	-72683.4699	0.9312	2
54	J	1044452.229	8740.5263	1.0084	-3350.9568	-73280.9692	0.935	2
55	I	1044452.229	8733.8207	1.0084	-3342.2885	-73280.9692	0.935	2
55	J	1046960.809	10381.6291	1.0099	-713.8276	-73932.1912	0.9386	2
56	I	1046960.809	10371.0694	1.0099	-712.1662	-73932.1912	0.9386	2
56	J	1049656.83	11884.9553	1.0113	1743.8479	-74638.048	0.9419	2
57	I	1049656.83	11871.0021	1.0113	1738.8458	-74638.048	0.9419	2
57	J	1052538.925	13176.4727	1.0125	3952.8554	-75399.5262	0.9446	2
58	I	1052538.925	13161.0541	1.0125	3942.3274	-75399.5262	0.9446	2
58	J	1055605.618	14203.0239	1.0135	5857.7177	-76217.6825	0.9468	2
59	I	1055605.618	14188.8016	1.0134	5844.789	-76217.6825	0.9468	2
59	J	1056074.883	14315.9221	1.0136	6136.0426	-76343.6004	0.9471	2
60	I	1056192.88	15496.2523	1.0147	7472.9033	-76375.293	0.9494	2
60	J	1052761.988	16592.5534	1.0158	8775.6971	-75458.7608	0.9524	2
61	I	1052761.988	16585.1576	1.0158	8762.2311	-75458.7608	0.9524	2
61	J	1049151.849	17306.2811	1.0165	9671.6262	-74505.3634	0.9547	2
62	I	1049151.849	17301.6341	1.0165	9656.8698	-74505.3634	0.9547	2
62	J	1045364.657	17636.7566	1.0169	10138.0897	-73517.2162	0.9562	2
63	I	1045364.657	17635.0622	1.0169	10122.4117	-73517.2162	0.9562	2
63	J	1045364.657	17676.7341	1.0169	10145.7261	-73517.2162	0.9563	2
64	I	1045364.657	17678.4738	1.0169	10130.0354	-73517.2162	0.9563	2
64	J	1049151.849	17423.103	1.0166	9693.8534	-74505.3634	0.9548	2
65	I	1049151.849	17428.8718	1.0166	9679.4076	-74505.3634	0.9548	2
65	J	1052761.988	16776.9768	1.0159	8810.2833	-75458.7608	0.9526	2
66	I	1052761.988	16787.4724	1.0159	8798.6723	-75458.7608	0.9526	2
66	J	1056192.88	15743.4707	1.0149	7528.1057	-76375.293	0.9497	2
67	I	1056192.88	15759.5279	1.0149	7521.3365	-76375.293	0.9497	2
67	J	1056074.883	14566.1115	1.0138	6187.5477	-76343.6004	0.9474	2
68	I	1055605.618	14426.0436	1.0137	5898.6844	-76217.6825	0.9471	2

68	J	1052538.925	13189.4774	1.0125	3981.0626	-75399.5262	0.9447	2
69	I	1052538.925	13213.1925	1.0126	3984.2267	-75399.5262	0.9447	2
69	J	1049656.83	11700.7405	1.0111	1758.4211	-74638.048	0.9417	2
70	I	1049656.83	11720.3754	1.0112	1760.7018	-74638.048	0.9417	2
70	J	1046960.809	9988.1717	1.0095	-716.519	-73932.1912	0.9382	2
71	I	1046960.809	9998.7595	1.0096	-717.7155	-73932.1912	0.9382	2
71	J	1044452.229	8123.3398	1.0078	-3374.7542	-73280.9692	0.9344	2
72	I	1044452.229	8120.5111	1.0078	-3381.7141	-73280.9692	0.9344	2
72	J	1042132.361	6209.1287	1.006	-6132.553	-72683.4699	0.9303	2
73	I	1042132.361	6189.1689	1.0059	-6147.2298	-72683.4699	0.9303	2
73	J	1040002.403	4366.4269	1.0042	-8894.5356	-72138.8593	0.9263	2
74	I	1040002.403	4327.3626	1.0042	-8917.7183	-72138.8593	0.9262	2
74	J	1038063.485	2730.5866	1.0026	-11557.436	-71646.3834	0.9225	2
75	I	1038063.485	2673.2463	1.0026	-11587.5317	-71646.3834	0.9224	2
75	J	1036316.678	1446.6527	1.0014	-14015.7093	-71205.3697	0.9192	2
76	I	1036316.678	2838.8511	1.0027	-13942.1256	-71205.3697	0.9206	2
76	J	1038063.485	3995.9244	1.0038	-11474.1264	-71646.3834	0.9238	2
77	I	1038063.485	3998.2711	1.0039	-11462.7218	-71646.3834	0.9238	2
77	J	1040002.403	5485.8055	1.0053	-8823.822	-72138.8593	0.9274	2
78	I	1040002.403	5484.5314	1.0053	-8814.0735	-72138.8593	0.9274	2
78	J	1042132.361	7201.0777	1.0069	-6089.2956	-72683.4699	0.9313	2
79	I	1042132.361	7196.6012	1.0069	-6081.7803	-72683.4699	0.9313	2
79	J	1044452.229	9037.6551	1.0087	-3358.4688	-73280.9692	0.9353	2
80	I	1044452.229	9029.7993	1.0086	-3353.961	-73280.9692	0.9353	2
80	J	1046960.809	10893.5288	1.0104	-716.7723	-73932.1912	0.9391	2
81	I	1046960.809	10882.3435	1.0104	-715.8552	-73932.1912	0.9391	2
81	J	1049656.83	12675.8778	1.0121	1757.5336	-74638.048	0.9426	2
82	I	1049656.83	12661.549	1.0121	1754.7012	-74638.048	0.9426	2
82	J	1052538.925	14307.3349	1.0136	3996.674	-75399.5262	0.9458	2
83	I	1052538.925	14291.5964	1.0136	3990.8082	-75399.5262	0.9457	2
83	J	1055605.618	15730.1681	1.0149	5945.1124	-76217.6825	0.9483	2
84	I	1055605.618	15715.5371	1.0149	5938.9201	-76217.6825	0.9483	2
84	J	1056074.883	15917.7561	1.0151	6238.1845	-76343.6004	0.9487	2
85	I	1056192.88	17028.0701	1.0161	7581.2056	-76375.293	0.951	2
85	J	1052761.988	18037.0189	1.0171	8872.7341	-75458.7608	0.9539	2
86	I	1052761.988	18028.2491	1.0171	8869.5059	-75458.7608	0.9539	2
86	J	1049151.849	18675.3787	1.0178	9762.9843	-74505.3634	0.9561	2
87	I	1049151.849	18667.9971	1.0178	9759.1111	-74505.3634	0.9561	2
87	J	1045364.657	18948.2303	1.0181	10222.8463	-73517.2162	0.9576	2
88	I	1045364.657	18941.8648	1.0181	10217.7938	-73517.2162	0.9576	2
88	J	1045364.657	18951.9391	1.0181	10224.058	-73517.2162	0.9576	2
89	I	1045364.657	18946.7185	1.0181	10217.9626	-73517.2162	0.9576	2
89	J	1049151.849	18686.2475	1.0178	9766.3744	-74505.3634	0.9561	2
90	I	1049151.849	18682.728	1.0178	9759.9576	-74505.3634	0.9561	2
90	J	1052761.988	18054.3409	1.0171	8877.4929	-75458.7608	0.9539	2
91	I	1052761.988	18053.4946	1.0171	8872.0375	-75458.7608	0.9539	2

91	J	1056192.88	17062.068	1.0162	7589.6645	-76375.293	0.951	2
92	I	1056192.88	17065.2743	1.0162	7586.9803	-76375.293	0.951	2
92	J	1056074.883	15940.4146	1.0151	6243.7856	-76343.6004	0.9487	2
93	I	1055605.618	15776.3828	1.0149	5947.7287	-76217.6825	0.9484	2
93	J	1052538.925	14358.0621	1.0136	3993.6924	-75399.5262	0.9458	2
94	I	1052538.925	14369.8792	1.0137	3997.3724	-75399.5262	0.9458	2
94	J	1049656.83	12741.9574	1.0121	1755.6313	-74638.048	0.9427	2
95	I	1049656.83	12754.3685	1.0122	1757.9229	-74638.048	0.9427	2
95	J	1046960.809	10974.7677	1.0105	-714.735	-73932.1912	0.9392	2
96	I	1046960.809	10985.2106	1.0105	-715.6582	-73932.1912	0.9392	2
96	J	1044452.229	9130.1024	1.0087	-3350.7202	-73280.9692	0.9354	2
97	I	1044452.229	9136.7577	1.0087	-3356.4929	-73280.9692	0.9354	2
97	J	1042132.361	7297.4107	1.007	-6074.8642	-72683.4699	0.9314	2
98	I	1042132.361	7297.7057	1.007	-6087.3006	-72683.4699	0.9314	2
98	J	1040002.403	5574.9657	1.0054	-8802.2324	-72138.8593	0.9275	2
99	I	1040002.403	5566.0206	1.0054	-8823.1491	-72138.8593	0.9275	2
99	J	1038063.485	4064.5296	1.0039	-11444.3811	-71646.3834	0.9239	2
100	I	1038063.485	4043.5901	1.0039	-11474.7822	-71646.3834	0.9238	2
100	J	1036316.678	2867.5462	1.0028	-13913.6613	-71205.3697	0.9206	2
101	I	1036316.678	2857.2331	1.0028	-13956.6271	-71205.3697	0.9206	2
101	J	1038063.485	3932.8928	1.0038	-11441.2832	-71646.3834	0.9237	2
102	I	1038063.485	3939.0842	1.0038	-11438.8813	-71646.3834	0.9238	2
102	J	1040002.403	5343.5582	1.0051	-8782.4174	-72138.8593	0.9273	2
103	I	1040002.403	5347.787	1.0051	-8780.2663	-72138.8593	0.9273	2
103	J	1042132.361	7000.9209	1.0067	-6057.214	-72683.4699	0.9312	2
104	I	1042132.361	7003.4048	1.0067	-6055.361	-72683.4699	0.9312	2
104	J	1044452.229	8818.8174	1.0084	-3342.8801	-73280.9692	0.9351	2
105	I	1044452.229	8819.2562	1.0084	-3341.6441	-73280.9692	0.9351	2
105	J	1046960.809	10708.4479	1.0102	-715.5708	-73932.1912	0.9389	2
106	I	1046960.809	10706.6744	1.0102	-715.2809	-73932.1912	0.9389	2
106	J	1049656.83	12584.5003	1.012	1753.3523	-74638.048	0.9426	2
107	I	1049656.83	12580.3652	1.012	1752.4856	-74638.048	0.9425	2
107	J	1052538.925	14370.6943	1.0137	4000.0269	-75399.5262	0.9458	2
108	I	1052538.925	14365.1056	1.0136	3997.9897	-75399.5262	0.9458	2
108	J	1055605.618	16006.1746	1.0152	5969.4855	-76217.6825	0.9486	2
109	I	1055605.618	15999.4666	1.0152	5966.6049	-76217.6825	0.9486	2
109	J	1056074.883	16244.3622	1.0154	6270.1866	-76343.6004	0.949	2
110	I	1056192.88	17272.3968	1.0164	7602.8913	-76375.293	0.9512	2
110	J	1052761.988	18181.4429	1.0173	8877.007	-75458.7608	0.954	2
111	I	1052761.988	18173.1136	1.0173	8872.7613	-75458.7608	0.954	2
111	J	1049151.849	18753.8584	1.0179	9749.2455	-74505.3634	0.9562	2
112	I	1049151.849	18744.9521	1.0179	9744.1462	-74505.3634	0.9561	2
112	J	1045364.657	18999.3926	1.0182	10195.2937	-73517.2162	0.9576	2
113	I	1045364.657	18990.1646	1.0182	10189.3915	-73517.2162	0.9576	2
113	J	1045364.657	19019.1508	1.0182	10190.1343	-73517.2162	0.9576	2
114	I	1045364.657	19010.0733	1.0182	10183.7264	-73517.2162	0.9576	2

114	J	1049151.849	18813.4894	1.0179	9734.5257	-74505.3634	0.9562	2
115	I	1049151.849	18805.2437	1.0179	9728.1481	-74505.3634	0.9562	2
115	J	1052761.988	18281.9448	1.0174	8854.9063	-75458.7608	0.9541	2
116	I	1052761.988	18275.3403	1.0174	8849.2671	-75458.7608	0.9541	2
116	J	1056192.88	17422.8377	1.0165	7580.3451	-76375.293	0.9514	2
117	I	1056192.88	17418.6534	1.0165	7576.1939	-76375.293	0.9514	2
117	J	1056074.883	16430.6346	1.0156	6245.1534	-76343.6004	0.9492	2
118	I	1055605.618	16206.7461	1.0154	5941.2458	-76217.6825	0.9488	2
118	J	1052538.925	14628.8731	1.0139	3981.6384	-75399.5262	0.946	2
119	I	1052538.925	14630.0286	1.0139	3981.1694	-75399.5262	0.946	2
119	J	1049656.83	12890.3711	1.0123	1745.4412	-74638.048	0.9428	2
120	I	1049656.83	12893.0754	1.0123	1745.6814	-74638.048	0.9428	2
120	J	1046960.809	11046.9908	1.0106	-712.026	-73932.1912	0.9393	2
121	I	1046960.809	11048.8647	1.0106	-712.3202	-73932.1912	0.9393	2
121	J	1044452.229	9166.8612	1.0088	-3328.7746	-73280.9692	0.9354	2
122	I	1044452.229	9165.4982	1.0088	-3331.4538	-73280.9692	0.9354	2
122	J	1042132.361	7327.9344	1.007	-6035.1236	-72683.4699	0.9315	2
123	I	1042132.361	7319.8676	1.007	-6042.6847	-72683.4699	0.9315	2
123	J	1040002.403	5613.989	1.0054	-8755.5858	-72138.8593	0.9276	2
124	I	1040002.403	5595.4161	1.0054	-8770.8285	-72138.8593	0.9276	2
124	J	1038063.485	4111.6271	1.004	-11411.0658	-71646.3834	0.9239	2
125	I	1038063.485	4079.4521	1.0039	-11436.0281	-71646.3834	0.9239	2
125	J	1036316.678	2910.0309	1.0028	-13920.7352	-71205.3697	0.9207	2
126	I	1036316.678	2843.9636	1.0027	-13979.2869	-71205.3697	0.9205	2
126	J	1038063.485	3920.6026	1.0038	-11457.5196	-71646.3834	0.9237	2
127	I	1038063.485	3919.8845	1.0038	-11469.1727	-71646.3834	0.9237	2
127	J	1040002.403	5325.6512	1.0051	-8803.2385	-72138.8593	0.9273	2
128	I	1040002.403	5326.2077	1.0051	-8812.229	-72138.8593	0.9273	2
128	J	1042132.361	6979.0511	1.0067	-6077.0231	-72683.4699	0.9311	2
129	I	1042132.361	6981.2098	1.0067	-6083.0528	-72683.4699	0.9311	2
129	J	1044452.229	8792.6722	1.0084	-3356.5566	-73280.9692	0.935	2
130	I	1044452.229	8796.0952	1.0084	-3359.7256	-73280.9692	0.935	2
130	J	1046960.809	10675.792	1.0102	-718.8641	-73932.1912	0.9389	2
131	I	1046960.809	10680.0956	1.0102	-719.4207	-73932.1912	0.9389	2
131	J	1049656.83	12541.5198	1.0119	1763.5693	-74638.048	0.9425	2
132	I	1049656.83	12546.1244	1.012	1765.2841	-74638.048	0.9425	2
132	J	1052538.925	14312.4281	1.0136	4025.5403	-75399.5262	0.9458	2
133	I	1052538.925	14317.3963	1.0136	4029.0166	-75399.5262	0.9458	2
133	J	1055605.618	15928.5475	1.0151	6010.6336	-76217.6825	0.9486	2
134	I	1055605.618	15932.8838	1.0151	6015.038	-76217.6825	0.9486	2
134	J	1056074.883	16172.603	1.0153	6320.1758	-76343.6004	0.949	2
135	I	1056192.88	17195.6571	1.0163	7669.136	-76375.293	0.9512	2
135	J	1052761.988	18084.6653	1.0172	8946.6803	-75458.7608	0.954	2
136	I	1052761.988	18086.5866	1.0172	8951.4609	-75458.7608	0.954	2
136	J	1049151.849	18638.8556	1.0178	9826.5338	-74505.3634	0.9561	2
137	I	1049151.849	18640.1674	1.0178	9831.4619	-74505.3634	0.9561	2

137	J	1045364.657	18855.7087	1.018	10275.9696	-73517.2162	0.9575	2
138	I	1045364.657	18856.7087	1.018	10280.9126	-73517.2162	0.9575	2
138	J	1045364.657	18835.758	1.018	10269.7132	-73517.2162	0.9575	2
139	I	1045364.657	18836.7686	1.018	10274.5759	-73517.2162	0.9575	2
139	J	1049151.849	18579.8174	1.0177	9808.6151	-74505.3634	0.956	2
140	I	1049151.849	18581.1909	1.0177	9813.3695	-74505.3634	0.956	2
140	J	1052761.988	17988.7313	1.0171	8919.6002	-75458.7608	0.9539	2
141	I	1052761.988	17990.7636	1.0171	8924.233	-75458.7608	0.9539	2
141	J	1056192.88	17062.8571	1.0162	7632.4229	-76375.293	0.9511	2
142	I	1056192.88	17065.5942	1.0162	7636.787	-76375.293	0.9511	2
142	J	1056074.883	16012.2706	1.0152	6286.1156	-76343.6004	0.9488	2
143	I	1055605.618	15732.6437	1.0149	5985.3037	-76217.6825	0.9484	2
143	J	1052538.925	14007.52	1.0133	4002.1535	-75399.5262	0.9455	2
144	I	1052538.925	14010.3088	1.0133	4005.4235	-75399.5262	0.9455	2
144	J	1049656.83	12126.807	1.0116	1750.4989	-74638.048	0.9421	2
145	I	1049656.83	12127.8984	1.0116	1752.449	-74638.048	0.9421	2
145	J	1046960.809	10139.4303	1.0097	-717.312	-73932.1912	0.9384	2
146	I	1046960.809	10135.6299	1.0097	-718.2667	-73932.1912	0.9384	2
146	J	1044452.229	8116.3547	1.0078	-3335.8822	-73280.9692	0.9344	2
147	I	1044452.229	8104.4048	1.0078	-3341.9476	-73280.9692	0.9344	2
147	J	1042132.361	6142.7388	1.0059	-6031.4012	-72683.4699	0.9304	2
148	I	1042132.361	6119.0177	1.0059	-6044.9819	-72683.4699	0.9303	2
148	J	1040002.403	4314.3857	1.0041	-8722.9936	-72138.8593	0.9264	2
149	I	1040002.403	4276.1994	1.0041	-8745.7943	-72138.8593	0.9263	2
149	J	1038063.485	2735.3346	1.0026	-11324.3959	-71646.3834	0.9227	2
150	I	1038063.485	2682.385	1.0026	-11356.0514	-71646.3834	0.9226	2
150	J	1036316.678	1516.4712	1.0015	-13745.4308	-71205.3697	0.9195	2
151	I	1036316.678	2845.6827	1.0027	-14001.096	-71205.3697	0.9205	2
151	J	1038063.485	3951.816	1.0038	-11483.2783	-71646.3834	0.9237	2
152	I	1038063.485	3944.3124	1.0038	-11511.0574	-71646.3834	0.9237	2
152	J	1040002.403	5400.9481	1.0052	-8842.3916	-72138.8593	0.9273	2
153	I	1040002.403	5396.7825	1.0052	-8864.7295	-72138.8593	0.9273	2
153	J	1042132.361	7124.5975	1.0068	-6118.5141	-72683.4699	0.9312	2
154	I	1042132.361	7124.5519	1.0068	-6134.3203	-72683.4699	0.9312	2
154	J	1044452.229	9035.8018	1.0087	-3387.4969	-73280.9692	0.9352	2
155	I	1044452.229	9039.7772	1.0087	-3396.2749	-73280.9692	0.9352	2
155	J	1046960.809	11042.1876	1.0105	-725.6624	-73932.1912	0.9392	2
156	I	1046960.809	11049.8187	1.0106	-727.3303	-73932.1912	0.9392	2
156	J	1049656.83	13052.2938	1.0124	1793.7849	-74638.048	0.943	2
157	I	1049656.83	13062.751	1.0124	1798.8925	-74638.048	0.9431	2
157	J	1052538.925	14980.6231	1.0142	4103.3205	-75399.5262	0.9465	2
158	I	1052538.925	14993.5315	1.0142	4114.2758	-75399.5262	0.9465	2
158	J	1055605.618	16757.9515	1.0159	6142.7848	-76217.6825	0.9495	2
159	I	1055605.618	16771.1894	1.0159	6157.5812	-76217.6825	0.9495	2
159	J	1056074.883	17035.7573	1.0161	6470.7866	-76343.6004	0.95	2
160	I	1056192.88	18078.0328	1.0171	7856.3358	-76375.293	0.9522	2

160	J	1052761.988	18946.3462	1.018	9151.9736	-75458.7608	0.955	2
161	I	1052761.988	18956.7667	1.018	9171.3138	-75458.7608	0.955	2
161	J	1049151.849	19469.2146	1.0186	10053.6475	-74505.3634	0.9571	2
162	I	1049151.849	19478.4786	1.0186	10075.6188	-74505.3634	0.9572	2
162	J	1045364.657	19637.6128	1.0188	10516.3472	-73517.2162	0.9585	2
163	I	1045364.657	19645.5536	1.0188	10540.6287	-73517.2162	0.9585	2
163	J	1045364.657	19553.8285	1.0187	10514.1926	-73517.2162	0.9584	2
164	I	1045364.657	19560.0991	1.0187	10540.0025	-73517.2162	0.9585	2
164	J	1049151.849	19220.3443	1.0183	10047.2964	-74505.3634	0.9569	2
165	I	1049151.849	19224.4719	1.0183	10073.4297	-74505.3634	0.9569	2
165	J	1052761.988	18539.7232	1.0176	9141.8774	-75458.7608	0.9546	2
166	I	1052761.988	18541.0779	1.0176	9166.6871	-75458.7608	0.9546	2
166	J	1056192.88	17514.1271	1.0166	7826.7162	-76375.293	0.9517	2
167	I	1056192.88	17511.8589	1.0166	7848.0307	-76375.293	0.9517	2
167	J	1056074.883	16373.6544	1.0155	6450.1032	-76343.6004	0.9493	2
168	I	1055605.618	16071.2988	1.0152	6147.5878	-76217.6825	0.9488	2
168	J	1052538.925	14195.0047	1.0135	4083.4274	-75399.5262	0.9457	2
169	I	1052538.925	14185.8692	1.0135	4093.5852	-75399.5262	0.9457	2
169	J	1049656.83	12189.9826	1.0116	1776.0818	-74638.048	0.9422	2
170	I	1049656.83	12180.9606	1.0116	1780.7966	-74638.048	0.9422	2
170	J	1046960.809	10139.2098	1.0097	-725.1963	-73932.1912	0.9384	2
171	I	1046960.809	10130.2966	1.0097	-726.7376	-73932.1912	0.9384	2
171	J	1044452.229	8137.4395	1.0078	-3348.5627	-73280.9692	0.9344	2
172	I	1044452.229	8130.2477	1.0078	-3357.1557	-73280.9692	0.9344	2
172	J	1042132.361	6277.9475	1.006	-6017.5013	-72683.4699	0.9305	2
173	I	1042132.361	6272.9669	1.006	-6033.4211	-72683.4699	0.9305	2
173	J	1040002.403	4651.7948	1.0045	-8653.9507	-72138.8593	0.9268	2
174	I	1040002.403	4649.176	1.0045	-8676.6535	-72138.8593	0.9268	2
174	J	1038063.485	3339.3326	1.0032	-11183.1524	-71646.3834	0.9234	2
175	I	1038063.485	3338.0959	1.0032	-11211.143	-71646.3834	0.9234	2
175	J	1036316.678	2402.8601	1.0023	-13539.004	-71205.3697	0.9205	2
176	I	1036316.678	2822.7965	1.0027	-13764.0931	-71205.3697	0.9207	2
176	J	1038063.485	4226.7282	1.0041	-11444.1531	-71646.3834	0.924	2
177	I	1038063.485	4212.2387	1.0041	-11434.5353	-71646.3834	0.924	2
177	J	1040002.403	6048.5649	1.0058	-8875.4812	-72138.8593	0.9279	2
178	I	1040002.403	6031.8972	1.0058	-8869.1564	-72138.8593	0.9279	2
178	J	1042132.361	8174.7475	1.0078	-6164.9512	-72683.4699	0.9322	2
179	I	1042132.361	8157.0285	1.0078	-6161.6833	-72683.4699	0.9322	2
179	J	1044452.229	10476.0093	1.01	-3410.5688	-73280.9692	0.9366	2
180	I	1044452.229	10458.6945	1.01	-3409.5361	-73280.9692	0.9366	2
180	J	1046960.809	12825.8239	1.0123	-708.0986	-73932.1912	0.941	2
181	I	1046960.809	12810.5356	1.0122	-708.1222	-73932.1912	0.9409	2
181	J	1049656.83	15107.5398	1.0144	1853.7645	-74638.048	0.9451	2
182	I	1049656.83	15095.5662	1.0144	1854.135	-74638.048	0.945	2
182	J	1052538.925	17221.6383	1.0164	4197.056	-75399.5262	0.9487	2
183	I	1052538.925	17215.3853	1.0164	4199.4259	-75399.5262	0.9487	2

183	J	1055605.618	19093.1008	1.0181	6256.3577	-76217.6825	0.9518	2
184	I	1055605.618	19093.8029	1.0181	6262.8611	-76217.6825	0.9518	2
184	J	1056074.883	19363.0783	1.0183	6579.0159	-76343.6004	0.9523	2
185	I	1056192.88	20641.8687	1.0195	8003.0927	-76375.293	0.9548	2
185	J	1052761.988	21773.8085	1.0207	9349.5587	-75458.7608	0.9579	2
186	I	1052761.988	21790.9951	1.0207	9367.6485	-75458.7608	0.9579	2
186	J	1049151.849	22467.3426	1.0214	10290.5982	-74505.3634	0.9602	2
187	I	1049151.849	22491.3418	1.0214	10312.5958	-74505.3634	0.9603	2
187	J	1045364.657	22702.7455	1.0217	10778.1181	-73517.2162	0.9617	2
188	I	1045364.657	22731.8966	1.0217	10802.2095	-73517.2162	0.9618	2
188	J	1045364.657	22574.1478	1.0216	10781.4076	-73517.2162	0.9616	2
189	I	1045364.657	22606.3463	1.0216	10805.624	-73517.2162	0.9616	2
189	J	1049151.849	22083.5632	1.021	10299.1666	-74505.3634	0.9599	2
190	I	1049151.849	22116.4372	1.0211	10321.6068	-74505.3634	0.9599	2
190	J	1052761.988	21140.8552	1.0201	9359.8397	-75458.7608	0.9573	2
191	I	1052761.988	21172.0656	1.0201	9378.9318	-75458.7608	0.9573	2
191	J	1056192.88	19760.7351	1.0187	7997.4941	-76375.293	0.954	2
192	I	1056192.88	19788.3433	1.0187	8012.2387	-76375.293	0.954	2
192	J	1056074.883	18268.1421	1.0173	6575.9799	-76343.6004	0.9512	2
193	I	1055605.618	17995.5051	1.017	6271.6203	-76217.6825	0.9508	2
193	J	1052538.925	16023.2382	1.0152	4202.749	-75399.5262	0.9476	2
194	I	1052538.925	16041.4207	1.0152	4208.1302	-75399.5262	0.9476	2
194	J	1049656.83	13864.1633	1.0132	1855.2123	-74638.048	0.9439	2
195	I	1049656.83	13879.4172	1.0132	1856.3539	-74638.048	0.9439	2
195	J	1046960.809	11587.8959	1.0111	-714.1377	-73932.1912	0.9398	2
196	I	1046960.809	11603.5543	1.0111	-713.8269	-73932.1912	0.9398	2
196	J	1044452.229	9308.2598	1.0089	-3425.2887	-73280.9692	0.9355	2
197	I	1044452.229	9331.8919	1.0089	-3419.9595	-73280.9692	0.9355	2
197	J	1042132.361	7152.0851	1.0069	-6188.4588	-72683.4699	0.9312	2
198	I	1042132.361	7193.2596	1.0069	-6170.4871	-72683.4699	0.9312	2
198	J	1040002.403	5247.4177	1.005	-8909.0507	-72138.8593	0.9271	2
199	I	1040002.403	5315.7513	1.0051	-8871.1497	-72138.8593	0.9272	2
199	J	1038063.485	3712.1496	1.0036	-11495.0861	-71646.3834	0.9235	2
200	I	1038063.485	3812.2052	1.0037	-11434.4554	-71646.3834	0.9236	2
200	J	1036316.678	2640.2443	1.0025	-13867.0055	-71205.3697	0.9205	2
214	I	1036316.678	3831.1216	1.0037	-11840.1053	-71205.3697	0.9236	2
214	J	1038063.485	4739.1077	1.0046	-9959.4513	-71646.3834	0.926	2
215	I	1038063.485	5160.8596	1.005	-9578.4284	-71646.3834	0.9267	2
215	J	1040002.403	6463.7364	1.0062	-7544.082	-72138.8593	0.9296	2
216	I	1040002.403	6718.2803	1.0065	-7323.3303	-72138.8593	0.9301	2
216	J	1042132.361	8436.6591	1.0081	-5168.6789	-72683.4699	0.9334	2
217	I	1042132.361	8586.3106	1.0082	-5050.833	-72683.4699	0.9336	2
217	J	1044452.229	10710.9035	1.0103	-2813.1637	-73280.9692	0.9374	2
218	I	1044452.229	10792.528	1.0103	-2762.1569	-73280.9692	0.9375	2
218	J	1046960.809	13284.8076	1.0127	-488.2557	-73932.1912	0.9416	2
219	I	1046960.809	13319.6474	1.0127	-481.5693	-73932.1912	0.9416	2

219	J	1049656.83	16121.4107	1.0154	1773.5536	-74638.048	0.9459	2
220	I	1049656.83	16122.6804	1.0154	1751.0839	-74638.048	0.9459	2
220	J	1052538.925	19168.9062	1.0182	3928.3656	-75399.5262	0.9503	2
221	I	1052538.925	19147.5755	1.0182	3889.4177	-75399.5262	0.9503	2
221	J	1055605.618	22384.8633	1.0212	5930.7742	-76217.6825	0.9546	2
222	I	1055605.618	22359.8262	1.0212	5888.1142	-76217.6825	0.9546	2
222	J	1056074.883	22911.1692	1.0217	6216.2071	-76343.6004	0.9553	2
223	I	1056192.88	24101.4455	1.0228	7435.1992	-76375.293	0.9575	2
223	J	1052761.988	24982.299	1.0237	8647.6142	-75458.7608	0.9603	2
224	I	1052761.988	24965.4994	1.0237	8609.1007	-75458.7608	0.9602	2
224	J	1049151.849	25584.2357	1.0244	9450.0095	-74505.3634	0.9624	2
225	I	1049151.849	25565.5941	1.0244	9416.984	-74505.3634	0.9623	2
225	J	1045364.657	25899.0528	1.0248	9862.12	-73517.2162	0.9639	2
226	I	1045364.657	25878.8467	1.0248	9837.3138	-73517.2162	0.9638	2
226	J	1045364.657	26008.9996	1.0249	9863.036	-73517.2162	0.964	2
227	I	1045364.657	25988.4791	1.0249	9848.457	-73517.2162	0.964	2
227	J	1049151.849	25910.4477	1.0247	9453.0969	-74505.3634	0.9627	2
228	I	1049151.849	25891.6914	1.0247	9450.1042	-74505.3634	0.9627	2
228	J	1052761.988	25513.9116	1.0242	8653.9249	-75458.7608	0.9608	2
229	I	1052761.988	25499.7076	1.0242	8662.836	-75458.7608	0.9608	2
229	J	1056192.88	24836.0551	1.0235	7486.5165	-76375.293	0.9583	2
230	I	1056192.88	24831.0557	1.0235	7506.4344	-76375.293	0.9583	2
230	J	1056074.883	24042.2	1.0228	6254.6732	-76343.6004	0.9564	2
231	I	1055605.618	23276.6577	1.0221	5966.154	-76217.6825	0.9555	2
231	J	1052538.925	19991.5085	1.019	3913.0773	-75399.5262	0.9511	2
232	I	1052538.925	20008.6377	1.019	3946.8914	-75399.5262	0.9511	2
232	J	1049656.83	16893.898	1.0161	1759.5277	-74638.048	0.9467	2
233	I	1049656.83	16892.9221	1.0161	1781.204	-74638.048	0.9467	2
233	J	1046960.809	14000.8947	1.0134	-479.5931	-73932.1912	0.9423	2
234	I	1046960.809	13966.1171	1.0133	-486.5596	-73932.1912	0.9423	2
234	J	1044452.229	11366.8462	1.0109	-2757.7816	-73280.9692	0.9381	2
235	I	1044452.229	11278.579	1.0108	-2813.9159	-73280.9692	0.9379	2
235	J	1042132.361	9040.8071	1.0087	-5035.9857	-72683.4699	0.9341	2
236	I	1042132.361	8870.7434	1.0085	-5169.7642	-72683.4699	0.9338	2
236	J	1040002.403	7049.0843	1.0068	-7292.1462	-72138.8593	0.9304	2
237	I	1040002.403	6755.4735	1.0065	-7544.2621	-72138.8593	0.9299	2
237	J	1038063.485	5377.9511	1.0052	-9529.6034	-71646.3834	0.927	2
238	I	1038063.485	4900.248	1.0047	-9957.484	-71646.3834	0.9261	2
238	J	1036316.678	3956.2761	1.0038	-11778.5723	-71205.3697	0.9237	2
1087	I	1056074.883	18260.898	1.0173	6579.4026	-76343.6004	0.9512	2
1087	J	1055605.618	17972.5867	1.017	6261.3835	-76217.6825	0.9508	2
1088	I	1056074.883	16364.3769	1.0155	6452.6265	-76343.6004	0.9493	2
1088	J	1055605.618	16078.0684	1.0152	6132.1183	-76217.6825	0.9488	2
1089	I	1056074.883	15988.7102	1.0151	6287.4967	-76343.6004	0.9488	2
1089	J	1055605.618	15729.6655	1.0149	5981.5788	-76217.6825	0.9484	2
1090	I	1056074.883	16441.7444	1.0156	6245.1175	-76343.6004	0.9492	2

1090	J	1055605.618	16208.1157	1.0154	5943.3762	-76217.6825	0.9488	2
1091	I	1056074.883	15966.6536	1.0151	6245.0741	-76343.6004	0.9487	2
1091	J	1055605.618	15767.759	1.0149	5945.8103	-76217.6825	0.9484	2
1092	I	1056074.883	14562.3297	1.0138	6189.5911	-76343.6004	0.9474	2
1092	J	1055605.618	14403.8816	1.0136	5898.6311	-76217.6825	0.947	2
1093	I	1056074.883	15036.0498	1.0142	6068.6497	-76343.6004	0.9477	2
1093	J	1055605.618	14955.4447	1.0142	5786.9872	-76217.6825	0.9474	2
1094	I	1056074.883	23820.3628	1.0226	6264.99	-76343.6004	0.9562	2
1094	J	1055605.618	23263.3141	1.022	5934.8049	-76217.6825	0.9555	2
1095	I	1056074.883	19323.6917	1.0183	6578.9954	-76343.6004	0.9522	2
1095	J	1056192.88	20632.693	1.0195	7990.4155	-76375.293	0.9548	2
1096	I	1056074.883	17045.6543	1.0161	6473.4314	-76343.6004	0.95	2
1096	J	1056192.88	18066.3636	1.0171	7839.4885	-76375.293	0.9522	2
1097	I	1056074.883	16171.8081	1.0153	6321.4435	-76343.6004	0.949	2
1097	J	1056192.88	17192.7767	1.0163	7664.5832	-76375.293	0.9512	2
1098	I	1056074.883	16246.1998	1.0154	6269.158	-76343.6004	0.949	2
1098	J	1056192.88	17280.0211	1.0164	7606.3998	-76375.293	0.9513	2
1099	I	1056074.883	15900.2391	1.0151	6236.1156	-76343.6004	0.9487	2
1099	J	1056192.88	17039.1703	1.0161	7585.065	-76375.293	0.951	2
1100	I	1056074.883	14287.7735	1.0135	6133.3618	-76343.6004	0.947	2
1100	J	1056192.88	15506.7048	1.0147	7485.4971	-76375.293	0.9495	2
1101	I	1056074.883	13686.972	1.013	6080.609	-76343.6004	0.9464	2
1101	J	1056192.88	14719.3495	1.0139	7409.4387	-76375.293	0.9486	2
1102	I	1056074.883	23174.2367	1.0219	6203.4475	-76343.6004	0.9555	2
1102	J	1056192.88	24118.4671	1.0228	7475.8796	-76375.293	0.9576	2

Elem	Part	Stress (After Immediate Loss) : A (kN/m ²)	Elastic Deform. Loss : B (kN/m ²)	Stress(Elastic Loss)/ Stress(Immediate Loss)	Creep/Shrinkage Loss (kN/m ²)	Relaxation Loss (kN/m ²)	Stress(After All Loss)/ Stress(After Immediate Loss)	Effective Num.
The Loss of tendon group [ef] at the stage of [FASE 3]								
Tendon Group	ef	Stage	FASE 3					
26	I	1028797.835	3808.5015	1.0037	-1283.6017	-69335.6215	0.9351	2
26	J	1032610.074	5186.3241	1.005	-1171.4745	-70277.8774	0.9358	2
27	I	1032610.074	5193.7695	1.005	-1165.0834	-70277.8774	0.9358	2
27	J	1036314.787	6523.2629	1.0063	-671.7451	-71204.8935	0.9369	2
28	I	1036314.787	6530.8638	1.0063	-668.2023	-71204.8935	0.9369	2
28	J	1039577.032	7835.2828	1.0075	153.8713	-72030.5494	0.9384	2
29	I	1039577.032	7841.6047	1.0075	152.5173	-72030.5494	0.9384	2
29	J	1042400.801	9125.5332	1.0088	1237.8168	-72752.3769	0.9401	2
30	I	1042400.801	9129.2805	1.0088	1230.3949	-72752.3769	0.9401	2
30	J	1044789.63	10381.2158	1.0099	2504.1399	-73368.2476	0.9421	2
31	I	1044789.63	10381.4911	1.0099	2490.0776	-73368.2476	0.9421	2
31	J	1046746.495	11579.4261	1.0111	3872.321	-73876.3471	0.9442	2
32	I	1046746.495	11574.6965	1.0111	3851.4266	-73876.3471	0.9442	2
32	J	1048513.409	12694.609	1.0121	5261.1811	-74337.9249	0.9462	2
33	I	1048513.409	12685.3142	1.0121	5233.7211	-74337.9249	0.9462	2
33	J	1050675.99	13701.0045	1.013	6591.7228	-74906.5017	0.948	2
34	I	1050675.99	13688.7794	1.013	6560.6963	-74906.5017	0.948	2
34	J	1051048.727	13834.8097	1.0132	6780.0289	-75004.9065	0.9483	2
35	I	1053258.344	14842.6859	1.0141	7765.2832	-75590.7238	0.9497	2
35	J	1051271.862	15725.4494	1.015	8814.9483	-75063.8727	0.9519	2
36	I	1051271.862	15705.0512	1.0149	8775.1975	-75063.8727	0.9519	2
36	J	1047859.47	16342.7895	1.0156	9555.756	-74166.7832	0.9539	2
37	I	1047859.47	16316.9741	1.0156	9511.4239	-74166.7832	0.9539	2
37	J	1044037.977	16690.5856	1.016	9954.4558	-73173.9432	0.9554	2
38	I	1044037.977	16660.0307	1.016	9907.0752	-73173.9432	0.9554	2
38	J	1044037.977	16850.9465	1.0161	9949.0104	-73173.9432	0.9556	2
39	I	1044037.977	16816.7786	1.0161	9900.4578	-73173.9432	0.9555	2
39	J	1047859.47	16822.3621	1.0161	9540.7041	-74166.7832	0.9544	2
40	I	1047859.47	16785.7807	1.016	9492.712	-74166.7832	0.9543	2
40	J	1051271.862	16520.2027	1.0157	8793.5456	-75063.8727	0.9527	2
41	I	1051271.862	16482.5307	1.0157	8747.73	-75063.8727	0.9526	2
41	J	1053258.344	15961.9154	1.0152	7776.0433	-75590.7238	0.9508	2
42	I	1053258.344	15925.2125	1.0151	7734.6939	-75590.7238	0.9507	2
42	J	1051048.727	15282.0884	1.0145	6771.3706	-75004.9065	0.9496	2
43	I	1050675.99	15201.8028	1.0145	6524.6796	-74906.5017	0.9494	2
43	J	1048513.409	14728.8026	1.014	5256.5492	-74337.9249	0.9482	2
44	I	1048513.409	14700.8376	1.014	5231.3437	-74337.9249	0.9481	2
44	J	1046746.495	14096.6562	1.0135	3890.6009	-73876.3471	0.9466	2
45	I	1046746.495	14072.7095	1.0134	3872.1353	-73876.3471	0.9466	2

45	J	1044789.63	13370.7193	1.0128	2535.5038	-73368.2476	0.945	2
46	I	1044789.63	13351.6312	1.0128	2523.8499	-73368.2476	0.945	2
46	J	1042400.801	12577.5724	1.0121	1270.5623	-72752.3769	0.9435	2
47	I	1042400.801	12564.2935	1.0121	1265.0248	-72752.3769	0.9435	2
47	J	1039577.032	11751.9699	1.0113	176.1705	-72030.5494	0.9422	2
48	I	1039577.032	11744.688	1.0113	175.1249	-72030.5494	0.9422	2
48	J	1036314.787	10922.0121	1.0105	-669.7716	-71204.8935	0.9412	2
49	I	1036314.787	10920.8794	1.0105	-668.4017	-71204.8935	0.9412	2
49	J	1032610.074	10106.1163	1.0098	-1194.2579	-70277.8774	0.9406	2
50	I	1032610.074	10111.3587	1.0098	-1192.3289	-70277.8774	0.9406	2
50	J	1028797.835	9310.9652	1.0091	-1331.2955	-69335.6215	0.9404	2
51	I	1028797.835	3705.7486	1.0036	-1287.2731	-69335.6215	0.935	2
51	J	1032610.074	5496.3972	1.0053	-1178.038	-70277.8774	0.9361	2
52	I	1032610.074	5480.7759	1.0053	-1175.5552	-70277.8774	0.9361	2
52	J	1036314.787	7135.0158	1.0069	-677.6162	-71204.8935	0.9375	2
53	I	1036314.787	7118.7028	1.0069	-676.2185	-71204.8935	0.9375	2
53	J	1039577.032	8673.3771	1.0083	158.4798	-72030.5494	0.9392	2
54	I	1039577.032	8656.7156	1.0083	157.7759	-72030.5494	0.9392	2
54	J	1042400.801	10119.4282	1.0097	1260.1531	-72752.3769	0.9411	2
55	I	1042400.801	10102.2123	1.0097	1256.5017	-72752.3769	0.9411	2
55	J	1044789.63	11457.2723	1.011	2545.8787	-73368.2476	0.9432	2
56	I	1044789.63	11439.4796	1.0109	2538.6818	-73368.2476	0.9432	2
56	J	1046746.495	12656.0944	1.0121	3928.4999	-73876.3471	0.9453	2
57	I	1046746.495	12637.5236	1.0121	3917.5728	-73876.3471	0.9452	2
57	J	1048513.409	13681.2275	1.013	5320.7452	-74337.9249	0.9472	2
58	I	1048513.409	13663.2206	1.013	5306.664	-74337.9249	0.9472	2
58	J	1050675.99	14499.1452	1.0138	6639.2968	-74906.5017	0.9488	2
59	I	1050675.99	14483.8417	1.0138	6624.6734	-74906.5017	0.9488	2
59	J	1051048.727	14581.6887	1.0139	6837.1652	-75004.9065	0.949	2
60	I	1053258.344	15653.0205	1.0149	7866.9393	-75590.7238	0.9506	2
60	J	1051271.862	16659.2542	1.0158	8936.9629	-75063.8727	0.9529	2
61	I	1051271.862	16651.7792	1.0158	8923.2529	-75063.8727	0.9529	2
61	J	1047859.47	17324.6568	1.0165	9715.0508	-74166.7832	0.955	2
62	I	1047859.47	17319.9947	1.0165	9700.229	-74166.7832	0.955	2
62	J	1044037.977	17638.121	1.0169	10141.2834	-73173.9432	0.9565	2
63	I	1044037.977	17636.4259	1.0169	10125.6005	-73173.9432	0.9565	2
63	J	1044037.977	17678.102	1.0169	10148.9221	-73173.9432	0.9566	2
64	I	1044037.977	17679.8414	1.0169	10133.2265	-73173.9432	0.9566	2
64	J	1047859.47	17441.6213	1.0166	9737.3739	-74166.7832	0.9552	2
65	I	1047859.47	17447.3961	1.0167	9722.8642	-74166.7832	0.9551	2
65	J	1051271.862	16844.5503	1.016	8972.1578	-75063.8727	0.9532	2
66	I	1051271.862	16855.1233	1.016	8960.3371	-75063.8727	0.9532	2
66	J	1053258.344	15903.4563	1.0151	7924.9336	-75590.7238	0.9509	2
67	I	1053258.344	15919.9373	1.0151	7917.8165	-75590.7238	0.9509	2
67	J	1051048.727	14838.4198	1.0141	6894.2527	-75004.9065	0.9493	2
68	I	1050675.99	14729.938	1.014	6685.4153	-74906.5017	0.9491	2

68	J	1048513.409	13698.2168	1.0131	5357.8325	-74337.9249	0.9473	2
69	I	1048513.409	13726.184	1.0131	5362.1075	-74337.9249	0.9473	2
69	J	1046746.495	12466.9429	1.0119	3958.069	-73876.3471	0.9451	2
70	I	1046746.495	12494.8762	1.0119	3963.2139	-73876.3471	0.9451	2
70	J	1044789.63	11036.7648	1.0106	2567.2903	-73368.2476	0.9428	2
71	I	1044789.63	11061.5907	1.0106	2571.7019	-73368.2476	0.9428	2
71	J	1042400.801	9428.8547	1.009	1272.4511	-72752.3769	0.9405	2
72	I	1042400.801	9448.443	1.0091	1275.1671	-72752.3769	0.9405	2
72	J	1039577.032	7666.5324	1.0074	161.8444	-72030.5494	0.9382	2
73	I	1039577.032	7679.2816	1.0074	162.3427	-72030.5494	0.9383	2
73	J	1036314.787	5755.5689	1.0056	-681.2859	-71204.8935	0.9362	2
74	I	1036314.787	5760.4173	1.0056	-682.9289	-71204.8935	0.9362	2
74	J	1032610.074	3675.997	1.0036	-1185.1499	-70277.8774	0.9344	2
75	I	1032610.074	3671.639	1.0036	-1188.095	-70277.8774	0.9343	2
75	J	1028797.835	1376.9148	1.0013	-1296.1052	-69335.6215	0.9327	2
76	I	1028797.835	3708.9393	1.0036	-1288.9441	-69335.6215	0.935	2
76	J	1032610.074	5515.5028	1.0053	-1177.5376	-70277.8774	0.9361	2
77	I	1032610.074	5502.2547	1.0053	-1176.4872	-70277.8774	0.9361	2
77	J	1036314.787	7219.9884	1.007	-677.7016	-71204.8935	0.9376	2
78	I	1036314.787	7205.7338	1.007	-677.0828	-71204.8935	0.9376	2
78	J	1039577.032	8872.3936	1.0085	158.1961	-72030.5494	0.9394	2
79	I	1039577.032	8857.4517	1.0085	157.8509	-72030.5494	0.9394	2
79	J	1042400.801	10483.2384	1.0101	1262.8466	-72752.3769	0.9415	2
80	I	1042400.801	10467.3168	1.01	1260.9453	-72752.3769	0.9415	2
80	J	1044789.63	12039.2901	1.0115	2557.7243	-73368.2476	0.9437	2
81	I	1044789.63	12022.2446	1.0115	2553.7604	-73368.2476	0.9437	2
81	J	1046746.495	13511.7556	1.0129	3958.3361	-73876.3471	0.9461	2
82	I	1046746.495	13493.5167	1.0129	3952.1425	-73876.3471	0.9461	2
82	J	1048513.409	14865.0841	1.0142	5379.2449	-74337.9249	0.9484	2
83	I	1048513.409	14847.0788	1.0142	5371.3959	-74337.9249	0.9484	2
83	J	1050675.99	16064.4596	1.0153	6738.0719	-74906.5017	0.9504	2
84	I	1050675.99	16048.8477	1.0153	6731.0662	-74906.5017	0.9504	2
84	J	1051048.727	16219.2299	1.0154	6950.7089	-75004.9065	0.9507	2
85	I	1053258.344	17203.0317	1.0163	7980.8644	-75590.7238	0.9521	2
85	J	1051271.862	18110.4139	1.0172	9035.7682	-75063.8727	0.9544	2
86	I	1051271.862	18101.5541	1.0172	9032.4813	-75063.8727	0.9544	2
86	J	1047859.47	18695.4082	1.0178	9806.8178	-74166.7832	0.9564	2
87	I	1047859.47	18688.0034	1.0178	9802.9274	-74166.7832	0.9564	2
87	J	1044037.977	18949.7088	1.0182	10226.0667	-73173.9432	0.9579	2
88	I	1044037.977	18943.3415	1.0181	10221.0126	-73173.9432	0.9578	2
88	J	1044037.977	18953.4168	1.0182	10227.2787	-73173.9432	0.9579	2
89	I	1044037.977	18948.1943	1.0181	10221.1814	-73173.9432	0.9579	2
89	J	1047859.47	18706.2461	1.0179	9810.2218	-74166.7832	0.9564	2
90	I	1047859.47	18702.6994	1.0178	9803.7764	-74166.7832	0.9564	2
90	J	1051271.862	18127.5322	1.0172	9040.6053	-75063.8727	0.9544	2
91	I	1051271.862	18126.5985	1.0172	9035.0503	-75063.8727	0.9544	2

91	J	1053258.344	17236.5475	1.0164	7989.7309	-75590.7238	0.9522	2
92	I	1053258.344	17239.6493	1.0164	7986.906	-75590.7238	0.9522	2
92	J	1051048.727	16240.1707	1.0155	6956.8542	-75004.9065	0.9507	2
93	I	1050675.99	16108.6925	1.0153	6740.9236	-74906.5017	0.9505	2
93	J	1048513.409	14910.7758	1.0142	5374.9653	-74337.9249	0.9484	2
94	I	1048513.409	14923.9175	1.0142	5379.8859	-74337.9249	0.9485	2
94	J	1046746.495	13568.8759	1.013	3953.1282	-73876.3471	0.9462	2
95	I	1046746.495	13584.2899	1.013	3958.1305	-73876.3471	0.9462	2
95	J	1044789.63	12106.5186	1.0116	2553.6124	-73368.2476	0.9438	2
96	I	1044789.63	12122.6515	1.0116	2557.6109	-73368.2476	0.9438	2
96	J	1042400.801	10555.725	1.0101	1260.7789	-72752.3769	0.9415	2
97	I	1042400.801	10572.3384	1.0101	1263.2033	-72752.3769	0.9416	2
97	J	1039577.032	8942.2051	1.0086	158.3278	-72030.5494	0.9395	2
98	I	1039577.032	8959.0492	1.0086	158.8774	-72030.5494	0.9395	2
98	J	1036314.787	7275.4931	1.007	-675.7542	-71204.8935	0.9377	2
99	I	1036314.787	7292.696	1.007	-677.1184	-71204.8935	0.9377	2
99	J	1032610.074	5541.4695	1.0054	-1174.4368	-70277.8774	0.9362	2
100	I	1032610.074	5559.2191	1.0054	-1177.2859	-70277.8774	0.9362	2
100	J	1028797.835	3698.2585	1.0036	-1286.481	-69335.6215	0.9349	2
101	I	1028797.835	3753.6358	1.0036	-1290.0359	-69335.6215	0.935	2
101	J	1032610.074	5397.7045	1.0052	-1174.9274	-70277.8774	0.936	2
102	I	1032610.074	5397.9173	1.0052	-1174.6789	-70277.8774	0.936	2
102	J	1036314.787	7004.5917	1.0068	-675.869	-71204.8935	0.9374	2
103	I	1036314.787	7003.6559	1.0068	-675.7066	-71204.8935	0.9374	2
103	J	1039577.032	8608.7977	1.0083	155.57	-72030.5494	0.9391	2
104	I	1039577.032	8606.9528	1.0083	155.5124	-72030.5494	0.9391	2
104	J	1042400.801	10222.07	1.0098	1254.5615	-72752.3769	0.9412	2
105	I	1042400.801	10219.043	1.0098	1254.0747	-72752.3769	0.9412	2
105	J	1044789.63	11833.5842	1.0113	2546.3615	-73368.2476	0.9435	2
106	I	1044789.63	11829.1997	1.0113	2545.2246	-73368.2476	0.9435	2
106	J	1046746.495	13416.2919	1.0128	3950.3631	-73876.3471	0.946	2
107	I	1046746.495	13410.3383	1.0128	3948.4457	-73876.3471	0.946	2
107	J	1048513.409	14933.7842	1.0142	5383.9709	-74337.9249	0.9485	2
108	I	1048513.409	14927.0457	1.0142	5381.2387	-74337.9249	0.9485	2
108	J	1050675.99	16348.8504	1.0156	6765.6923	-74906.5017	0.9507	2
109	I	1050675.99	16341.4964	1.0156	6762.4306	-74906.5017	0.9507	2
109	J	1051048.727	16554.529	1.0158	6986.3422	-75004.9065	0.951	2
110	I	1053258.344	17450.8809	1.0166	8003.7111	-75590.7238	0.9524	2
110	J	1051271.862	18255.7326	1.0174	9040.137	-75063.8727	0.9546	2
111	I	1051271.862	18247.271	1.0174	9035.8137	-75063.8727	0.9545	2
111	J	1047859.47	18774.025	1.0179	9793.0236	-74166.7832	0.9565	2
112	I	1047859.47	18765.0828	1.0179	9787.9015	-74166.7832	0.9565	2
112	J	1044037.977	19000.8774	1.0182	10198.5059	-73173.9432	0.9579	2
113	I	1044037.977	18991.6467	1.0182	10192.6019	-73173.9432	0.9579	2
113	J	1044037.977	19020.6354	1.0182	10193.3449	-73173.9432	0.9579	2
114	I	1044037.977	19011.5552	1.0182	10186.935	-73173.9432	0.9579	2

114	J	1047859.47	18833.6459	1.018	9778.2377	-74166.7832	0.9565	2
115	I	1047859.47	18825.3652	1.018	9771.8317	-74166.7832	0.9565	2
115	J	1051271.862	18356.182	1.0175	9017.6304	-75063.8727	0.9546	2
116	I	1051271.862	18349.4602	1.0175	9011.8885	-75063.8727	0.9546	2
116	J	1053258.344	17601.5233	1.0167	7979.9762	-75590.7238	0.9525	2
117	I	1053258.344	17597.1123	1.0167	7975.6086	-75590.7238	0.9525	2
117	J	1051048.727	16740.9752	1.0159	6958.4485	-75004.9065	0.9512	2
118	I	1050675.99	16549.1644	1.0158	6733.6881	-74906.5017	0.9509	2
118	J	1048513.409	15193.1752	1.0145	5359.178	-74337.9249	0.9487	2
119	I	1048513.409	15194.3131	1.0145	5358.5519	-74337.9249	0.9487	2
119	J	1046746.495	13726.3626	1.0131	3932.2419	-73876.3471	0.9463	2
120	I	1046746.495	13729.8616	1.0131	3932.7794	-73876.3471	0.9463	2
120	J	1044789.63	12181.8674	1.0117	2535.3346	-73368.2476	0.9439	2
121	I	1044789.63	12186.4069	1.0117	2536.4892	-73368.2476	0.9439	2
121	J	1042400.801	10588.1085	1.0102	1249.8671	-72752.3769	0.9416	2
122	I	1042400.801	10593.0518	1.0102	1250.9459	-72752.3769	0.9416	2
122	J	1039577.032	8962.9355	1.0086	155.4871	-72030.5494	0.9395	2
123	I	1039577.032	8967.438	1.0086	155.7778	-72030.5494	0.9395	2
123	J	1036314.787	7306.1637	1.0071	-673.4184	-71204.8935	0.9377	2
124	I	1036314.787	7309.6805	1.0071	-674.4571	-71204.8935	0.9377	2
124	J	1032610.074	5592.4132	1.0054	-1171.6348	-70277.8774	0.9362	2
125	I	1032610.074	5594.5175	1.0054	-1174.0192	-70277.8774	0.9362	2
125	J	1028797.835	3766.4514	1.0037	-1286.943	-69335.6215	0.935	2
126	I	1028797.835	3763.1736	1.0037	-1291.9432	-69335.6215	0.935	2
126	J	1032610.074	5400.0277	1.0052	-1176.4721	-70277.8774	0.936	2
127	I	1032610.074	5406.0394	1.0052	-1177.53	-70277.8774	0.936	2
127	J	1036314.787	7004.4217	1.0068	-677.285	-71204.8935	0.9374	2
128	I	1036314.787	7010.0171	1.0068	-677.8398	-71204.8935	0.9374	2
128	J	1039577.032	8604.5167	1.0083	156.3299	-72030.5494	0.9391	2
129	I	1039577.032	8610.3064	1.0083	156.6297	-72030.5494	0.9391	2
129	J	1042400.801	10211.2436	1.0098	1260.058	-72752.3769	0.9412	2
130	I	1042400.801	10217.188	1.0098	1261.4303	-72752.3769	0.9412	2
130	J	1044789.63	11812.9497	1.0113	2559.2695	-73368.2476	0.9435	2
131	I	1044789.63	11818.9286	1.0113	2561.8158	-73368.2476	0.9435	2
131	J	1046746.495	13381.8652	1.0128	3973.0893	-73876.3471	0.946	2
132	I	1046746.495	13387.5149	1.0128	3976.8094	-73876.3471	0.946	2
132	J	1048513.409	14880.9914	1.0142	5418.2482	-74337.9249	0.9485	2
133	I	1048513.409	14886.5367	1.0142	5422.891	-74337.9249	0.9485	2
133	J	1050675.99	16274.3352	1.0155	6812.3137	-74906.5017	0.9507	2
134	I	1050675.99	16278.9094	1.0155	6817.2932	-74906.5017	0.9507	2
134	J	1051048.727	16486.2126	1.0157	7042.0188	-75004.9065	0.951	2
135	I	1053258.344	17376.3054	1.0165	8073.4405	-75590.7238	0.9524	2
135	J	1051271.862	18159.7016	1.0173	9111.0915	-75063.8727	0.9545	2
136	I	1051271.862	18161.6389	1.0173	9115.9587	-75063.8727	0.9545	2
136	J	1047859.47	18659.2198	1.0178	9870.6597	-74166.7832	0.9564	2
137	I	1047859.47	18660.5356	1.0178	9875.6096	-74166.7832	0.9565	2

137	J	1044037.977	18857.2072	1.0181	10279.2073	-73173.9432	0.9578	2
138	I	1044037.977	18858.2076	1.0181	10284.1518	-73173.9432	0.9578	2
138	J	1044037.977	18837.2547	1.018	10272.9491	-73173.9432	0.9578	2
139	I	1044037.977	18838.2658	1.018	10277.8132	-73173.9432	0.9578	2
139	J	1047859.47	18600.1099	1.0178	9852.6631	-74166.7832	0.9564	2
140	I	1047859.47	18601.4943	1.0178	9857.4386	-74166.7832	0.9564	2
140	J	1051271.862	18063.3341	1.0172	9083.5314	-75063.8727	0.9544	2
141	I	1051271.862	18065.4289	1.0172	9088.2487	-75063.8727	0.9544	2
141	J	1053258.344	17242.0187	1.0164	8034.8669	-75590.7238	0.9522	2
142	I	1053258.344	17244.9816	1.0164	8039.4595	-75590.7238	0.9522	2
142	J	1051048.727	16322.8633	1.0155	7004.2644	-75004.9065	0.9508	2
143	I	1050675.99	16075.2816	1.0153	6783.8414	-74906.5017	0.9505	2
143	J	1048513.409	14565.5529	1.0139	5387.5323	-74337.9249	0.9481	2
144	I	1048513.409	14569.8875	1.0139	5391.9217	-74337.9249	0.9481	2
144	J	1046746.495	12943.379	1.0124	3946.9609	-73876.3471	0.9456	2
145	I	1046746.495	12947.8887	1.0124	3951.29	-73876.3471	0.9456	2
145	J	1044789.63	11228.2159	1.0107	2539.3127	-73368.2476	0.943	2
146	I	1044789.63	11231.1575	1.0107	2543.0565	-73368.2476	0.943	2
146	J	1042400.801	9442.0067	1.0091	1247.0812	-72752.3769	0.9405	2
147	I	1042400.801	9442.1166	1.0091	1249.5091	-72752.3769	0.9405	2
147	J	1039577.032	7595.779	1.0073	150.4529	-72030.5494	0.9382	2
148	I	1039577.032	7591.6979	1.0073	150.9576	-72030.5494	0.9382	2
148	J	1036314.787	5680.8491	1.0055	-676.3017	-71204.8935	0.9361	2
149	I	1036314.787	5671.5131	1.0055	-677.877	-71204.8935	0.9361	2
149	J	1032610.074	3660.4062	1.0035	-1169.0997	-70277.8774	0.9344	2
150	I	1032610.074	3644.6329	1.0035	-1172.1504	-70277.8774	0.9343	2
150	J	1028797.835	1461.6239	1.0014	-1278.5834	-69335.6215	0.9328	2
151	I	1028797.835	3786.3435	1.0037	-1293.7394	-69335.6215	0.935	2
151	J	1032610.074	5468.5403	1.0053	-1178.7181	-70277.8774	0.9361	2
152	I	1032610.074	5479.9772	1.0053	-1181.2728	-70277.8774	0.9361	2
152	J	1036314.787	7137.009	1.0069	-679.5068	-71204.8935	0.9375	2
153	I	1036314.787	7148.284	1.0069	-680.9226	-71204.8935	0.9375	2
153	J	1039577.032	8817.6861	1.0085	158.7328	-72030.5494	0.9393	2
154	I	1039577.032	8829.641	1.0085	159.4688	-72030.5494	0.9394	2
154	J	1042400.801	10523.3815	1.0101	1274.1139	-72752.3769	0.9415	2
155	I	1042400.801	10536.2297	1.0101	1277.8386	-72752.3769	0.9415	2
155	J	1044789.63	12242.4304	1.0117	2593.8035	-73368.2476	0.944	2
156	I	1044789.63	12256.2694	1.0117	2601.1212	-73368.2476	0.944	2
156	J	1046746.495	13944.8226	1.0133	4037.6967	-73876.3471	0.9466	2
157	I	1046746.495	13959.2894	1.0133	4048.8389	-73876.3471	0.9466	2
157	J	1048513.409	15588.0279	1.0149	5521.8107	-74337.9249	0.9492	2
158	I	1048513.409	15603.2706	1.0149	5536.4594	-74337.9249	0.9493	2
158	J	1050675.99	17129.3268	1.0163	6961.5927	-74906.5017	0.9516	2
159	I	1050675.99	17143.6686	1.0163	6978.3279	-74906.5017	0.9517	2
159	J	1051048.727	17373.4793	1.0165	7209.3805	-75004.9065	0.952	2
160	I	1053258.344	18272.0503	1.0173	8270.3039	-75590.7238	0.9534	2

160	J	1051271.862	19026.5179	1.0181	9320.0915	-75063.8727	0.9556	2
161	I	1051271.862	19037.0827	1.0181	9339.7826	-75063.8727	0.9556	2
161	J	1047859.47	19490.9076	1.0186	10098.7777	-74166.7832	0.9575	2
162	I	1047859.47	19500.2079	1.0186	10120.8465	-74166.7832	0.9575	2
162	J	1044037.977	19639.205	1.0188	10519.6596	-73173.9432	0.9588	2
163	I	1044037.977	19647.1484	1.0188	10543.9487	-73173.9432	0.9588	2
163	J	1044037.977	19555.4148	1.0187	10517.5044	-73173.9432	0.9587	2
164	I	1044037.977	19561.688	1.0187	10543.3224	-73173.9432	0.9587	2
164	J	1047859.47	19241.8	1.0184	10092.4023	-74166.7832	0.9572	2
165	I	1047859.47	19245.9615	1.0184	10118.6517	-74166.7832	0.9572	2
165	J	1051271.862	18618.4223	1.0177	9309.839	-75063.8727	0.9552	2
166	I	1051271.862	18619.8908	1.0177	9335.0992	-75063.8727	0.9552	2
166	J	1053258.344	17702.6775	1.0168	8239.2555	-75590.7238	0.9529	2
167	I	1053258.344	17700.6093	1.0168	8261.6776	-75590.7238	0.9529	2
167	J	1051048.727	16699.7501	1.0159	7186.674	-75004.9065	0.9514	2
168	I	1050675.99	16429.9406	1.0156	6967.3988	-74906.5017	0.951	2
168	J	1048513.409	14774.818	1.0141	5496.5033	-74337.9249	0.9484	2
169	I	1048513.409	14765.3279	1.0141	5510.0709	-74337.9249	0.9484	2
169	J	1046746.495	13029.947	1.0124	4004.768	-73876.3471	0.9457	2
170	I	1046746.495	13020.0345	1.0124	4014.9981	-73876.3471	0.9457	2
170	J	1044789.63	11248.6317	1.0108	2560.4201	-73368.2476	0.943	2
171	I	1044789.63	11238.1572	1.0108	2567.3645	-73368.2476	0.943	2
171	J	1042400.801	9481.3515	1.0091	1247.874	-72752.3769	0.9405	2
172	I	1042400.801	9471.9516	1.0091	1251.5448	-72752.3769	0.9405	2
172	J	1039577.032	7760.955	1.0075	145.8452	-72030.5494	0.9383	2
173	I	1039577.032	7753.3791	1.0075	146.5823	-72030.5494	0.9383	2
173	J	1036314.787	6104.2067	1.0059	-675.7828	-71204.8935	0.9365	2
174	I	1036314.787	6099.4703	1.0059	-677.2485	-71204.8935	0.9365	2
174	J	1032610.074	4507.1406	1.0044	-1159.8528	-70277.8774	0.9352	2
175	I	1032610.074	4506.1811	1.0044	-1162.4806	-70277.8774	0.9352	2
175	J	1028797.835	2944.0889	1.0029	-1264.8378	-69335.6215	0.9342	2
176	I	1028797.835	3699.3654	1.0036	-1258.9423	-69335.6215	0.935	2
176	J	1032610.074	5979.3784	1.0058	-1157.5661	-70277.8774	0.9366	2
177	I	1032610.074	5959.4121	1.0058	-1156.757	-70277.8774	0.9366	2
177	J	1036314.787	8129.0089	1.0078	-661.1233	-71204.8935	0.9385	2
178	I	1036314.787	8109.2942	1.0078	-660.8029	-71204.8935	0.9385	2
178	J	1039577.032	10219.5944	1.0098	186.1377	-72030.5494	0.9407	2
179	I	1039577.032	10200.9317	1.0098	185.8963	-72030.5494	0.9407	2
179	J	1042400.801	12267.8714	1.0118	1321.0242	-72752.3769	0.9432	2
180	I	1042400.801	12251.0844	1.0118	1320.4689	-72752.3769	0.9432	2
180	J	1044789.63	14260.6641	1.0136	2665.8617	-73368.2476	0.946	2
181	I	1044789.63	14246.723	1.0136	2665.5498	-73368.2476	0.946	2
181	J	1046746.495	16163.7244	1.0154	4134.3209	-73876.3471	0.9488	2
182	I	1046746.495	16153.4185	1.0154	4135.2142	-73876.3471	0.9488	2
182	J	1048513.409	17932.2918	1.0171	5637.068	-74337.9249	0.9516	2
183	I	1048513.409	17927.6041	1.0171	5640.2583	-74337.9249	0.9516	2

183	J	1050675.99	19522.4734	1.0186	7086.0512	-74906.5017	0.954	2
184	I	1050675.99	19524.4425	1.0186	7093.4147	-74906.5017	0.954	2
184	J	1051048.727	19752.7327	1.0188	7326.3375	-75004.9065	0.9544	2
185	I	1053258.344	20867.3218	1.0198	8423.0582	-75590.7238	0.956	2
185	J	1051271.862	21867.5428	1.0208	9520.6765	-75063.8727	0.9585	2
186	I	1051271.862	21885.1386	1.0208	9539.0958	-75063.8727	0.9585	2
186	J	1047859.47	22492.8604	1.0215	10336.6345	-74166.7832	0.9606	2
187	I	1047859.47	22516.9808	1.0215	10358.73	-74166.7832	0.9606	2
187	J	1044037.977	22704.626	1.0217	10781.5018	-73173.9432	0.962	2
188	I	1044037.977	22733.7865	1.0218	10805.6008	-73173.9432	0.962	2
188	J	1044037.977	22576.0238	1.0216	10784.7924	-73173.9432	0.9619	2
189	I	1044037.977	22608.2319	1.0217	10809.0164	-73173.9432	0.9619	2
189	J	1047859.47	22108.8934	1.0211	10345.2461	-74166.7832	0.9602	2
190	I	1047859.47	22141.8962	1.0211	10367.7861	-74166.7832	0.9602	2
190	J	1051271.862	21233.3815	1.0202	9531.179	-75063.8727	0.9579	2
191	I	1051271.862	21265.0434	1.0202	9550.6181	-75063.8727	0.9579	2
191	J	1053258.344	19980.9316	1.019	8417.304	-75590.7238	0.9552	2
192	I	1053258.344	20009.5248	1.019	8432.8154	-75590.7238	0.9552	2
192	J	1051048.727	18646.2778	1.0177	7323.3324	-75004.9065	0.9533	2
193	I	1050675.99	18414.6744	1.0175	7103.7648	-74906.5017	0.953	2
193	J	1048513.409	16712.1396	1.0159	5645.9495	-74337.9249	0.9504	2
194	I	1048513.409	16732.2272	1.016	5653.1333	-74337.9249	0.9505	2
194	J	1046746.495	14883.6577	1.0142	4142.198	-73876.3471	0.9476	2
195	I	1046746.495	14899.7487	1.0142	4144.621	-73876.3471	0.9476	2
195	J	1044789.63	12965.7354	1.0124	2670.3159	-73368.2476	0.9447	2
196	I	1044789.63	12978.3449	1.0124	2669.3775	-73368.2476	0.9448	2
196	J	1042400.801	11019.6912	1.0106	1321.5754	-72752.3769	0.942	2
197	I	1042400.801	11031.4556	1.0106	1319.4709	-72752.3769	0.9421	2
197	J	1039577.032	9096.7734	1.0088	183.4103	-72030.5494	0.9396	2
198	I	1039577.032	9110.2957	1.0088	182.7299	-72030.5494	0.9397	2
198	J	1036314.787	7227.0556	1.007	-666.0555	-71204.8935	0.9376	2
199	I	1036314.787	7244.0677	1.007	-663.4706	-71204.8935	0.9376	2
199	J	1032610.074	5412.4652	1.0052	-1164.0493	-70277.8774	0.9361	2
200	I	1032610.074	5432.4208	1.0053	-1158.2527	-70277.8774	0.9361	2
200	J	1028797.835	3624.0065	1.0035	-1267.9547	-69335.6215	0.9349	2
214	I	1028797.835	4044.7771	1.0039	-1007.3009	-69335.6215	0.9356	2
214	J	1032610.074	5835.9677	1.0057	-924.1922	-70277.8774	0.9367	2
215	I	1032610.074	5870.458	1.0057	-891.3974	-70277.8774	0.9368	2
215	J	1036314.787	7716.3448	1.0074	-472.0278	-71204.8935	0.9383	2
216	I	1036314.787	7743.6206	1.0075	-460.0441	-71204.8935	0.9383	2
216	J	1039577.032	9737.2647	1.0094	264.0124	-72030.5494	0.9403	2
217	I	1039577.032	9752.5018	1.0094	256.5599	-72030.5494	0.9403	2
217	J	1042400.801	11946.3601	1.0115	1248.7396	-72752.3769	0.9429	2
218	I	1042400.801	11947.7622	1.0115	1224.7009	-72752.3769	0.9428	2
218	J	1044789.63	14363.4357	1.0137	2439.6014	-73368.2476	0.9459	2
219	I	1044789.63	14350.4455	1.0137	2402.059	-73368.2476	0.9458	2

219	J	1046746.495	16986.9969	1.0162	3784.5496	-73876.3471	0.9493	2
220	I	1046746.495	16960.5867	1.0162	3737.1439	-73876.3471	0.9492	2
220	J	1048513.409	19803.2568	1.0189	5223.9002	-74337.9249	0.953	2
221	I	1048513.409	19767.3188	1.0189	5172.2094	-74337.9249	0.9529	2
221	J	1050675.99	22802.688	1.0217	6695.2021	-74906.5017	0.9568	2
222	I	1050675.99	22771.5488	1.0217	6647.0679	-74906.5017	0.9567	2
222	J	1051048.727	23290.8552	1.0222	6903.2464	-75004.9065	0.9574	2
223	I	1053258.344	24316.2802	1.0231	7816.4518	-75590.7238	0.9587	2
223	J	1051271.862	25070.7513	1.0238	8802.7134	-75063.8727	0.9608	2
224	I	1051271.862	25053.3586	1.0238	8763.5121	-75063.8727	0.9608	2
224	J	1047859.47	25608.0502	1.0244	9491.5013	-74166.7832	0.9627	2
225	I	1047859.47	25589.2791	1.0244	9458.3314	-74166.7832	0.9627	2
225	J	1044037.977	25900.8033	1.0248	9865.1607	-73173.9432	0.9642	2
226	I	1044037.977	25880.5895	1.0248	9840.3468	-73173.9432	0.9641	2
226	J	1044037.977	26010.7549	1.0249	9866.0769	-73173.9432	0.9643	2
227	I	1044037.977	25990.2286	1.0249	9851.4934	-73173.9432	0.9642	2
227	J	1047859.47	25934.4563	1.0247	9494.5982	-74166.7832	0.963	2
228	I	1047859.47	25915.6543	1.0247	9491.5923	-74166.7832	0.963	2
228	J	1051271.862	25603.5578	1.0244	8809.1094	-75063.8727	0.9613	2
229	I	1051271.862	25589.3516	1.0243	8818.1793	-75063.8727	0.9613	2
229	J	1053258.344	25056.7668	1.0238	7870.2784	-75590.7238	0.9595	2
230	I	1053258.344	25052.4623	1.0238	7891.2126	-75590.7238	0.9595	2
230	J	1051048.727	24437.1799	1.0233	6945.5974	-75004.9065	0.9585	2
231	I	1050675.99	23706.9613	1.0226	6734.76	-74906.5017	0.9577	2
231	J	1048513.409	20632.232	1.0197	5202.6969	-74337.9249	0.9537	2
232	I	1048513.409	20662.1159	1.0197	5247.5762	-74337.9249	0.9538	2
232	J	1046746.495	17759.1678	1.017	3751.9869	-73876.3471	0.95	2
233	I	1046746.495	17785.1078	1.017	3797.7205	-73876.3471	0.95	2
233	J	1044789.63	15062.871	1.0144	2407.3897	-73368.2476	0.9465	2
234	I	1044789.63	15078.5804	1.0144	2446.5075	-73368.2476	0.9466	2
234	J	1042400.801	12551.6417	1.012	1225.8604	-72752.3769	0.9434	2
235	I	1042400.801	12553.2291	1.012	1252.3167	-72752.3769	0.9435	2
235	J	1039577.032	10226.5895	1.0098	257.5232	-72030.5494	0.9408	2
236	I	1039577.032	10211.8063	1.0098	265.9834	-72030.5494	0.9408	2
236	J	1036314.787	8074.8686	1.0078	-457.1231	-71204.8935	0.9386	2
237	I	1036314.787	8043.8006	1.0078	-470.8113	-71204.8935	0.9386	2
237	J	1032610.074	6065.6857	1.0059	-886.4915	-70277.8774	0.937	2
238	I	1032610.074	6023.515	1.0058	-923.3255	-70277.8774	0.9369	2
238	J	1028797.835	4137.46	1.004	-1002.1944	-69335.6215	0.9357	2
1087	I	1051048.727	18639.3185	1.0177	7327.143	-75004.9065	0.9533	2
1087	J	1050675.99	18390.1479	1.0175	7092.1881	-74906.5017	0.953	2
1088	I	1051048.727	16690.2836	1.0159	7189.4863	-75004.9065	0.9514	2
1088	J	1050675.99	16436.6553	1.0156	6949.9057	-74906.5017	0.951	2
1089	I	1051048.727	16299.1809	1.0155	7005.8129	-75004.9065	0.9508	2
1089	J	1050675.99	16071.6887	1.0153	6779.6232	-74906.5017	0.9505	2
1090	I	1051048.727	16752.2479	1.0159	6958.4085	-75004.9065	0.9512	2

1090	J	1050675.99	16550.7951	1.0158	6736.0983	-74906.5017	0.9509	2
1091	I	1051048.727	16266.9002	1.0155	6958.2836	-75004.9065	0.9507	2
1091	J	1050675.99	16099.7748	1.0153	6738.7549	-74906.5017	0.9504	2
1092	I	1051048.727	14835.1047	1.0141	6896.5346	-75004.9065	0.9493	2
1092	J	1050675.99	14706.1082	1.014	6685.341	-74906.5017	0.9491	2
1093	I	1051048.727	15286.3802	1.0145	6761.0659	-75004.9065	0.9496	2
1093	J	1050675.99	15234.3254	1.0145	6557.9631	-74906.5017	0.9494	2
1094	I	1051048.727	24212.8254	1.023	6957.0882	-75004.9065	0.9583	2
1094	J	1050675.99	23689.2401	1.0225	6699.3874	-74906.5017	0.9576	2
1095	I	1051048.727	19712.8892	1.0188	7326.326	-75004.9065	0.9544	2
1095	J	1053258.344	20857.2931	1.0198	8409.719	-75590.7238	0.956	2
1096	I	1051048.727	17383.5958	1.0165	7212.3211	-75004.9065	0.952	2
1096	J	1053258.344	18259.967	1.0173	8252.5813	-75590.7238	0.9534	2
1097	I	1051048.727	16485.4704	1.0157	7043.4285	-75004.9065	0.951	2
1097	J	1053258.344	17373.3649	1.0165	8068.6519	-75590.7238	0.9524	2
1098	I	1051048.727	16556.2324	1.0158	6985.1941	-75004.9065	0.951	2
1098	J	1053258.344	17458.8301	1.0166	8007.4036	-75590.7238	0.9524	2
1099	I	1051048.727	16201.2434	1.0154	6948.408	-75004.9065	0.9507	2
1099	J	1053258.344	17214.4245	1.0163	7984.9248	-75590.7238	0.9522	2
1100	I	1051048.727	14553.014	1.0138	6834.1859	-75004.9065	0.949	2
1100	J	1053258.344	15663.776	1.0149	7880.1871	-75590.7238	0.9506	2
1101	I	1051048.727	13921.9871	1.0132	6774.9589	-75004.9065	0.9483	2
1101	J	1053258.344	14857.9971	1.0141	7799.9251	-75590.7238	0.9497	2
1102	I	1051048.727	23556.7196	1.0224	6889.033	-75004.9065	0.9576	2
1102	J	1053258.344	24335.2194	1.0231	7859.2089	-75590.7238	0.9588	2

Elem	Part	Stress (After Immediate Loss) : A (kN/m ²)	Elastic Deform. Loss : B (kN/m ²)	Stress(Elastic Loss)/ Stress(Immediate Loss)	Creep/Shrinkage Loss (kN/m ²)	Relaxation Loss (kN/m ²)	Stress(After All Loss)/ Stress(After Immediate Loss)	Effective Num.
The Loss of tendon group [gh] at the stage of [FASE 3]								
Tendon Group	gh	Stage	FASE 3					
26	I	1030421.257	4355.3851	1.0042	6816.7666	-69735.4385	0.9432	2
26	J	1033960.305	6246.0865	1.006	7050.4839	-70614.4392	0.9446	2
27	I	1033960.305	6206.3001	1.006	7008.3211	-70614.4392	0.9445	2
27	J	1037405.412	7935.2619	1.0076	7306.6967	-71479.9445	0.9458	2
28	I	1037405.412	7897.8993	1.0076	7262.2518	-71479.9445	0.9457	2
28	J	1040463.443	9459.0965	1.0091	7609.1931	-72256.4213	0.947	2
29	I	1040463.443	9425.5129	1.0091	7563.9259	-72256.4213	0.9469	2
29	J	1043137.667	10815.9851	1.0104	7942.2071	-72941.8379	0.9481	2
30	I	1043137.667	10786.0823	1.0103	7896.7352	-72941.8379	0.948	2
30	J	1045430.994	12004.6201	1.0115	8289.1032	-73534.4197	0.9491	2
31	I	1045430.994	11977.6111	1.0115	8243.3771	-73534.4197	0.949	2
31	J	1047345.899	13026.0687	1.0124	8633.5376	-74032.6332	0.95	2
32	I	1047345.899	13000.0511	1.0124	8587.3594	-74032.6332	0.9499	2
32	J	1049094.211	13887.4298	1.0132	8960.927	-74490.2327	0.9508	2
33	I	1049094.211	13862.5876	1.0132	8914.3791	-74490.2327	0.9507	2
33	J	1051188.637	14599.451	1.0139	9258.2952	-75041.8744	0.9513	2
34	I	1051188.637	14577.6299	1.0139	9214.8353	-75041.8744	0.9512	2
34	J	1051549.222	14673.5448	1.014	9268.3257	-75137.2287	0.9513	2
35	I	1053650.341	15450.7405	1.0147	9485.3891	-75695.0928	0.9518	2
35	J	1052675.954	16071.2807	1.0153	9754.927	-75435.9093	0.9529	2
36	I	1052675.954	16048.0112	1.0152	9710.9725	-75435.9093	0.9528	2
36	J	1049487.646	16477.936	1.0157	9914.846	-74593.5701	0.9541	2
37	I	1049487.646	16451.0016	1.0157	9868.8615	-74593.5701	0.954	2
37	J	1045940.874	16706.6434	1.016	9996.6316	-73666.7743	0.9551	2
38	I	1045940.874	16675.9535	1.0159	9949.0518	-73666.7743	0.955	2
38	J	1045940.878	16867.0992	1.0161	9991.1608	-73666.7751	0.9552	2
39	I	1045940.878	16832.7929	1.0161	9942.4043	-73666.7751	0.9552	2
39	J	1049487.649	16959.951	1.0162	9899.1682	-74593.571	0.9545	2
40	I	1049487.649	16922.1624	1.0161	9849.3895	-74593.571	0.9544	2
40	J	1052675.957	16876.8299	1.016	9730.9526	-75435.9102	0.9536	2
41	I	1052675.957	16835.9512	1.016	9680.3039	-75435.9102	0.9535	2
41	J	1053650.34	16603.5782	1.0158	9497.6065	-75695.0925	0.9529	2
42	I	1053650.34	16561.1637	1.0157	9447.2175	-75695.0925	0.9528	2
42	J	1051549.221	16180.5414	1.0154	9254.5579	-75137.2284	0.9527	2
43	I	1051188.635	16153.2864	1.0154	9162.1682	-75041.874	0.9527	2
43	J	1049094.21	16050.3368	1.0153	8947.64	-74490.2324	0.9528	2
44	I	1049094.21	16014.3157	1.0153	8905.1258	-74490.2324	0.9527	2
44	J	1047345.901	15772.556	1.0151	8661.8652	-74032.6337	0.9526	2
45	I	1047345.901	15739.9128	1.015	8621.4505	-74032.6337	0.9526	2

45	J	1045430.996	15358.4115	1.0147	8363.4053	-73534.4203	0.9524	2
46	I	1045430.996	15331.3191	1.0147	8326.249	-73534.4203	0.9523	2
46	J	1043137.669	14800.7402	1.0142	8067.1776	-72941.8384	0.952	2
47	I	1043137.669	14782.3192	1.0142	8034.8115	-72941.8384	0.9519	2
47	J	1040463.445	14107.4795	1.0136	7791.3228	-72256.4218	0.9516	2
48	I	1040463.445	14100.1372	1.0136	7764.9054	-72256.4218	0.9516	2
48	J	1037405.414	13288.3651	1.0128	7554.8003	-71479.9451	0.9512	2
49	I	1037405.414	13293.6502	1.0128	7534.7894	-71479.9451	0.9512	2
49	J	1033960.307	12354.1123	1.0119	7376.2779	-70614.4398	0.9508	2
50	I	1033960.307	12372.1473	1.012	7362.4469	-70614.4398	0.9508	2
50	J	1030421.259	11316.1675	1.011	7273.0541	-69735.439	0.9504	2
51	I	1030421.257	4258.6472	1.0041	6835.4323	-69735.4385	0.9431	2
51	J	1033960.305	6708.024	1.0065	7098.4147	-70614.4392	0.9451	2
52	I	1033960.305	6673.7176	1.0065	7081.3834	-70614.4392	0.945	2
52	J	1037405.412	8820.1123	1.0085	7395.0544	-71479.9445	0.9467	2
53	I	1037405.412	8785.1303	1.0085	7376.2705	-71479.9445	0.9467	2
53	J	1040463.443	10633.9133	1.0102	7726.0332	-72256.4213	0.9482	2
54	I	1040463.443	10599.7428	1.0102	7705.6304	-72256.4213	0.9481	2
54	J	1043137.667	12157.2932	1.0117	8074.8652	-72941.8379	0.9495	2
55	I	1043137.667	12124.5442	1.0116	8053.0064	-72941.8379	0.9494	2
55	J	1045430.994	13397.13	1.0128	8424.5627	-73534.4197	0.9505	2
56	I	1045430.994	13366.293	1.0128	8401.3903	-73534.4197	0.9505	2
56	J	1047345.899	14361.1042	1.0137	8758.8253	-74032.6332	0.9514	2
57	I	1047345.899	14332.3236	1.0137	8734.7981	-74032.6332	0.9513	2
57	J	1049094.211	15062.3034	1.0144	9063.4728	-74490.2327	0.952	2
58	I	1049094.211	15037.2148	1.0143	9039.6697	-74490.2327	0.9519	2
58	J	1051188.637	15517.2512	1.0148	9326.4735	-75041.8744	0.9522	2
59	I	1051188.637	15498.2304	1.0147	9306.0237	-75041.8744	0.9522	2
59	J	1051549.222	15533.3556	1.0148	9347.7713	-75137.2287	0.9522	2
60	I	1053650.341	16346.6438	1.0155	9610.3571	-75695.0928	0.9528	2
60	J	1052675.954	17053.5744	1.0162	9890.3299	-75435.9093	0.9539	2
61	I	1052675.954	17045.6308	1.0162	9875.1772	-75435.9093	0.9539	2
61	J	1049487.646	17479.1994	1.0167	10080.2595	-74593.5701	0.9552	2
62	I	1049487.646	17474.4106	1.0167	10064.8877	-74593.5701	0.9552	2
62	J	1045940.874	17656.4842	1.0169	10184.2662	-73666.7743	0.9562	2
63	I	1045940.874	17654.7794	1.0169	10168.5177	-73666.7743	0.9562	2
63	J	1045940.878	17696.5125	1.0169	10191.936	-73666.7751	0.9562	2
64	I	1045940.878	17698.2485	1.0169	10176.1748	-73666.7751	0.9562	2
64	J	1049487.649	17597.3636	1.0168	10103.389	-74593.571	0.9553	2
65	I	1049487.649	17603.1884	1.0168	10088.3416	-74593.571	0.9553	2
65	J	1052675.957	17244.0297	1.0164	9929.1234	-75435.9102	0.9542	2
66	I	1052675.957	17255.0605	1.0164	9916.0629	-75435.9102	0.9542	2
66	J	1053650.34	16611.3148	1.0158	9680.7039	-75695.0925	0.9531	2
67	I	1053650.34	16629.6706	1.0158	9672.0476	-75695.0925	0.9531	2
67	J	1051549.221	15813.5117	1.015	9424.848	-75137.2284	0.9525	2
68	I	1051188.635	15774.769	1.015	9390.3052	-75041.874	0.9526	2

68	J	1049094.21	15090.1954	1.0144	9124.8572	-74490.2324	0.9521	2
69	I	1049094.21	15129.7969	1.0144	9132.1721	-74490.2324	0.9521	2
69	J	1047345.901	14161.0372	1.0135	8821.5508	-74032.6337	0.9513	2
70	I	1047345.901	14207.3189	1.0136	8833.0286	-74032.6337	0.9513	2
70	J	1045430.996	12927.8392	1.0124	8489.4424	-73534.4203	0.9501	2
71	I	1045430.996	12978.3427	1.0124	8503.968	-73534.4203	0.9502	2
71	J	1043137.669	11358.2619	1.0109	8140.5082	-72941.8384	0.9488	2
72	I	1043137.669	11410.9798	1.0109	8157.5241	-72941.8384	0.9488	2
72	J	1040463.445	9432.7206	1.0091	7789.8544	-72256.4218	0.9471	2
73	I	1040463.445	9485.1088	1.0091	7808.7431	-72256.4218	0.9472	2
73	J	1037405.414	7131.4107	1.0069	7453.3266	-71479.9451	0.9452	2
74	I	1037405.414	7179.7514	1.0069	7473.0172	-71479.9451	0.9452	2
74	J	1033960.307	4435.3604	1.0043	7145.9781	-70614.4398	0.9429	2
75	I	1033960.307	4473.5584	1.0043	7164.8406	-70614.4398	0.943	2
75	J	1030421.259	1332.0832	1.0013	6880.7832	-69735.439	0.9403	2
76	I	1030421.257	4268.2818	1.0041	6845.2439	-69735.4385	0.9431	2
76	J	1033960.305	6736.044	1.0065	7092.7895	-70614.4392	0.9451	2
77	I	1033960.305	6710.27	1.0065	7085.5233	-70614.4392	0.945	2
77	J	1037405.412	8937.5674	1.0086	7390.4245	-71479.9445	0.9468	2
78	I	1037405.412	8910.4567	1.0086	7382.0009	-71479.9445	0.9468	2
78	J	1040463.443	10897.8162	1.0105	7729.3624	-72256.4213	0.9485	2
79	I	1040463.443	10870.1916	1.0104	7719.4913	-72256.4213	0.9484	2
79	J	1043137.667	12619.651	1.0121	8092.641	-72941.8379	0.9499	2
80	I	1043137.667	12591.809	1.0121	8081.2677	-72941.8379	0.9499	2
80	J	1045430.994	14105.6014	1.0135	8463.0817	-73534.4197	0.9512	2
81	I	1045430.994	14077.9877	1.0135	8450.3151	-73534.4197	0.9512	2
81	J	1047345.899	15359.9044	1.0147	8824.3708	-74032.6332	0.9524	2
82	I	1047345.899	15333.0201	1.0146	8810.7457	-74032.6332	0.9524	2
82	J	1049094.211	16391.1599	1.0156	9162.1422	-74490.2327	0.9534	2
83	I	1049094.211	16366.9523	1.0156	9148.8668	-74490.2327	0.9533	2
83	J	1051188.637	17213.8002	1.0164	9464.3765	-75041.8744	0.954	2
84	I	1051188.637	17194.8158	1.0164	9454.574	-75041.8744	0.954	2
84	J	1051549.222	17298.7585	1.0165	9502.1428	-75137.2287	0.954	2
85	I	1053650.341	17977.152	1.0171	9749.1601	-75695.0928	0.9545	2
85	J	1052675.954	18544.3085	1.0176	9999.5893	-75435.9093	0.9555	2
86	I	1052675.954	18534.9165	1.0176	9995.9552	-75435.9093	0.9554	2
86	J	1049487.646	18863.86	1.018	10175.4657	-74593.5701	0.9566	2
87	I	1049487.646	18856.2599	1.018	10171.4303	-74593.5701	0.9566	2
87	J	1045940.874	18969.6074	1.0181	10269.4091	-73666.7743	0.9575	2
88	I	1045940.874	18963.2155	1.0181	10264.3337	-73666.7743	0.9575	2
88	J	1045940.878	18973.3056	1.0181	10270.6258	-73666.7751	0.9575	2
89	I	1045940.878	18968.0565	1.0181	10264.5029	-73666.7751	0.9575	2
89	J	1049487.649	18874.4377	1.018	10178.9861	-74593.571	0.9566	2
90	I	1049487.649	18870.6627	1.018	10172.3001	-74593.571	0.9566	2
90	J	1052675.957	18560.2226	1.0176	10004.8888	-75435.9102	0.9555	2
91	I	1052675.957	18558.7724	1.0176	9998.7455	-75435.9102	0.9555	2

91	J	1053650.34	18008.5345	1.0171	9759.8299	-75695.0925	0.9545	2
92	I	1053650.34	18011.1738	1.0171	9756.3825	-75695.0925	0.9545	2
92	J	1051549.221	17313.5484	1.0165	9510.237	-75137.2284	0.9541	2
93	I	1051188.635	17251.2191	1.0164	9468.0374	-75041.874	0.954	2
93	J	1049094.21	16423.0737	1.0157	9154.311	-74490.2324	0.9534	2
94	I	1049094.21	16439.8398	1.0157	9162.6262	-74490.2324	0.9534	2
94	J	1047345.901	15397.2154	1.0147	8811.8543	-74032.6337	0.9524	2
95	I	1047345.901	15419.2689	1.0147	8822.8501	-74032.6337	0.9525	2
95	J	1045430.996	14147.5634	1.0135	8447.8801	-73534.4203	0.9513	2
96	I	1045430.996	14173.9577	1.0136	8460.7546	-73534.4203	0.9513	2
96	J	1043137.669	12662.6379	1.0121	8076.0659	-72941.8384	0.95	2
97	I	1043137.669	12693.9684	1.0122	8090.6049	-72941.8384	0.95	2
97	J	1040463.445	10935.4868	1.0105	7712.1646	-72256.4218	0.9485	2
98	I	1040463.445	10972.3864	1.0105	7728.4515	-72256.4218	0.9485	2
98	J	1037405.414	8959.739	1.0086	7372.9176	-71479.9451	0.9468	2
99	I	1037405.414	9002.8395	1.0087	7390.9188	-71479.9451	0.9469	2
99	J	1033960.307	6727.7629	1.0065	7074.4892	-70614.4398	0.9451	2
100	I	1033960.307	6776.5881	1.0066	7093.7702	-70614.4398	0.9451	2
100	J	1030421.259	4232.2879	1.0041	6830.9921	-69735.439	0.9431	2
101	I	1030421.257	4329.8946	1.0042	6852.7727	-69735.4385	0.9432	2
101	J	1033960.305	6574.2564	1.0064	7071.1163	-70614.4392	0.9449	2
102	I	1033960.305	6569.6672	1.0064	7069.6352	-70614.4392	0.9449	2
102	J	1037405.412	8649.7217	1.0083	7353.0639	-71479.9445	0.9465	2
103	I	1037405.412	8643.6708	1.0083	7351.2567	-71479.9445	0.9465	2
103	J	1040463.443	10557.34	1.0101	7684.6749	-72256.4213	0.9481	2
104	I	1040463.443	10550.2492	1.0101	7682.302	-72256.4213	0.9481	2
104	J	1043137.667	12295.9225	1.0118	8049.0732	-72941.8379	0.9496	2
105	I	1043137.667	12287.7735	1.0118	8046.0403	-72941.8379	0.9496	2
105	J	1045430.994	13862.6998	1.0133	8429.0599	-73534.4197	0.951	2
106	I	1045430.994	13853.6064	1.0133	8425.3498	-73534.4197	0.951	2
106	J	1047345.899	15255.406	1.0146	8808.0144	-74032.6332	0.9523	2
107	I	1047345.899	15245.4314	1.0146	8803.7738	-74032.6332	0.9523	2
107	J	1049094.211	16474.4729	1.0157	9170.6252	-74490.2327	0.9534	2
108	I	1049094.211	16464.5881	1.0157	9165.9914	-74490.2327	0.9534	2
108	J	1051188.637	17527.0173	1.0167	9503.1613	-75041.8744	0.9543	2
109	I	1051188.637	17517.4422	1.0167	9498.5893	-75041.8744	0.9543	2
109	J	1051549.222	17665.1856	1.0168	9550.7789	-75137.2287	0.9544	2
110	I	1053650.341	18240.5862	1.0173	9777.1437	-75695.0928	0.9548	2
110	J	1052675.954	18694.9167	1.0178	10004.525	-75435.9093	0.9556	2
111	I	1052675.954	18685.6727	1.0178	9999.7425	-75435.9093	0.9556	2
111	J	1049487.646	18943.6301	1.0181	10161.2048	-74593.5701	0.9567	2
112	I	1049487.646	18934.3852	1.018	10155.8911	-74593.5701	0.9566	2
112	J	1045940.874	19020.8619	1.0182	10241.7386	-73666.7743	0.9575	2
113	I	1045940.874	19011.5951	1.0182	10235.8096	-73666.7743	0.9575	2
113	J	1045940.878	19040.6163	1.0182	10236.5557	-73666.7751	0.9576	2
114	I	1045940.878	19031.5	1.0182	10230.1188	-73666.7751	0.9575	2

114	J	1049487.649	19003.1663	1.0181	10145.8634	-74593.571	0.9567	2
115	I	1049487.649	18994.5903	1.0181	10139.2184	-74593.571	0.9567	2
115	J	1052675.957	18795.0559	1.0179	9979.6189	-75435.9102	0.9557	2
116	I	1052675.957	18787.6402	1.0178	9973.27	-75435.9102	0.9557	2
116	J	1053650.34	18392.1204	1.0175	9748.1494	-75695.0925	0.9549	2
117	I	1053650.34	18386.7058	1.0175	9742.8245	-75695.0925	0.9549	2
117	J	1051549.221	17852.2544	1.017	9512.6424	-75137.2284	0.9546	2
118	I	1051188.635	17726.446	1.0169	9458.2144	-75041.874	0.9545	2
118	J	1049094.21	16737.1805	1.016	9128.3089	-74490.2324	0.9537	2
119	I	1049094.21	16738.2702	1.016	9127.2529	-74490.2324	0.9537	2
119	J	1047345.901	15574.7627	1.0149	8767.3183	-74032.6337	0.9526	2
120	I	1047345.901	15580.0189	1.0149	8768.5133	-74032.6337	0.9526	2
120	J	1045430.996	14228.549	1.0136	8391.7539	-73534.4203	0.9513	2
121	I	1045430.996	14237.8956	1.0136	8395.5211	-73534.4203	0.9513	2
121	J	1043137.669	12688.5553	1.0122	8016.5946	-72941.8384	0.9499	2
122	I	1043137.669	12702.8187	1.0122	8023.2272	-72941.8384	0.9499	2
122	J	1040463.445	10944.3491	1.0105	7657.7208	-72256.4218	0.9484	2
123	I	1040463.445	10964.0839	1.0105	7667.5269	-72256.4218	0.9485	2
123	J	1037405.414	8982.1369	1.0087	7331.3668	-71479.9451	0.9468	2
124	I	1037405.414	9007.5319	1.0087	7344.3963	-71479.9451	0.9469	2
124	J	1033960.307	6781.796	1.0066	7052.7826	-70614.4398	0.9451	2
125	I	1033960.307	6811.4338	1.0066	7068.5329	-70614.4398	0.9451	2
125	J	1030421.259	4317.0074	1.0042	6834.7806	-69735.439	0.9431	2
126	I	1030421.257	4354.0944	1.0042	6864.2063	-69735.4385	0.9432	2
126	J	1033960.305	6588.3174	1.0064	7081.3722	-70614.4392	0.9449	2
127	I	1033960.305	6599.7344	1.0064	7088.8244	-70614.4392	0.9449	2
127	J	1037405.412	8667.1189	1.0084	7370.8671	-71479.9445	0.9466	2
128	I	1037405.412	8677.7051	1.0084	7378.6673	-71479.9445	0.9466	2
128	J	1040463.443	10574.3744	1.0102	7710.3618	-72256.4213	0.9481	2
129	I	1040463.443	10584.5644	1.0102	7718.3323	-72256.4213	0.9481	2
129	J	1043137.667	12307.7357	1.0118	8082.9054	-72941.8379	0.9496	2
130	I	1043137.667	12317.4063	1.0118	8090.9892	-72941.8379	0.9496	2
130	J	1045430.994	13863.7451	1.0133	8471.186	-73534.4197	0.951	2
131	I	1045430.994	13872.7453	1.0133	8479.3279	-73534.4197	0.951	2
131	J	1047345.899	15239.8919	1.0146	8858.3985	-74032.6332	0.9523	2
132	I	1047345.899	15247.8523	1.0146	8866.5525	-74032.6332	0.9523	2
132	J	1049094.211	16436.656	1.0157	9228.8817	-74490.2327	0.9535	2
133	I	1049094.211	16443.7805	1.0157	9236.716	-74490.2327	0.9535	2
133	J	1051188.637	17463.2013	1.0166	9568.6006	-75041.8744	0.9543	2
134	I	1051188.637	17468.5936	1.0166	9575.5577	-75041.8744	0.9543	2
134	J	1051549.222	17609.1973	1.0167	9626.8212	-75137.2287	0.9544	2
135	I	1053650.341	18175.5861	1.0173	9862.291	-75695.0928	0.9548	2
135	J	1052675.954	18603.2993	1.0177	10083.0539	-75435.9093	0.9556	2
136	I	1052675.954	18605.331	1.0177	10088.4327	-75435.9093	0.9556	2
136	J	1049487.646	18830.4864	1.0179	10241.7661	-74593.5701	0.9566	2
137	I	1049487.646	18831.8358	1.0179	10246.8998	-74593.5701	0.9566	2

137	J	1045940.874	18877.3752	1.018	10322.7834	-73666.7743	0.9575	2
138	I	1045940.874	18878.3805	1.018	10327.7487	-73666.7743	0.9575	2
138	J	1045940.878	18857.3988	1.018	10316.4995	-73666.7751	0.9575	2
139	I	1045940.878	18858.417	1.018	10321.3841	-73666.7751	0.9575	2
139	J	1049487.649	18770.7737	1.0179	10223.1143	-74593.571	0.9566	2
140	I	1049487.649	18772.25	1.0179	10228.0679	-74593.571	0.9566	2
140	J	1052675.957	18504.3692	1.0176	10052.6554	-75435.9102	0.9555	2
141	I	1052675.957	18506.8332	1.0176	10057.8722	-75435.9102	0.9555	2
141	J	1053650.34	18034.7219	1.0171	9815.4858	-75695.0925	0.9546	2
142	I	1053650.34	18038.6834	1.0171	9821.0894	-75695.0925	0.9546	2
142	J	1051549.221	17435.045	1.0166	9575.8385	-75137.2284	0.9542	2
143	I	1051188.635	17253.3178	1.0164	9529.3245	-75041.874	0.9541	2
143	J	1049094.21	16092.4049	1.0153	9178.1123	-74490.2324	0.9531	2
144	I	1049094.21	16100.9691	1.0153	9185.5647	-74490.2324	0.9531	2
144	J	1047345.901	14748.8423	1.0141	8803.3988	-74032.6337	0.9518	2
145	I	1047345.901	14760.9098	1.0141	8812.988	-74032.6337	0.9518	2
145	J	1045430.996	13191.775	1.0126	8412.4391	-73534.4203	0.9503	2
146	I	1045430.996	13206.8754	1.0126	8424.6564	-73534.4203	0.9504	2
146	J	1043137.669	11401.1741	1.0109	8020.1957	-72941.8384	0.9487	2
147	I	1043137.669	11419.1071	1.0109	8035.1758	-72941.8384	0.9487	2
147	J	1040463.445	9356.6792	1.009	7642.0747	-72256.4218	0.9469	2
148	I	1040463.445	9376.3993	1.009	7659.649	-72256.4218	0.9469	2
148	J	1037405.414	7034.2293	1.0068	7293.3478	-71479.9451	0.9449	2
149	I	1037405.414	7053.4674	1.0068	7312.7948	-71479.9451	0.9449	2
149	J	1033960.307	4403.4334	1.0043	6987.7398	-70614.4398	0.9427	2
150	I	1033960.307	4417.5204	1.0043	7007.6646	-70614.4398	0.9428	2
150	J	1030421.259	1426.365	1.0014	6735.8185	-69735.439	0.9402	2
151	I	1030421.257	4391.0539	1.0043	6875.2755	-69735.4385	0.9433	2
151	J	1033960.305	6686.789	1.0065	7098.0118	-70614.4392	0.945	2
152	I	1033960.305	6713.4391	1.0065	7115.7175	-70614.4392	0.9451	2
152	J	1037405.412	8856.4481	1.0085	7405.2232	-71479.9445	0.9468	2
153	I	1037405.412	8883.0158	1.0086	7424.5292	-71479.9445	0.9468	2
153	J	1040463.443	10869.4943	1.0104	7765.9585	-72256.4213	0.9485	2
154	I	1040463.443	10895.9923	1.0105	7786.7417	-72256.4213	0.9485	2
154	J	1043137.667	12721.8603	1.0122	8163.4604	-72941.8379	0.9501	2
155	I	1043137.667	12747.8214	1.0122	8185.6628	-72941.8379	0.9501	2
155	J	1045430.994	14406.996	1.0138	8580.2602	-73534.4197	0.9516	2
156	I	1045430.994	14432.0304	1.0138	8603.7828	-73534.4197	0.9517	2
156	J	1047345.899	15918.2282	1.0152	8999.0475	-74032.6332	0.9531	2
157	I	1047345.899	15941.5605	1.0152	9023.5321	-74032.6332	0.9532	2
157	J	1049094.211	17249.9679	1.0164	9402.9877	-74490.2327	0.9544	2
158	I	1049094.211	17271.5977	1.0165	9427.7422	-74490.2327	0.9544	2
158	J	1051188.637	18406.1667	1.0175	9776.7675	-75041.8744	0.9554	2
159	I	1051188.637	18424.3034	1.0175	9800.1687	-75041.8744	0.9555	2
159	J	1051549.222	18582.8072	1.0177	9854.1649	-75137.2287	0.9556	2
160	I	1053650.341	19130.4833	1.0182	10101.9112	-75695.0928	0.9559	2

160	J	1052675.954	19500.4752	1.0185	10313.9667	-75435.9093	0.9567	2
161	I	1052675.954	19511.8928	1.0185	10335.7324	-75435.9093	0.9567	2
161	J	1049487.646	19673.3489	1.0187	10478.3308	-74593.5701	0.9577	2
162	I	1049487.646	19682.9553	1.0188	10501.2198	-74593.5701	0.9577	2
162	J	1045940.874	19660.6335	1.0188	10564.241	-73666.7743	0.9585	2
163	I	1045940.874	19668.6121	1.0188	10588.6319	-73666.7743	0.9585	2
163	J	1045940.878	19576.7652	1.0187	10562.0779	-73666.7751	0.9584	2
164	I	1045940.878	19583.0731	1.0187	10588.0042	-73666.7751	0.9584	2
164	J	1049487.649	19422.2456	1.0185	10471.7511	-74593.571	0.9574	2
165	I	1049487.649	19426.6931	1.0185	10498.9765	-74593.571	0.9574	2
165	J	1052675.957	19083.6734	1.0181	10302.7906	-75435.9102	0.9563	2
166	I	1052675.957	19085.8149	1.0181	10330.7135	-75435.9102	0.9563	2
166	J	1053650.34	18536.9209	1.0176	10064.5411	-75695.0925	0.9553	2
167	I	1053650.34	18535.738	1.0176	10091.8637	-75695.0925	0.9553	2
167	J	1051549.221	17867.446	1.017	9824.2143	-75137.2284	0.9549	2
168	I	1051188.635	17663.0008	1.0168	9786.0222	-75041.874	0.9547	2
168	J	1049094.21	16361.2638	1.0156	9362.866	-74490.2324	0.9535	2
169	I	1049094.21	16350.8039	1.0156	9385.7634	-74490.2324	0.9535	2
169	J	1047345.901	14887.1316	1.0142	8932.4544	-74032.6337	0.9521	2
170	I	1047345.901	14875.2501	1.0142	8954.8791	-74032.6337	0.9521	2
170	J	1045430.996	13249.4072	1.0127	8485.8312	-73534.4203	0.9505	2
171	I	1045430.996	13236.1171	1.0127	8508.0791	-73534.4203	0.9505	2
171	J	1043137.669	11467.5054	1.011	8040.9006	-72941.8384	0.9488	2
172	I	1043137.669	11454.842	1.011	8062.6959	-72941.8384	0.9488	2
172	J	1040463.445	9558.1715	1.0092	7615.0381	-72256.4218	0.9471	2
173	I	1040463.445	9547.4506	1.0092	7635.9612	-72256.4218	0.9471	2
173	J	1037405.414	7542.7126	1.0073	7225.9989	-71479.9451	0.9453	2
174	I	1037405.414	7535.8789	1.0073	7245.5669	-71479.9451	0.9453	2
174	J	1033960.307	5445.1361	1.0053	6890.9657	-70614.4398	0.9436	2
175	I	1033960.307	5444.3992	1.0053	6908.7095	-70614.4398	0.9437	2
175	J	1030421.259	3292.0217	1.0032	6625.6975	-69735.439	0.9419	2
176	I	1030421.257	4262.8739	1.0041	6780.0831	-69735.4385	0.943	2
176	J	1033960.305	7387.1253	1.0071	7104.7275	-70614.4392	0.9457	2
177	I	1033960.305	7362.7599	1.0071	7098.4613	-70614.4392	0.9457	2
177	J	1037405.412	10189.5339	1.0098	7474.587	-71479.9445	0.9481	2
178	I	1037405.412	10166.8013	1.0098	7468.9605	-71479.9445	0.9481	2
178	J	1040463.443	12697.6891	1.0122	7882.8506	-72256.4213	0.9503	2
179	I	1040463.443	12677.8826	1.0122	7878.3564	-72256.4213	0.9503	2
179	J	1043137.667	14916.046	1.0143	8313.7967	-72941.8379	0.9523	2
180	I	1043137.667	14900.0389	1.0143	8310.8946	-72941.8379	0.9523	2
180	J	1045430.994	16848.3121	1.0161	8750.5957	-73534.4197	0.9541	2
181	I	1045430.994	16836.8004	1.0161	8749.7639	-73534.4197	0.9541	2
181	J	1047345.899	18498.9774	1.0177	9176.6936	-74032.6332	0.9557	2
182	I	1047345.899	18492.359	1.0177	9178.7431	-74032.6332	0.9557	2
182	J	1049094.211	19876.7341	1.0189	9577.1316	-74490.2327	0.9571	2
183	I	1049094.211	19876.3291	1.0189	9582.5667	-74490.2327	0.9571	2

183	J	1051188.637	20998.7154	1.02	9938.6522	-75041.8744	0.958	2
184	I	1051188.637	21005.0411	1.02	9948.9729	-75041.8744	0.9581	2
184	J	1051549.222	21148.0217	1.0201	10002.3744	-75137.2287	0.9582	2
185	I	1053650.341	21864.8421	1.0208	10281.2015	-75695.0928	0.9587	2
185	J	1052675.954	22421.6792	1.0213	10532.2867	-75435.9093	0.9596	2
186	I	1052675.954	22441.6934	1.0213	10552.6534	-75435.9093	0.9597	2
186	J	1049487.646	22707.4696	1.0216	10723.8079	-74593.5701	0.9608	2
187	I	1049487.646	22732.6089	1.0217	10746.7268	-74593.5701	0.9608	2
187	J	1045940.874	22729.9358	1.0217	10827.0423	-73666.7743	0.9617	2
188	I	1045940.874	22759.2228	1.0218	10851.2425	-73666.7743	0.9617	2
188	J	1045940.878	22601.2729	1.0216	10830.3483	-73666.7751	0.9615	2
189	I	1045940.878	22633.6102	1.0216	10854.6741	-73666.7751	0.9616	2
189	J	1049487.649	22321.9252	1.0213	10732.7827	-74593.571	0.9604	2
190	I	1049487.649	22356.0111	1.0213	10756.1619	-74593.571	0.9605	2
190	J	1052675.957	21780.3762	1.0207	10544.0985	-75435.9102	0.959	2
191	I	1052675.957	21814.707	1.0207	10565.589	-75435.9102	0.9591	2
191	J	1053650.34	20955.194	1.0199	10274.7585	-75695.0925	0.9578	2
192	I	1053650.34	20988.1456	1.0199	10293.6627	-75695.0925	0.9578	2
192	J	1051549.221	20000.3201	1.019	9999.4801	-75137.2284	0.9571	2
193	I	1051188.635	19855.8365	1.0189	9964.7925	-75041.874	0.957	2
193	J	1049094.21	18597.0653	1.0177	9594.7372	-74490.2324	0.9559	2
194	I	1049094.21	18622.3654	1.0178	9606.8533	-74490.2324	0.9559	2
194	J	1047345.901	17137.7878	1.0164	9198.7863	-74032.6337	0.9545	2
195	I	1047345.901	17155.7297	1.0164	9204.0424	-74032.6337	0.9545	2
195	J	1045430.996	15450.5859	1.0148	8773.9741	-73534.4203	0.9528	2
196	I	1045430.996	15457.697	1.0148	8770.7827	-73534.4203	0.9528	2
196	J	1043137.669	13548.998	1.013	8336.917	-72941.8384	0.9511	2
197	I	1043137.669	13543.2232	1.013	8323.8264	-72941.8384	0.951	2
197	J	1040463.445	11453.4886	1.011	7905.3061	-72256.4218	0.9492	2
198	I	1040463.445	11433.4999	1.011	7882.0218	-72256.4218	0.9491	2
198	J	1037405.414	9187.7397	1.0089	7498.0179	-71479.9451	0.9472	2
199	I	1037405.414	9153.9215	1.0088	7465.6247	-71479.9451	0.9471	2
199	J	1033960.307	6778.1764	1.0066	7133.9469	-70614.4398	0.9452	2
200	I	1033960.307	6733.7948	1.0065	7095.7	-70614.4398	0.9451	2
200	J	1030421.259	4256.425	1.0041	6831.4351	-69735.439	0.9431	2
214	I	1030421.257	4182.1271	1.0041	5956.6448	-69735.4385	0.9422	2
214	J	1033960.305	6716.977	1.0065	6333.0218	-70614.4392	0.9443	2
215	I	1033960.305	6440.4148	1.0062	6086.1163	-70614.4392	0.9438	2
215	J	1037405.412	8956.9601	1.0086	6532.3156	-71479.9445	0.946	2
216	I	1037405.412	8759.144	1.0084	6337.53	-71479.9445	0.9456	2
216	J	1040463.443	11313.4335	1.0109	6847.7441	-72256.4213	0.948	2
217	I	1040463.443	11165.7774	1.0107	6688.4457	-72256.4213	0.9477	2
217	J	1043137.667	13772.2287	1.0132	7251.7849	-72941.8379	0.9502	2
218	I	1043137.667	13655.071	1.0131	7116.8371	-72941.8379	0.95	2
218	J	1045430.994	16308.6764	1.0156	7719.8154	-73534.4197	0.9526	2
219	I	1045430.994	16209.4276	1.0155	7602.5089	-73534.4197	0.9524	2

219	J	1047345.899	18900.8318	1.018	8230.9173	-74032.6332	0.9552	2
220	I	1047345.899	18813.2204	1.018	8128.3773	-74032.6332	0.955	2
220	J	1049094.211	21538.924	1.0205	8768.6545	-74490.2327	0.9579	2
221	I	1049094.211	21463.0184	1.0205	8682.0973	-74490.2327	0.9577	2
221	J	1051188.637	24239.227	1.0231	9323.411	-75041.8744	0.9605	2
222	I	1051188.637	24187.1081	1.023	9256.4556	-75041.8744	0.9604	2
222	J	1051549.222	24650.4491	1.0234	9363.4223	-75137.2287	0.9609	2
223	I	1053650.341	25266.8191	1.024	9503.309	-75695.0928	0.9612	2
223	J	1052675.954	25593.6612	1.0243	9719.625	-75435.9093	0.9619	2
224	I	1052675.954	25572.7626	1.0243	9676.357	-75435.9093	0.9618	2
224	J	1049487.646	25808.3348	1.0246	9840.4556	-74593.5701	0.9629	2
225	I	1049487.646	25788.4745	1.0246	9806.0707	-74593.5701	0.9628	2
225	J	1045940.874	25924.3631	1.0248	9906.0847	-73666.7743	0.9638	2
226	I	1045940.874	25904.0461	1.0248	9881.1682	-73666.7743	0.9638	2
226	J	1045940.878	26034.3787	1.0249	9907.0034	-73666.7751	0.9639	2
227	I	1045940.878	26013.7752	1.0249	9892.3595	-73666.7751	0.9639	2
227	J	1049487.649	26136.3736	1.0249	9843.6322	-74593.571	0.9632	2
228	I	1049487.649	26117.1858	1.0249	9840.5155	-74593.571	0.9632	2
228	J	1052675.957	26133.5261	1.0248	9726.5253	-75435.9102	0.9624	2
229	I	1052675.957	26119.3069	1.0248	9736.534	-75435.9102	0.9624	2
229	J	1053650.34	26033.3085	1.0247	9568.2379	-75695.0925	0.9619	2
230	I	1053650.34	26032.0786	1.0247	9593.6691	-75695.0925	0.962	2
230	J	1051549.221	25851.5386	1.0246	9419.6845	-75137.2284	0.9621	2
231	I	1051188.635	25186.4045	1.024	9377.3335	-75041.874	0.9615	2
231	J	1049094.21	22385.3362	1.0213	8731.2673	-74490.2324	0.9587	2
232	I	1049094.21	22450.1189	1.0214	8806.4222	-74490.2324	0.9588	2
232	J	1047345.901	19672.3031	1.0188	8157.3689	-74032.6337	0.9559	2
233	I	1047345.901	19757.7548	1.0189	8256.294	-74032.6337	0.9561	2
233	J	1045430.996	16978.0812	1.0162	7613.8891	-73534.4203	0.9532	2
234	I	1045430.996	17084.8411	1.0163	7736.1173	-73534.4203	0.9534	2
234	J	1043137.669	14302.6389	1.0137	7113.244	-72941.8384	0.9506	2
235	I	1043137.669	14437.0212	1.0138	7261.76	-72941.8384	0.9509	2
235	J	1040463.445	11663.6071	1.0112	6672.5835	-72256.4218	0.9482	2
236	I	1040463.445	11837.0042	1.0114	6853.4188	-72256.4218	0.9485	2
236	J	1037405.414	9090.8317	1.0088	6312.4586	-71479.9451	0.9459	2
237	I	1037405.414	9319.7926	1.009	6534.9153	-71479.9451	0.9464	2
237	J	1033960.307	6618.0813	1.0064	6055.7457	-70614.4398	0.944	2
238	I	1033960.307	6925.7348	1.0067	6333.0045	-70614.4398	0.9445	2
238	J	1030421.259	4253.9354	1.0041	5925.4771	-69735.439	0.9422	2
1087	I	1051549.221	19994.3807	1.019	10004.6797	-75137.2284	0.9571	2
1087	J	1051188.635	19825.7812	1.0189	9948.6093	-75041.874	0.9569	2
1088	I	1051549.221	17857.3026	1.017	9828.0614	-75137.2284	0.9549	2
1088	J	1051188.635	17669.5266	1.0168	9761.572	-75041.874	0.9547	2
1089	I	1051549.221	17410.9256	1.0166	9577.9861	-75137.2284	0.9542	2
1089	J	1051188.635	17247.6116	1.0164	9523.4102	-75041.874	0.9541	2
1090	I	1051549.221	17864.1103	1.017	9512.5873	-75137.2284	0.9546	2

1090	J	1051188.635	17728.974	1.0169	9461.5866	-75041.874	0.9545	2
1091	I	1051549.221	17342.0344	1.0165	9512.1707	-75137.2284	0.9541	2
1091	J	1051188.635	17241.2912	1.0164	9465.0083	-75041.874	0.954	2
1092	I	1051549.221	15811.8675	1.015	9427.9844	-75137.2284	0.9525	2
1092	J	1051188.635	15745.2047	1.015	9390.1582	-75041.874	0.9525	2
1093	I	1051549.221	16182.7727	1.0154	9240.4956	-75137.2284	0.9527	2
1093	J	1051188.635	16193.1559	1.0154	9208.6849	-75041.874	0.9528	2
1094	I	1051549.221	25618.1698	1.0244	9435.3796	-75137.2284	0.9619	2
1094	J	1051188.635	25153.6325	1.0239	9328.1277	-75041.874	0.9614	2
1095	I	1051549.222	21106.5424	1.0201	10002.3952	-75137.2287	0.9581	2
1095	J	1053650.341	21851.0392	1.0207	10264.933	-75695.0928	0.9586	2
1096	I	1051549.222	18593.7095	1.0177	9858.1649	-75137.2287	0.9556	2
1096	J	1053650.341	19116.5674	1.0181	10080.3159	-75695.0928	0.9559	2
1097	I	1051549.222	17608.6441	1.0167	9628.7393	-75137.2287	0.9544	2
1097	J	1053650.341	18172.3799	1.0172	9856.4592	-75695.0928	0.9548	2
1098	I	1051549.222	17666.4088	1.0168	9549.2027	-75137.2287	0.9544	2
1098	J	1053650.341	18249.9731	1.0173	9781.6504	-75695.0928	0.9548	2
1099	I	1051549.222	17279.091	1.0164	9499.0114	-75137.2287	0.954	2
1099	J	1053650.341	17989.839	1.0171	9754.1096	-75695.0928	0.9545	2
1100	I	1051549.222	15502.797	1.0147	9343.7228	-75137.2287	0.9522	2
1100	J	1053650.341	16358.7397	1.0155	9626.4979	-75695.0928	0.9528	2
1101	I	1051549.222	14763.538	1.014	9261.313	-75137.2287	0.9514	2
1101	J	1053650.341	15471.4454	1.0147	9527.6379	-75695.0928	0.9519	2
1102	I	1051549.222	24926.3289	1.0237	9344.0029	-75137.2287	0.9611	2
1102	J	1053650.341	25294.2432	1.024	9555.2547	-75695.0928	0.9612	2

4 COMBINAZIONE DEI CARICHI

4.1 GENERALITA'

Ai fini delle verifiche degli stati limite, il punto 2.5.3 del D.M. 2018 definisce le seguenti tipologie di combinazione delle azioni:

- Combinazione fondamentale (SLU), generalmente impiegata per gli stati limiti ultimi:

$$\gamma_{G1} \cdot G_1 + \gamma_{G2} \cdot G_2 + \gamma_P \cdot P + \gamma_{Q1} \cdot Q_{K1} + \sum_{i>1} \gamma_{Q,i} \cdot \psi_{0,i} \cdot Q_{K,i}$$

- Combinazione caratteristica (SLE rara), generalmente impiegata per gli stati limiti di esercizio irreversibili:

$$G_1 + G_2 + P + Q_{K1} + \sum_{i>1} \psi_{0,i} \cdot Q_{K,i}$$

- Combinazione frequente (SLE frequente), generalmente impiegata per gli stati limiti di esercizio reversibili:

$$G_1 + G_2 + P + \sum_{i \geq 1} \psi_{1,i} \cdot Q_{K,i}$$

- Combinazione quasi permanente (SLE quasi permanente), generalmente impiegata per gli effetti a lungo termine:

$$G_1 + G_2 + P + \sum_{i \geq 1} \psi_{2,i} \cdot Q_{K,i}$$

- Combinazione sismica (SLV), impiegata per gli stati limite ultimi connessi all'azione sismica E:

$$E + G_1 + G_2 + P + \sum_{i \geq 1} \psi_{2,i} \cdot Q_{K,i}$$

- Combinazione eccezionale (ECC), impiegata per gli stati limite ultimi connessi alle azioni eccezionali di progetto A_d:

$$G_1 + G_2 + P + A_d + \sum_{i \geq 1} \psi_{2,i} \cdot Q_{K,i}$$

Nelle precedenti relazioni, si è utilizzato il significato dei seguenti simboli:

- G_1 valore caratteristico delle azioni permanenti;
- G_2 valore caratteristico delle azioni permanenti non strutturali;
- P valore caratteristico dell'azione di pre-tensione o pre-compressione;
- Q_{K1} valore caratteristico dell'azione variabile di base di ogni combinazione;
- $Q_{K,i}$ valore caratteristico dell'azione variabile i ;
- γ_{G1} coefficiente parziale per le azioni permanenti;
- γ_{G2} coefficiente parziale per le azioni permanenti non strutturali;
- γ_P coefficiente parziale per le azioni di pre-tensione o pre-compressione;
- γ_{Q1} coefficiente parziale per l'azione variabile di base di ogni combinazione;
- $\gamma_{Q,i}$ coefficiente parziale per l'azione variabile i ;
- $\psi_{i,i}$ coefficienti di combinazione per i vari stati limite, descritti nella seguente tabella;
- + combinato con.

Con riferimento ai carichi variabili da traffico, si utilizzano i coefficienti di combinazione di cui alla tabella 5.1.VI del D.M. 2018.

Azioni	Effetto del Carico	ψ_0 di combinazione	ψ_1 frequenti	ψ_2 quasi permanenti
Azioni da traffico	Gruppo 1 - Schema 1 (carichi tandem)	0.75	0.75	0.0
	Gruppo 1 - Schema 1 (carichi distribuiti)	0.4	0.4	0.0
	Gruppo 1 - Schema 2	0.0	0.75	0.0
	Gruppo 2a	0.0	0.0	0.0
	Gruppo 4 (folla)	0.0	0.75	0.0
Azioni del vento	$q_{5,v}$ - Ponte scarico esecuzione	0.8	0.0	0.0
	$q_{5,v}$ - Ponte scarico SLU e SLE	0.6	0.2	0.0
	$q_{5,v}$ - Ponte carico	0.6	0.0	0.0
Azioni termiche	T_k	0.6	0.6	0.5

Tabella 4.1: estratto della tabella 5.1.VI del D.M. 2018 relativo ai soli carichi presenti sulle strutture in esame - coefficienti di combinazione delle azioni variabili per ponti stradali e pedonali

4.2 STATO LIMITE ULTIMO

Nelle verifiche agli stati limite ultimi si considerano i seguenti casi:

- **STR** Stato limite di resistenza degli elementi strutturali

Tipi di Carico	Effetto del Carico	Coefficiente γ_F	EQU ⁽¹⁾	A1 STR	A2 GEO
Permanenti	Favorevoli	γ_{G1}	0.90	1.00	1.00
	Sfavorevoli		1.10	1.35	1.00
Permanenti non Strutturali ⁽²⁾	Favorevoli	γ_{G2}	0.00	0.00	0.00
	Sfavorevoli		1.50	1.50	1.30
Variabili da traffico	Favorevoli	γ_Q	0.00	0.00	0.00
	Sfavorevoli		1.35	1.35	1.15
Variabili	Favorevoli	γ_{Qi}	0.00	0.00	0.00
	Sfavorevoli		1.50	1.50	1.30
Ritiro e Viscosità Variazioni termiche	Favorevoli	$\gamma_{\epsilon 2}, \gamma_{\epsilon 3}$	0.00	0.00	0.00
	Sfavorevoli		1.20	1.20	1.20

⁽¹⁾ equilibrio che non coinvolga parametri di deformabilità e resistenza del terreno; altrimenti si applicano i valori di GEO;

⁽²⁾ nel caso in cui i carichi permanenti non strutturali (es.: carichi permanenti portati) siano compiutamente definiti, si potranno adottare gli stessi coefficienti validi per le azioni permanenti.

Tabella 4.2: tabella 2.6.I del D.M. 2018 - coefficienti parziali per le azioni o l'effetto delle azioni nelle verifiche a SLU.

5 MODELLAZIONE FEM

Le analisi numeriche sono svolte mediante il codice di calcolo ad elementi finiti Midas Civil 2020, sviluppato dalla società MIDAS Information Technology Co., Ltd. (Seongnam, Gyeonggi-do, 463-824, Korea).

5.1 FASI DI CALCOLO

Il programma di calcolo esegue un'analisi per fasi attivando progressivamente gli elementi strutturali che entrano in gioco e considerando gli effetti differiti nel tempo dovuti a ritiro e fluage del calcestruzzo dall'istante in cui esso viene gettato, coinvolgendo gli elementi strutturali che da quel momento saranno presenti nella struttura.

Si distinguono le seguenti fasi di riferimento:

fase 0: descrive la situazione esistente rappresentata dalle travi in cap e dalla trave in misto acciaio-calcestruzzo realizzata durante il primo ampliamento.

fase 1: varo delle cinque travi longitudinali in misto acciaio-calcestruzzo, delle traverse metalliche e successivo getto della soletta; in questo modello la soletta non è ancora reagente. Durata della fase 2 giorni.

fase 2: viene attivata la sezione composta acciaio-calcestruzzo ed anno inizio gli effetti di ritiro e fluage del calcestruzzo su tutti gli elementi strutturali. Durata della fase 28 giorni.

fase 3: vengono applicati i carichi permanenti e variabili dopo 36500 giorni, cioè quando gli effetti differiti sono sostanzialmente terminati.

5.2 MODELLI STRUTTURALI

I modelli strutturali di calcolo sono rappresentati nelle figure seguenti e riflettono le fasi sopra descritte. Si specifica che, per simmetria, si è scelto di semplificare il modello considerando una sola campata e metà impalcato in direzione trasversale.

Le travi longitudinali, i correnti superiori e i correnti inferiori dei traversi sono stati modellati mediante elementi beam a due nodi i e j. Ciascuno caratterizzato da sei gradi di libertà (tre traslazionali e tre rotazionali).

I traversi sono connessi alle travi principali. Tuttavia i traversi metallici delle travi in ampliamento sono stati svincolati mediante dei *beam end relase*.

Anche le aste di soletta, opportunamente collegate alle travi longitudinali mediante link rigidi, sono rappresentate da elementi beam di sezione rettangolare.

Lungo i cordoli e sulle estremità delle aste di soletta sono stati introdotti degli elementi Beam "fittizi" (caratterizzati da un materiale con peso nullo e modulo di elasticità trascurabile), il cui unico scopo è quello di permettere l'assegnazione dei carichi permanenti (quali barriere, cordoli, ecc.).

A livello geometrico, si considera come piano di riferimento quello degli appoggi associando pertanto opportuni "offset" sezionali per modellare le corrette posizioni dei baricentri dei vari elementi. Convenzionalmente si adotta il seguente sistema di riferimento

- asse X = asse orizzontale longitudinale
- asse Y = asse orizzontale trasversale
- asse Z = asse verticale

I carichi sono modellati come:

- forze/coppie nodali
- forze/coppie per unità di lunghezza
- gradienti termici uniformi

Per quanto riguarda i carichi da traffico, il software impiegato consente di simulare l'effetto di un carico viaggiante (*vehicle*) lungo apposite corsie (*lane*), massimizzando gli effetti in tutti gli elementi modellati.

Infine sono stati definiti dei vincoli di tipo fisso e multidirezionale, secondo lo schema statico di progetto.

Si specifica che è stato realizzato un modello globale, che comprende le strutture esistenti e quelle del nuovo ampliamento. Tuttavia in questa relazione ci si focalizza sulle strutture originarie risalenti al 1964 e a quelle del primo ampliamento del 2004.

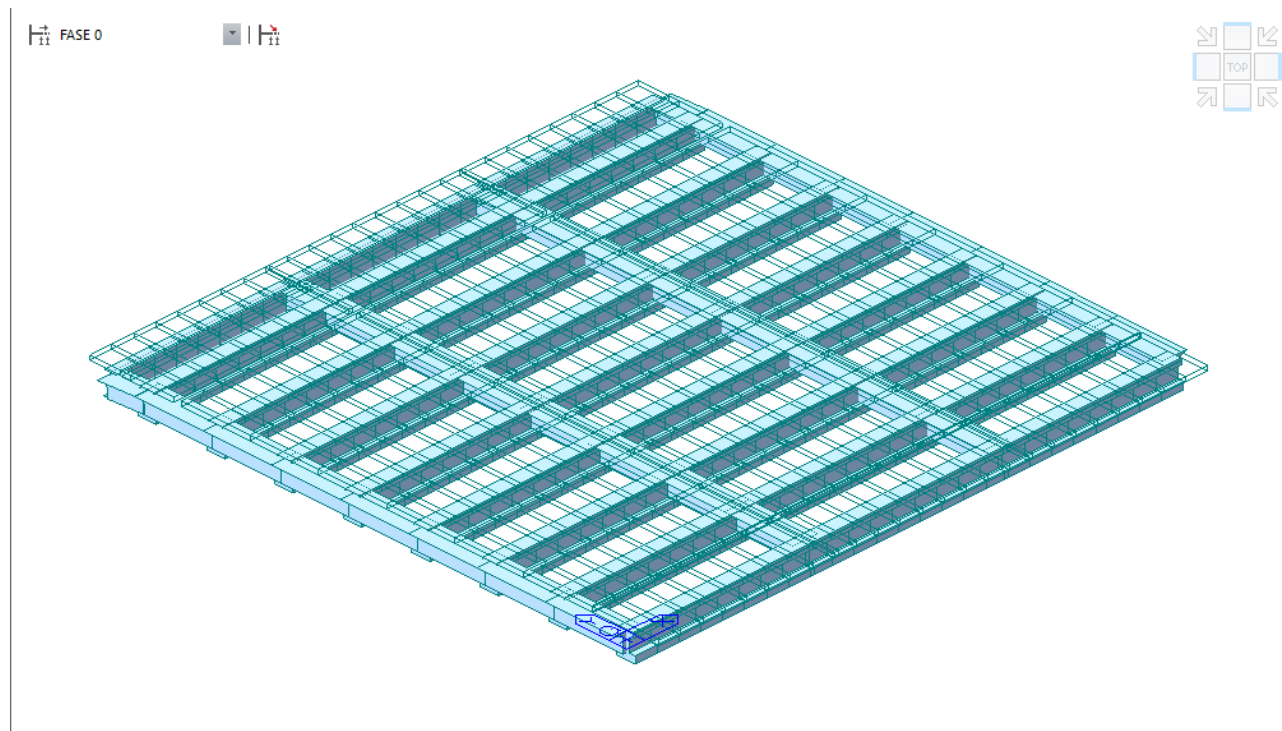


Figura 5.1: *Modello 3D Impalcato – Fase 0*

PostCS

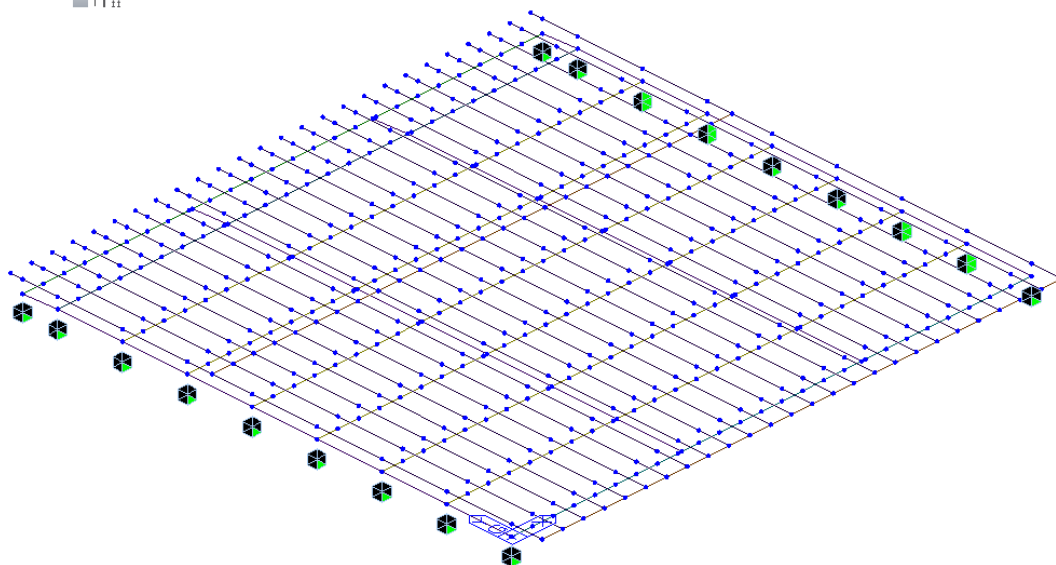


Figura 5.2: Sistema di vincolo

PostCS

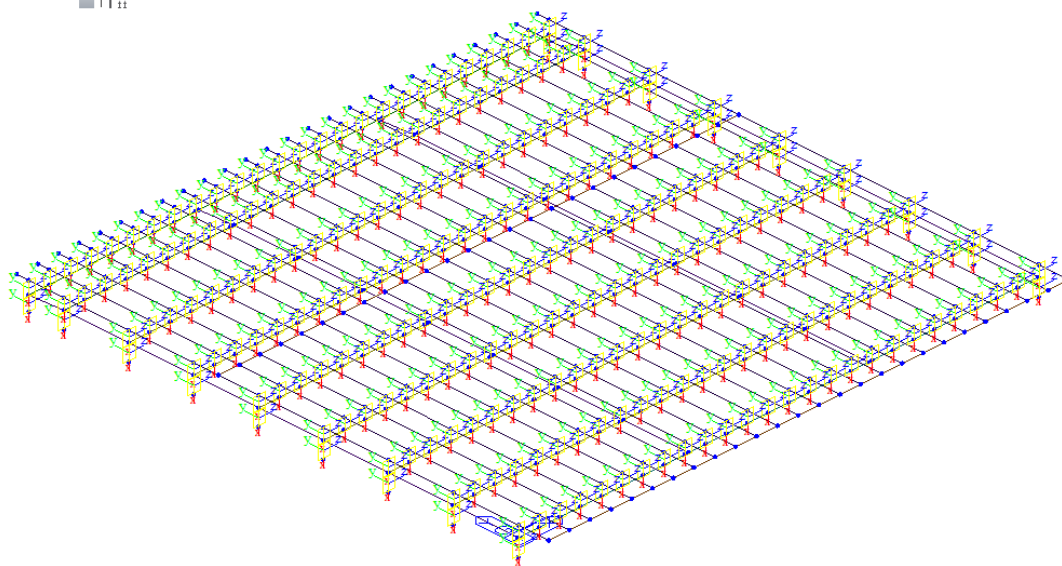


Figura 5.3: Rigid link

6 SINTESI ANALISI RISULTATI

6.1 TRAVI LONGITUDINALI

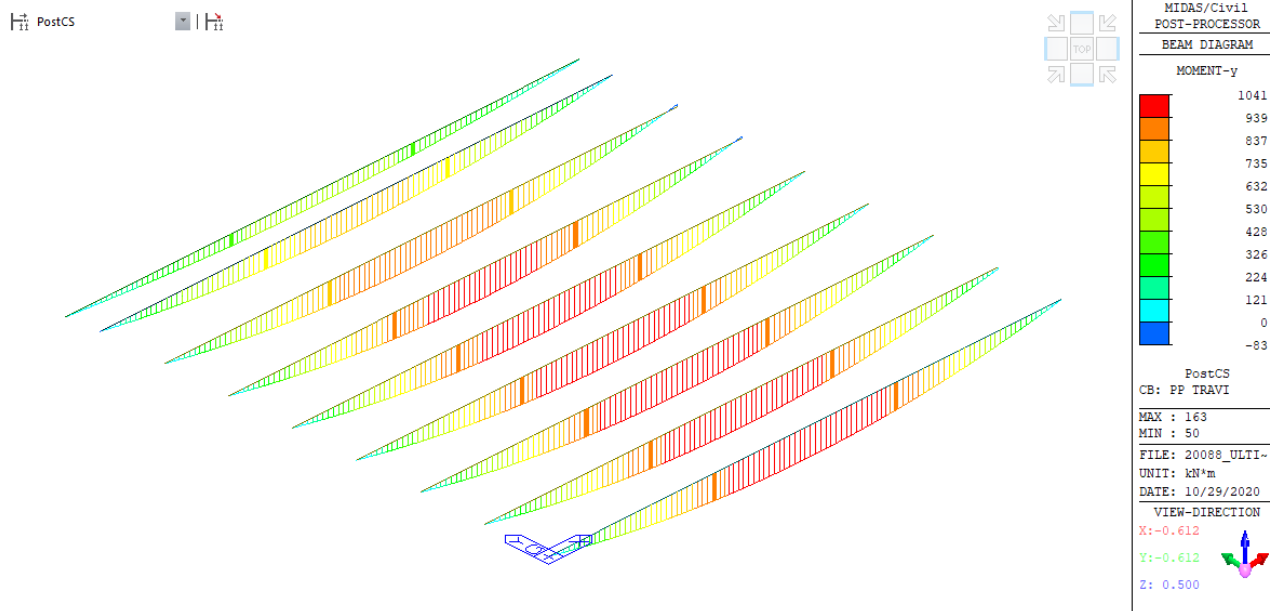


Figura 6.1: Direzione longitudinale – M_y – Peso Proprio Travi

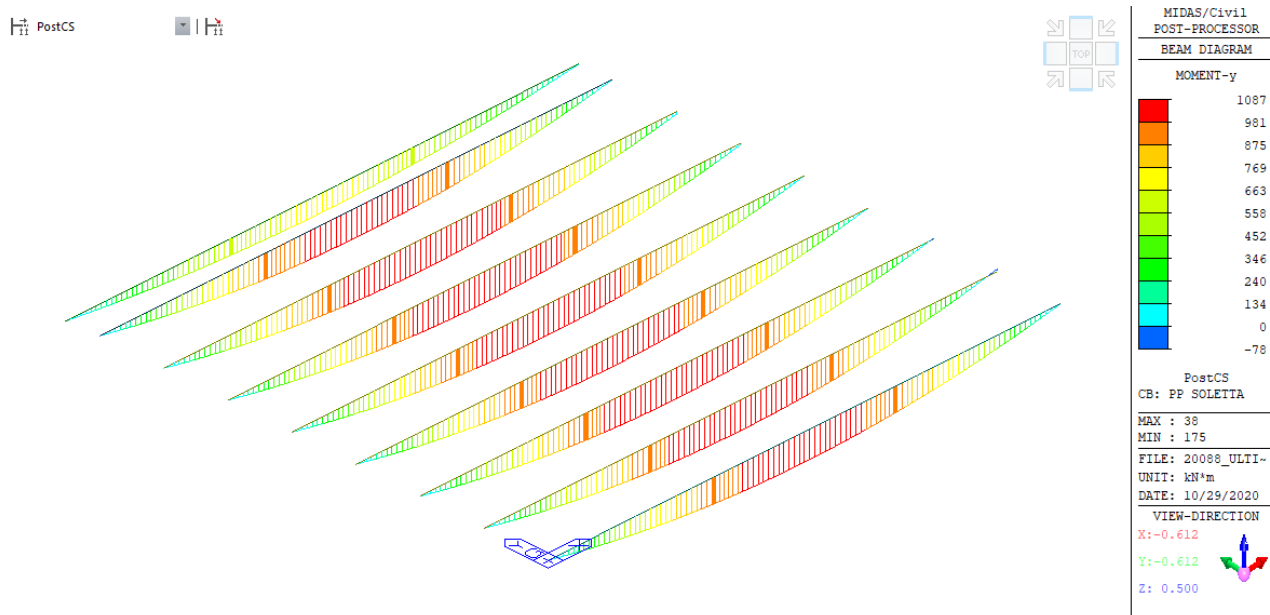


Figura 6.2: Direzione longitudinale – M_y – Peso Proprio Soletta

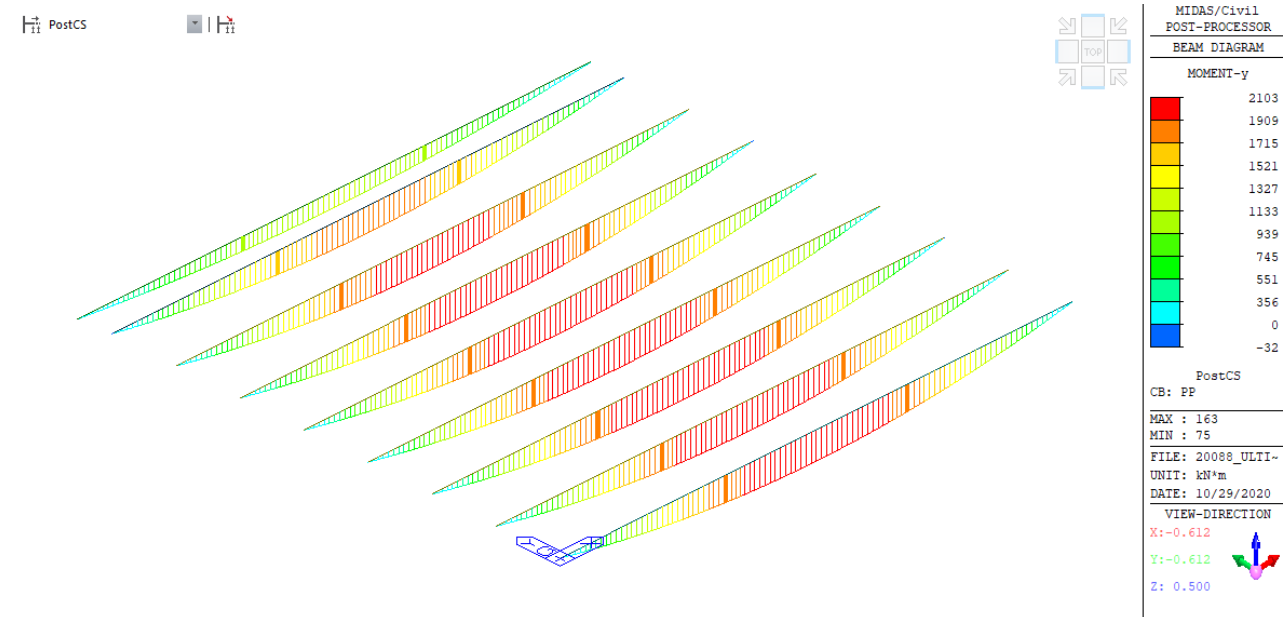


Figura 6.3: Direzione longitudinale – M_y – Peso Proprio Totale

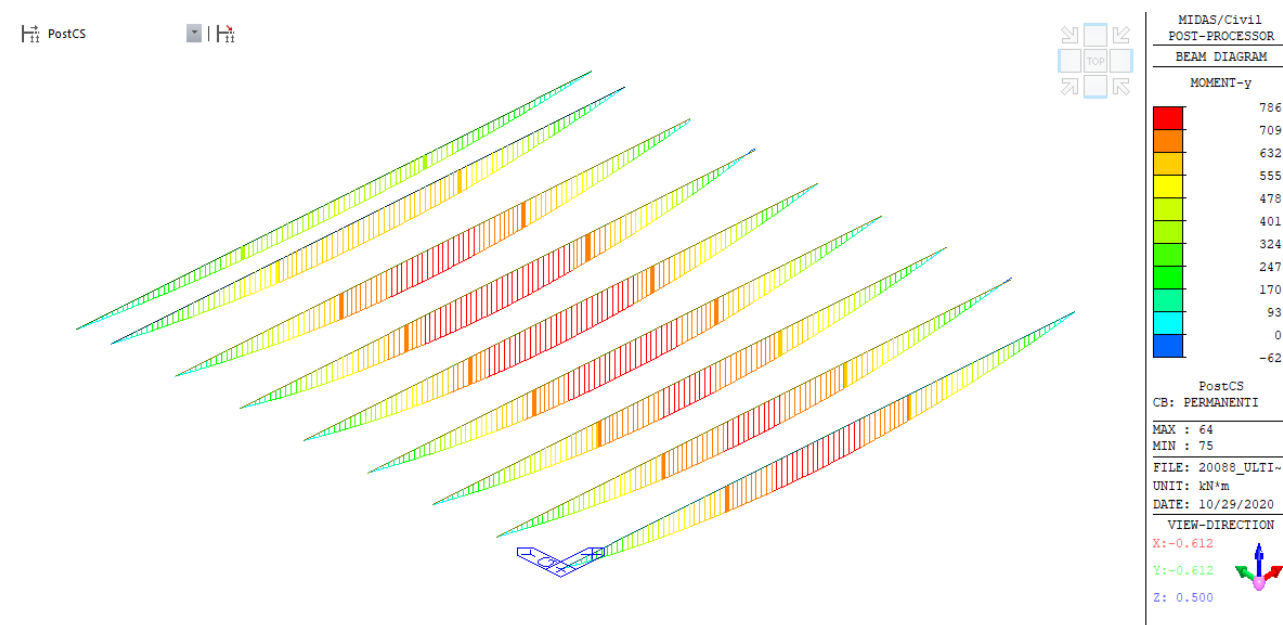


Figura 6.4: Direzione longitudinale – M_y – Permanenti

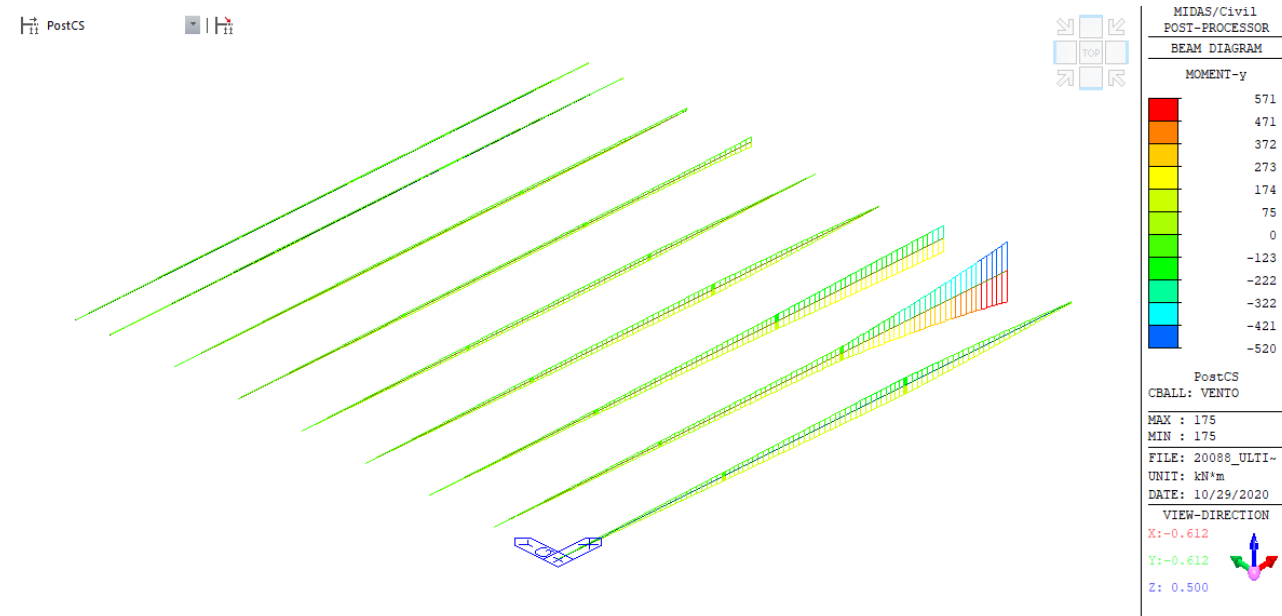


Figura 6.5: Direzione longitudinale – M_y – Vento

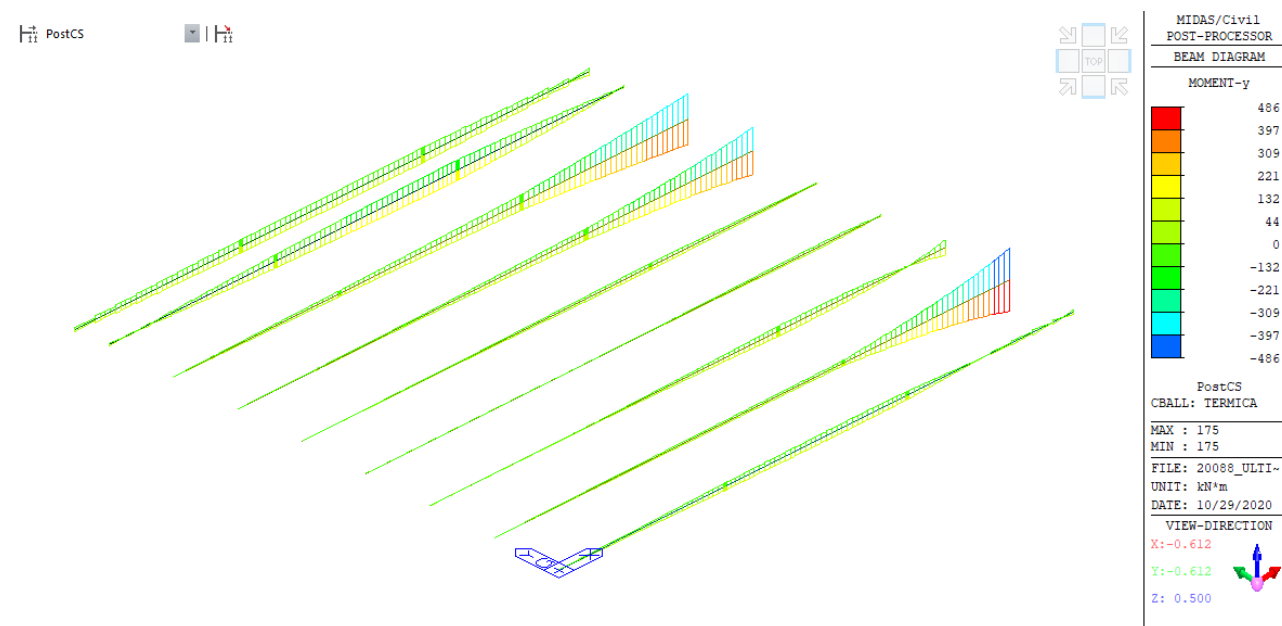


Figura 6.6: Direzione longitudinale – M_y – Temperatura

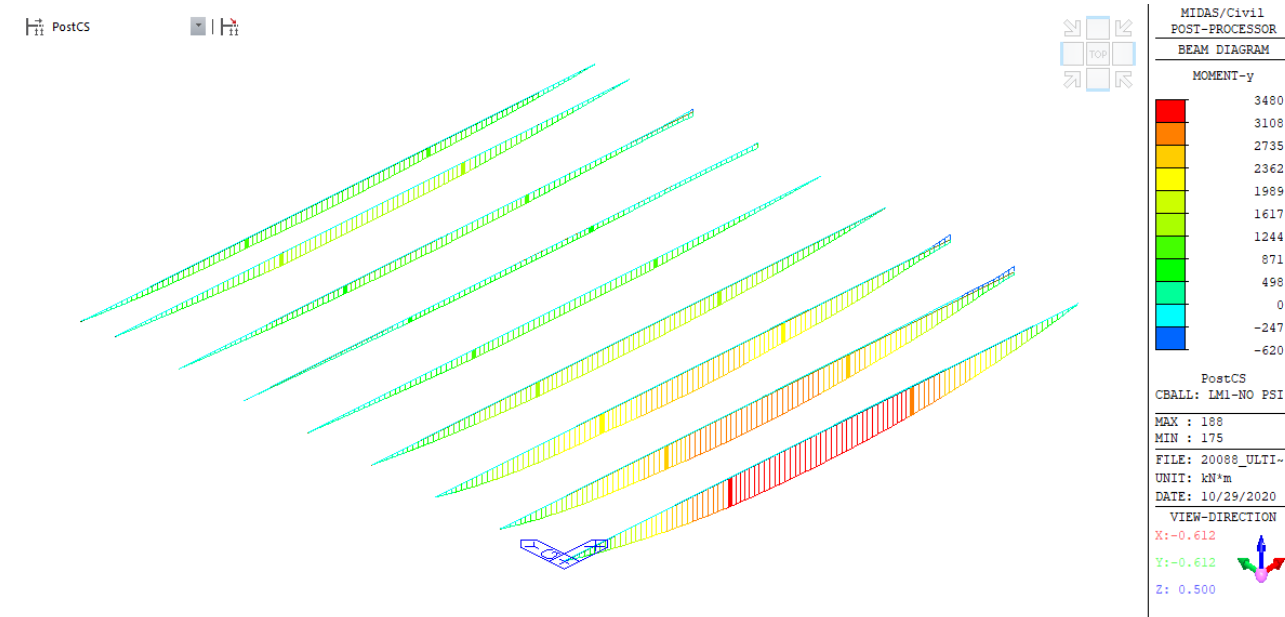


Figura 6.7: Direzione longitudinale – M_y – Traffico

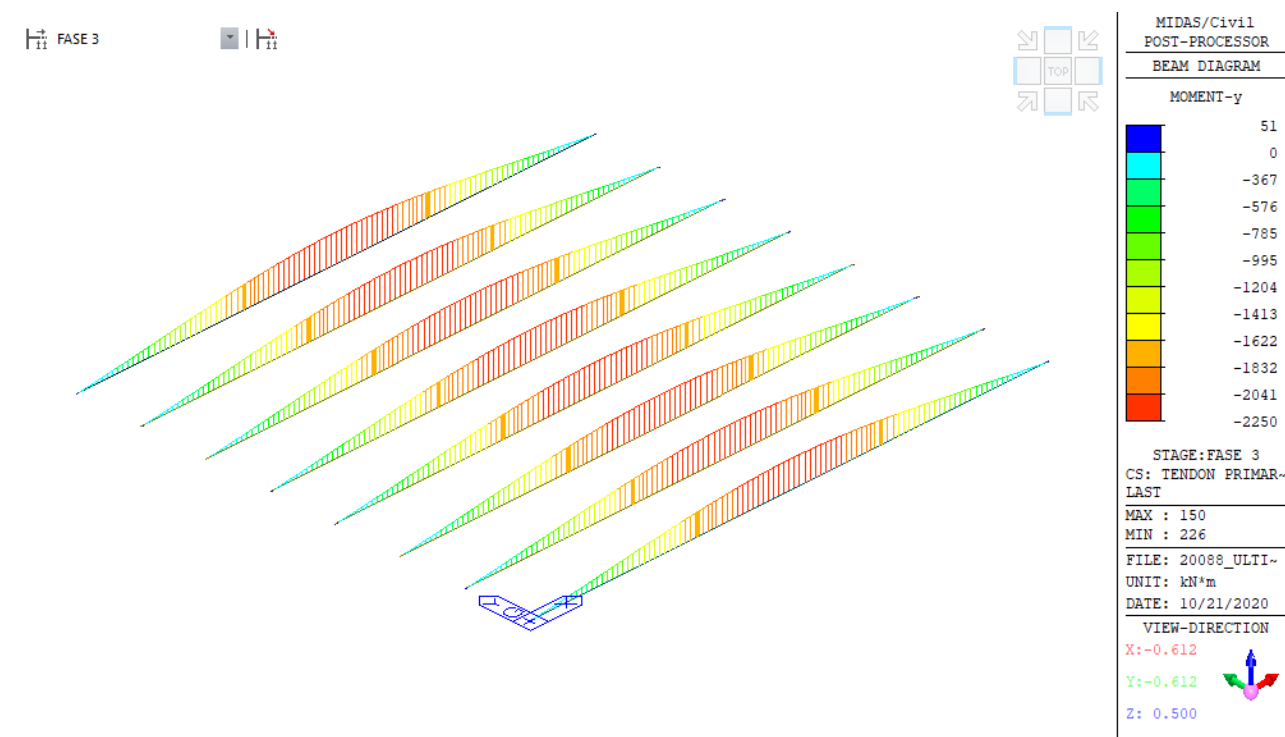
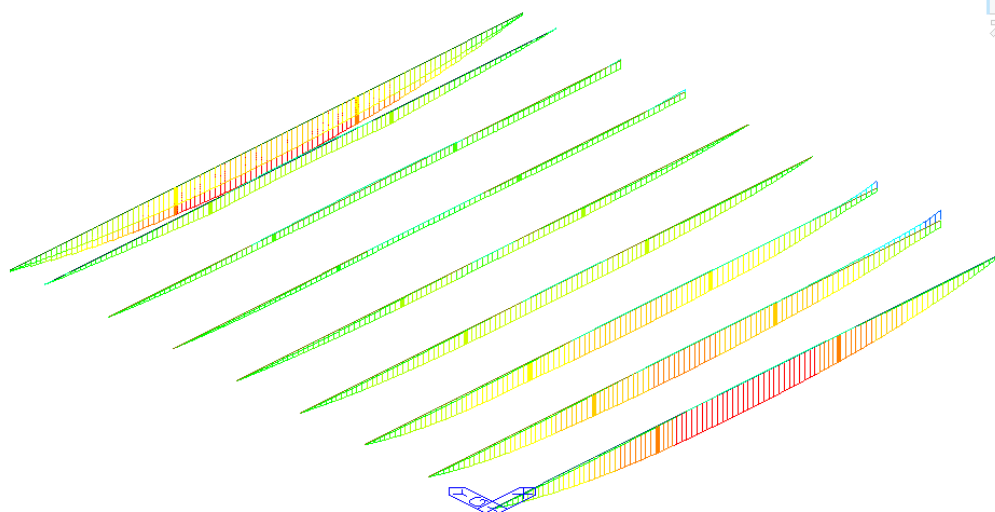
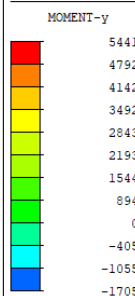


Figura 6.8: Direzione longitudinale – M_y – Precompressione

PostCS



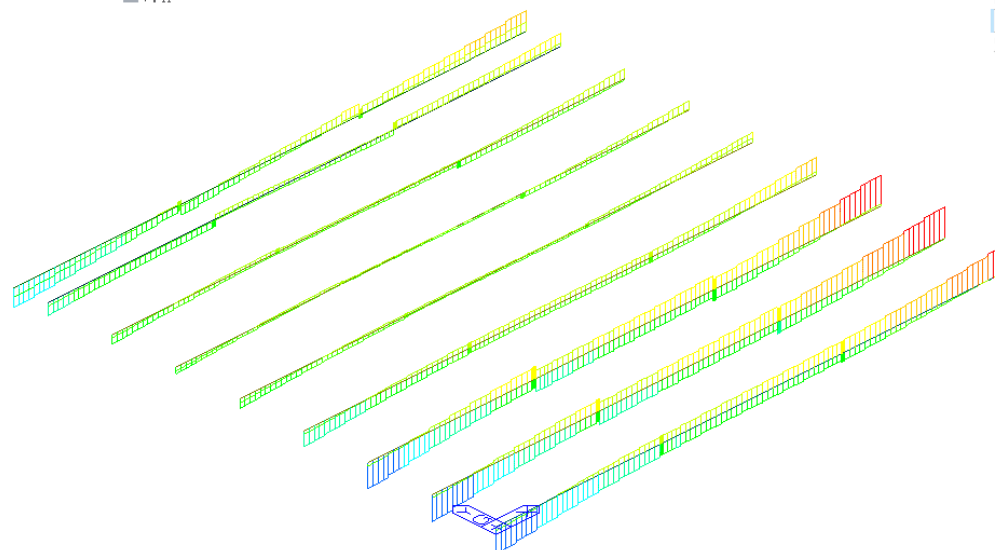
MIDAS/Civil
POST-PROCESSOR
BEAM DIAGRAM



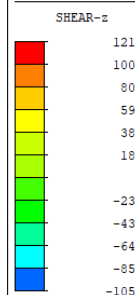
PostCS
CBALL: SLU
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MIN : 175
FILE: 20088_ULTI-
UNIT: kN*m
DATE: 10/29/2020
VIEW-DIRECTION
X: -0.612
Y: -0.612
Z: 0.500

Figura 6.9: Direzione longitudinale – M_y – Combinazione SLU

PostCS



MIDAS/Civil
POST-PROCESSOR
BEAM DIAGRAM



PostCS
CBALL: SLU
MAX : 175
MIN : 176
FILE: 20088_ULTI-
UNIT: kN
DATE: 10/29/2020
VIEW-DIRECTION
X: -0.612
Y: -0.612
Z: 0.500

Figura 6.10: Direzione longitudinale – T_z – Combinazione SLU

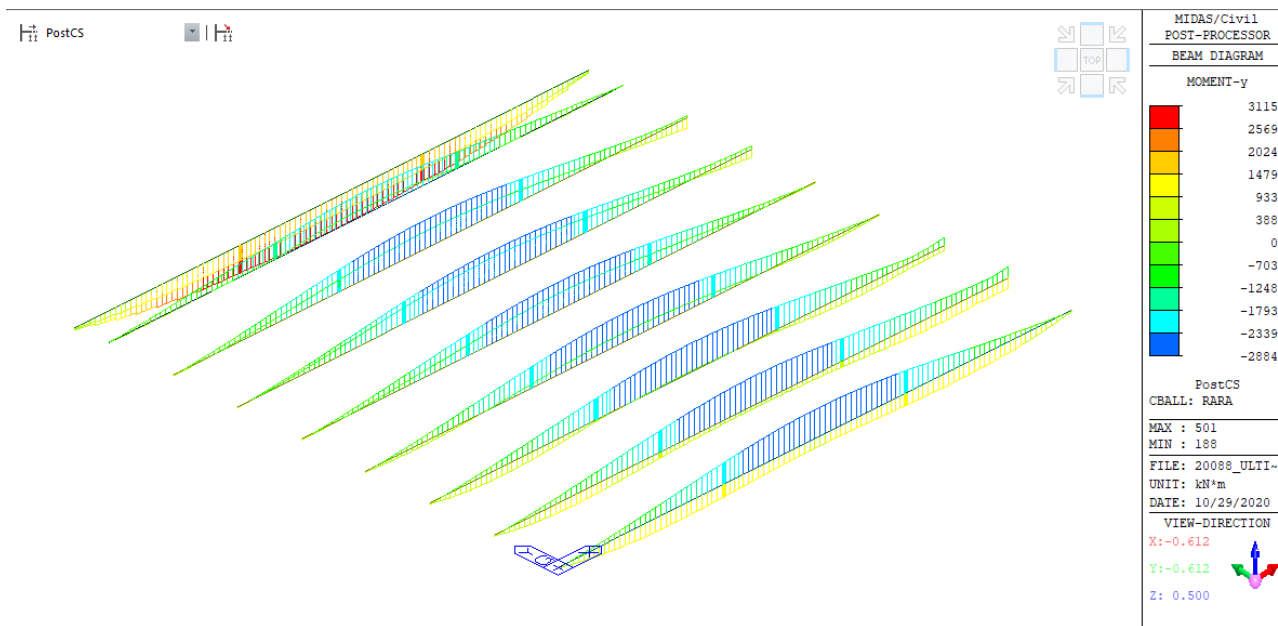


Figura 6.11: Direzione longitudinale – M_y – Combinazione SLE Rara

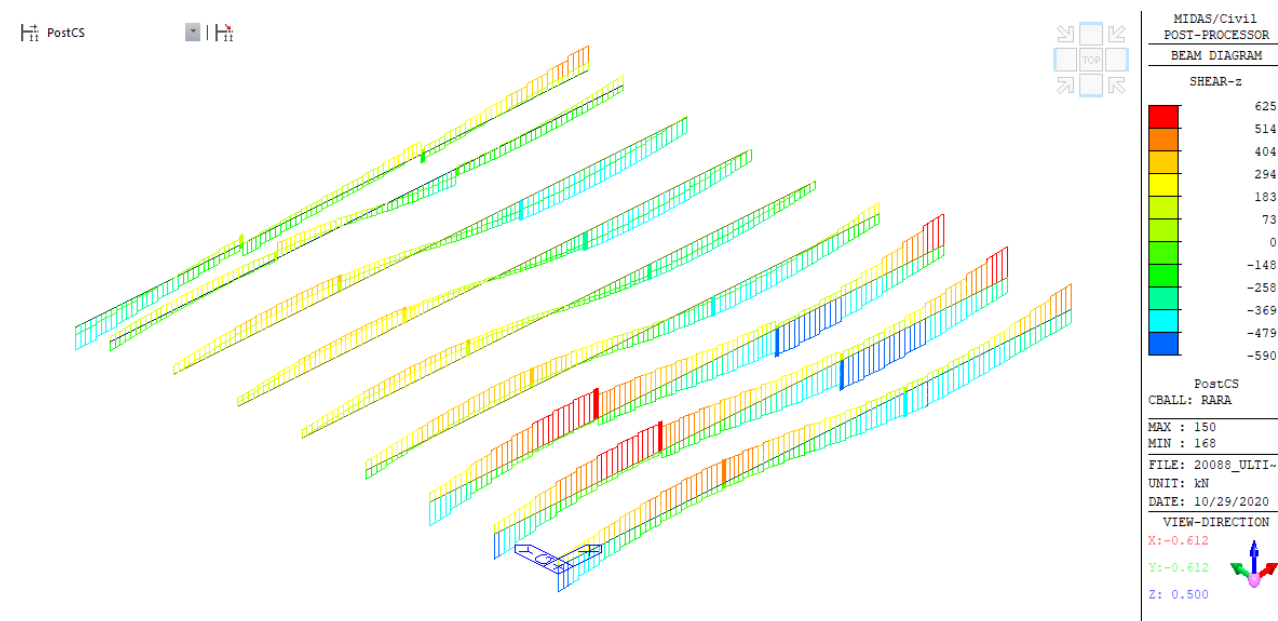
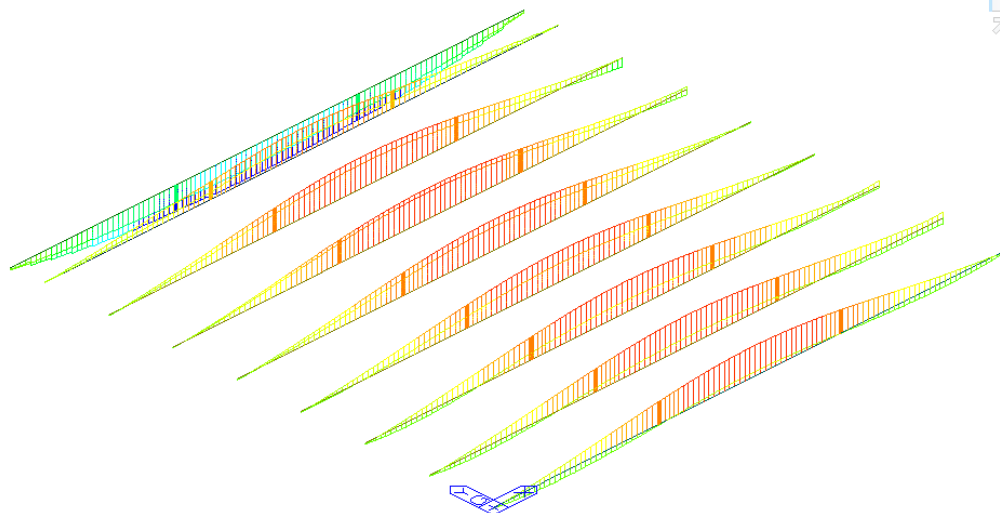


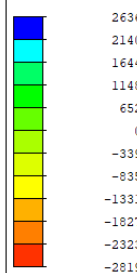
Figura 6.12: Direzione longitudinale – T_z – Combinazione SLE Rara

PostCS



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POST-PROCESSOR
BEAM DIAGRAM

MOMENT-y



PostCS
CBALL: FREQ

MAX : 501
MIN : 38

FILE: 20088_ULTI-
UNIT: kN*m
DATE: 10/29/2020

VIEW-DIRECTION

X: -0.612

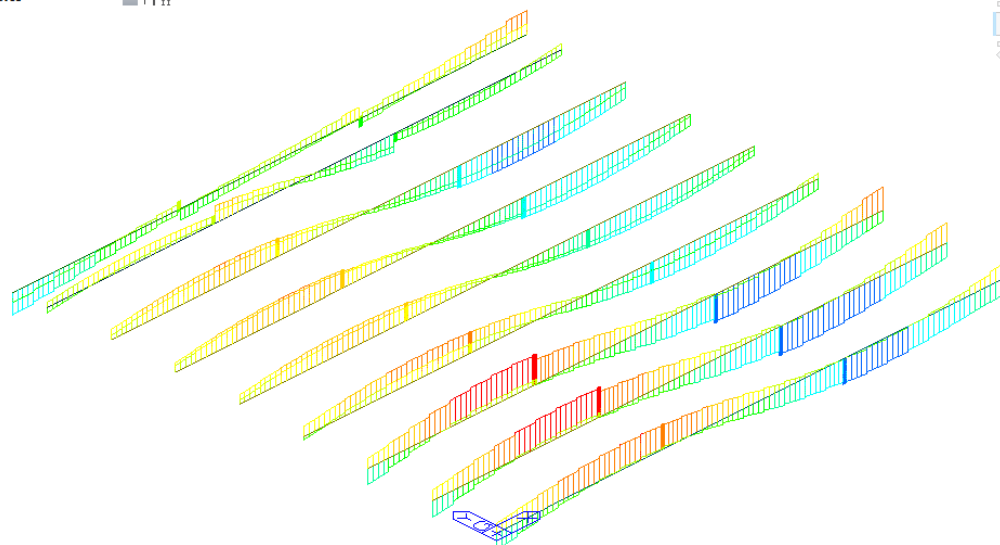
Y: -0.612

Z: 0.500



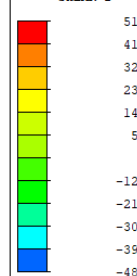
Figura 6.13: Direzione longitudinale – M_y – Combinazione SLE Frequente

PostCS



MIDAS/Civil
POST-PROCESSOR
BEAM DIAGRAM

SHEAR-z



PostCS
CBALL: FREQ

MAX : 133
MIN : 168

FILE: 20088_ULTI-
UNIT: kN
DATE: 10/29/2020

VIEW-DIRECTION

X: -0.612

Y: -0.612

Z: 0.500



Figura 6.14: Direzione longitudinale – T_z – Combinazione SLE Frequente

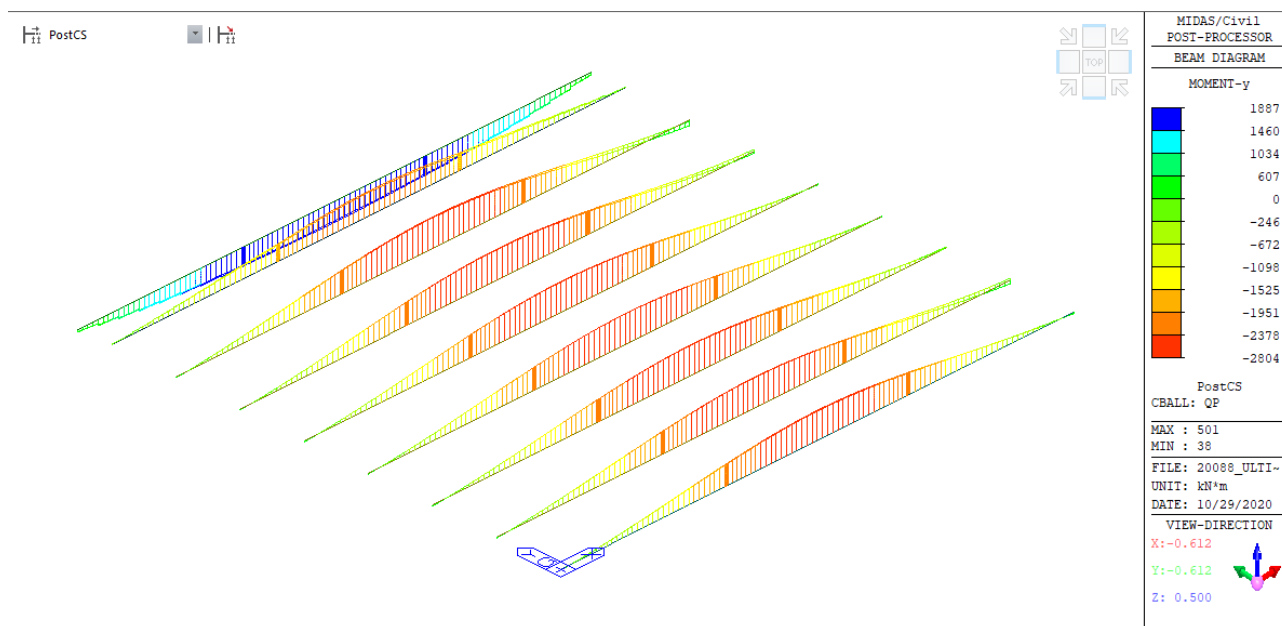


Figura 6.15: Direzione longitudinale – M_y – Combinazione SLE Quasi Permanente

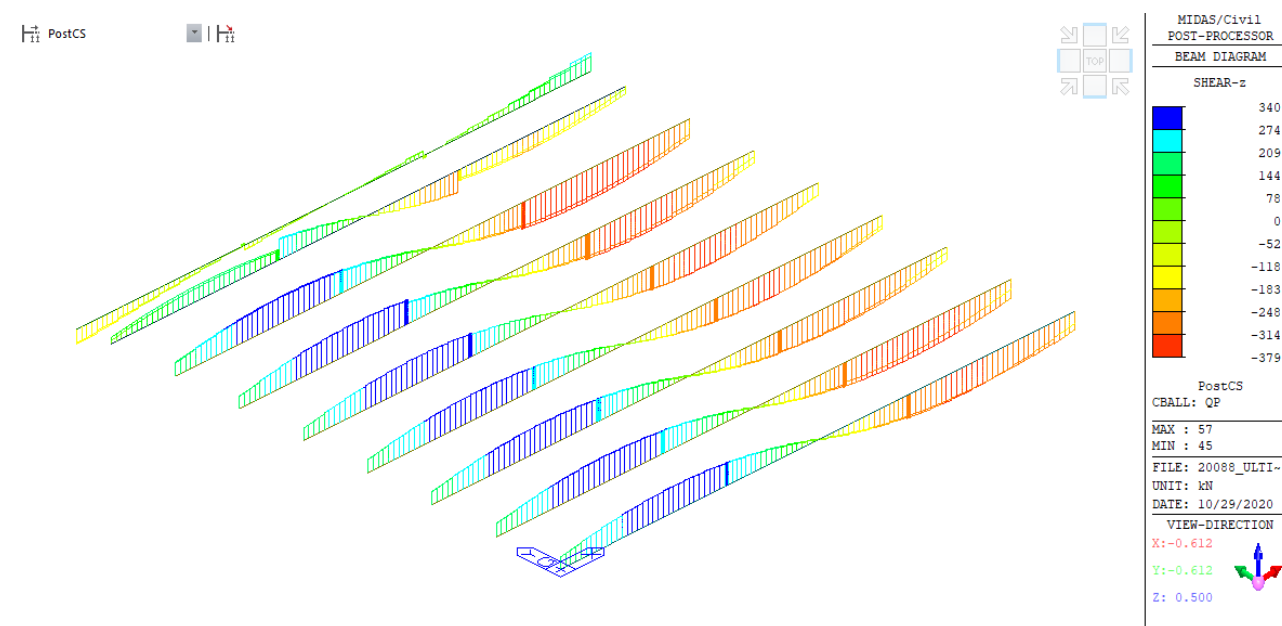


Figura 6.16: Direzione longitudinale – T_z – Combinazione SLE Quasi Permanente

6.2 APPOGGI

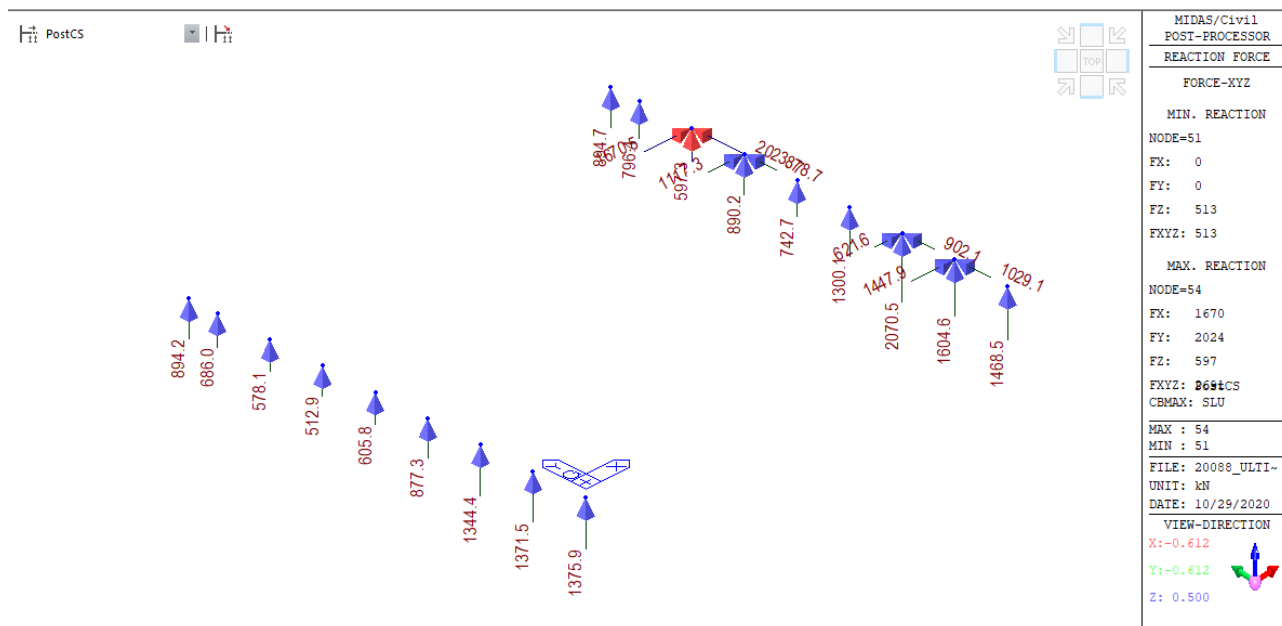


Figura 6.17: Comb.SLU – Azioni appoggi (MAX)

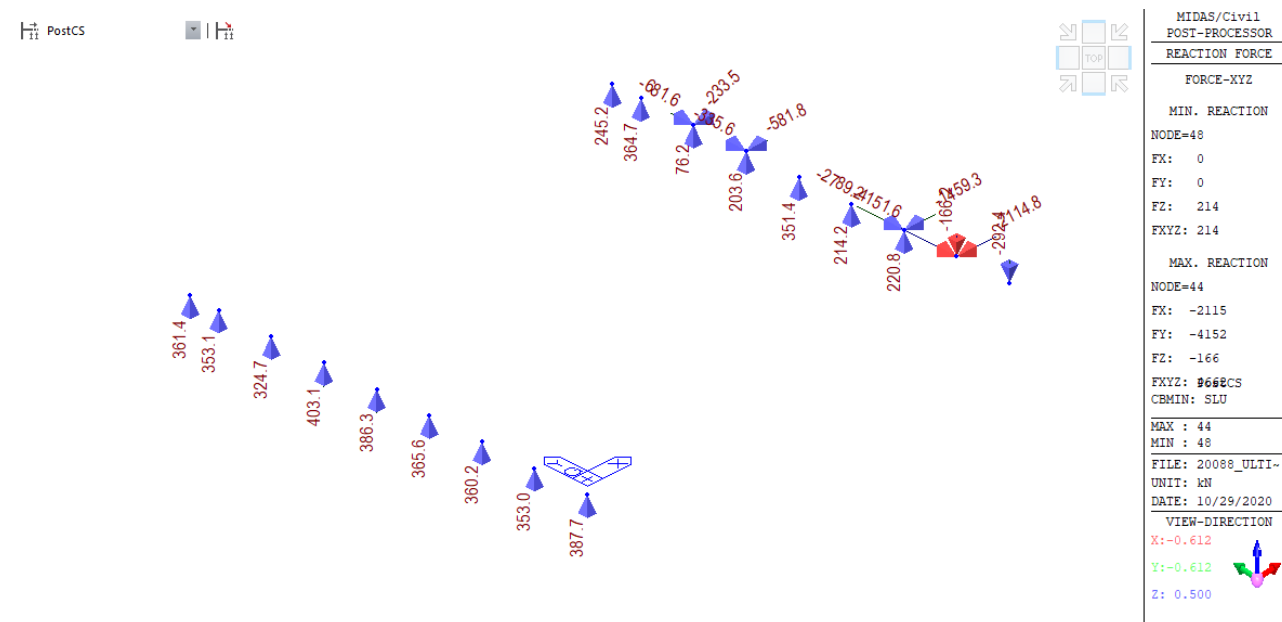


Figura 6.18: Comb.SLU – Azioni appoggi (MIN)

7 VERIFICA DELLE TRAVI PRINCIPALI ESISTENTI

Le verifiche sono state condotte con il programma di calcolo agli elementi finiti Midas Civil, utilizzato per le analisi.

Per le travi principali, la combinazione di carico più gravosa risulta la **SLU-1**, in quanto le sollecitazioni da traffico sono fattorizzate col massimo valore pari a 1.35.

Nel seguito verranno riportate le verifiche della trave in misto acciaio-calcestruzzo, TR6, realizzata durante il primo ampliamento.

Inoltre verrà analizzata, come rappresentativa tra le travi in cap, la trave TR14 poiché soggetta alle maggiori sollecitazioni. Ai fini della verifica, a favore di sicurezza, non sono state considerate le lamelle di carbonio disposte durante l'intervento di ampliamento del 2004.

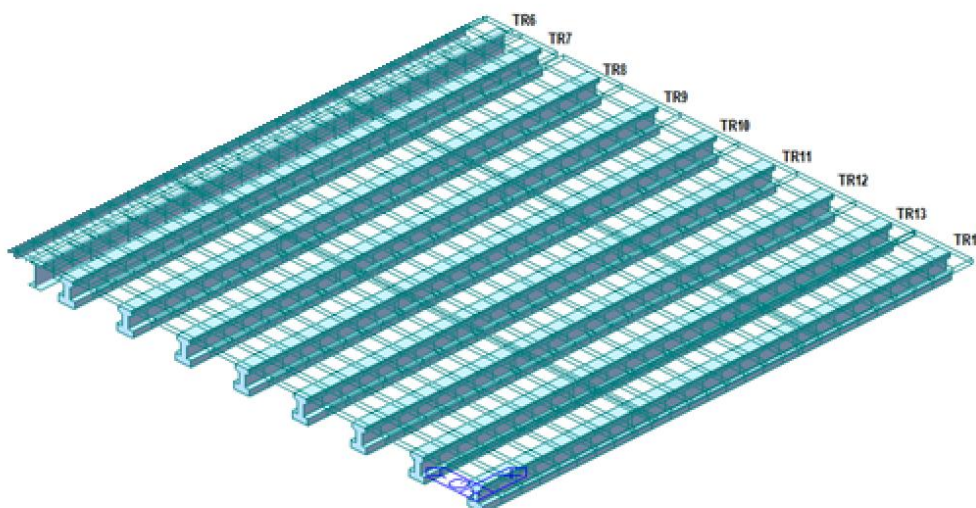


Figura 7.1: Numerazione travi principali

Sfruttando la simmetria, la verifica delle travi principali è stata condotta in corrispondenza dell'appoggio e della mezzeria di ciascuna trave.

La posizione di tali sezioni corrisponde alla posizione degli elementi delle trave esaminate nei quali sono stati riscontrati valori massimi e minimi delle sollecitazioni di calcolo.

Inoltre è stata condotta una verifica nella sezione ai quarti.

Nella figura seguente è possibile individuare la posizione delle sezioni esaminate.

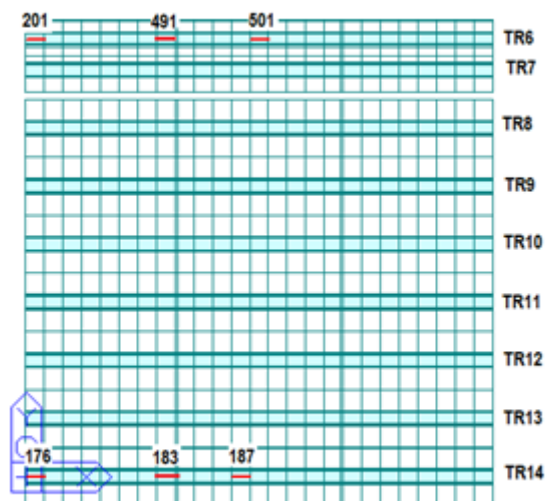


Figura 7.2: Individuazione sezioni tipologiche

7.1 VERIFICHE SLU E SLE

Si riporta di seguito per le sezioni, di cui sopra, il dettaglio delle verifiche a Stato Limite Ultimo (SLU) e Stato Limite di Esercizio (SLE) condotte mediante il post processore del programma di calcolo agli elementi finiti Midas Civil.

Per tutti i conci di trave è stata considerata, per la soletta, un'armatura longitudinale secondo quanto dedotto nelle tavole relative al progetto iniziale e al primo ampliamento.

Le verifiche condotte per la trave in misto acciaio-calcestruzzo sono le seguenti:

- Verifica a flessione per momenti flettenti positivi e negativi
- Verifica di resistenza a taglio
- Verifica all'instabilità flesso-torsionale
- Verifica di resistenza a taglio in direzione longitudinale (verifica della piolatura)
- Verifica della piolatura in condizioni di esercizio

Mentre le verifiche condotte per la trave in cap sono le seguenti:

- Verifica a flessione per momenti flettenti positivi e negativi
- Verifica di resistenza a taglio

7.2 VERIFICA TRAVE ESISTENTE IN MISTO ACCIAIO-CLS

Element Number	201
Position Information	I

1 Design Condition

1.1 Design Parameters

■ Partial factors

γ_C for concrete	1.50	γ_V for headed stud	1.25
γ_S for reinforcing steel	1.15	γ_{Ff} for equivalent constant Amplitude stress range	1.00
γ_{M0} for structural steel	1.05	γ_{Mf} for fatigue strength	1.00
γ_{M1} for structural steel	1.10	$\gamma_{Mf,s}$ for fatigue strength of studs in shear	1.15

1.2 Material Information

■ Structural steel

$$f_{sk} = 355.000 \text{ MPa} \quad E_s = 210000.000 \text{ MPa}$$

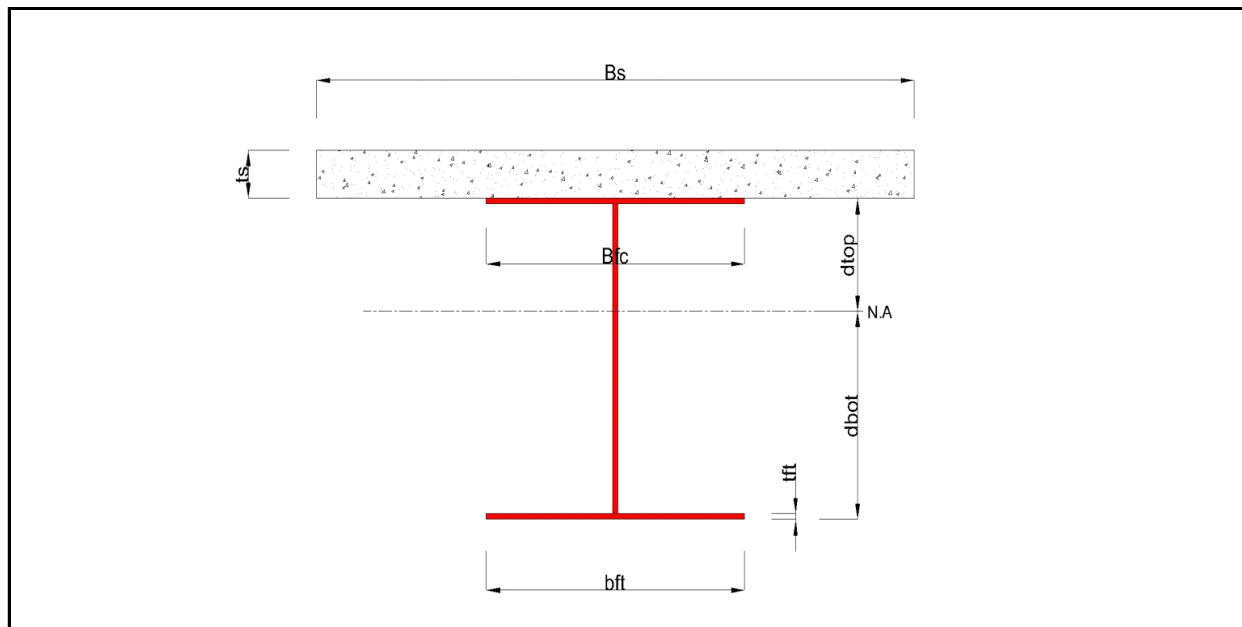
■ Concrete

$$f_{ck} = 25.000 \text{ MPa} \quad E_{cm} = 31000.000 \text{ MPa}$$

■ Reinforcement

$$f_{yk} = 450.000 \text{ MPa} \quad E_r = 210000.000 \text{ MPa}$$

1.3 Sectional Information



■ Section Dimensions

Slab

B_c	1785.000	mm	t_c	180.000	mm	H_h	70.000	mm
-------	----------	----	-------	---------	----	-------	--------	----

Girder

H_w	880.000	mm	B_1	500.000	mm	B_2	600.000	mm
t_w	16.000	mm	t_{f1}	40.000	mm	t_{f2}	40.000	mm

■ Section Stiffness

Before

$A_{,a}$	58080.000	mm ²
$I_{y,a}$	10166603988.981	mm ⁴
$I_{z,a}$	1136967040.000	mm ⁴
$C_{y,a}$	300.000	mm
$C_{z,a}$	448.320	mm

After

$A_{,c}$	109097.816	mm ²
$I_{y,c}$	22557786117.381	mm ⁴
$I_{z,c}$	14683153704.391	mm ⁴
$C_{y,c}$	300.000	mm
$C_{z,c}$	762.420	mm

Crack

$A_{,c}$	60114.000	mm ²
$I_{y,c}$	11059374356.650	mm ⁴
$I_{z,c}$	1679385361.768	mm ⁴
$C_{y,c}$	300.000	mm
$C_{z,c}$	471.046	mm

2 Bending Resistance

2.1 Positive Moment

■ Design load

Load combination name : SLU

$N_{a,Ed}$	-670.037	kN
$N_{c,Ed}$	153.273	kN
$M_{a,Ed}$	251.470	kN · m
$M_{c,Ed}$	34.575	kN · m

- Stress

Top Flange

Left	y_1	-250.000	mm	z_1	197.580	mm	σ_1	-2.824	MPa
	y_2	-8.000	mm	z_2	197.580	mm	σ_2	-22.442	MPa
Right	y_1	250.000	mm	z_1	197.580	mm	σ_1	-43.357	MPa
	y_2	8.000	mm	z_2	197.580	mm	σ_2	-23.739	MPa

Bottom Flange

Left	y_1	-300.000	mm	z_1	-762.420	mm	σ_1	26.446	MPa
	y_2	-8.000	mm	z_2	-762.420	mm	σ_2	2.775	MPa
Right	y_1	300.000	mm	z_1	-762.420	mm	σ_1	-22.194	MPa
	y_2	8.000	mm	z_2	-762.420	mm	σ_2	1.478	MPa

Web

Right	y_1	0.000	mm	z_1	157.580	mm	σ_1	-22.040	MPa
	y_2	0.000	mm	z_2	-722.420	mm	σ_2	1.075	MPa

■ Classification of sections

Part	Class
Top flange	1
Web	1
Bottom flange	1
Section	1

- Plastic resistance moment, $M_{pl,Rd}$

Plastic NA = 775.716 mm

N_{slab} = 4551.750 kN

$N_{g,top}$ = 7542.411 kN (Upper side of PNA)

$N_{g,bot}$ = 12094.161 kN (Lower side of PNA)

$M_{pl,Rd}$ = 10330.399 kN · m

x_{pl} = 434.284 mm

M_{Rd} = $\beta M_{pl,Rd}$ = 10330.399 kN · m

here, β = 1.000

M_{Rd} = 10330.399 kN · m > M_{Ed} = 286.045 kN · m ...OK

2 Bending Resistance

2.2 Negative Moment

■ Design load

Load combination name : SLU

$N_{a,Ed}$	-670.037	kN
$N_{c,Ed}$	-224.528	kN
$M_{a,Ed}$	251.470	kN · m
$M_{c,Ed}$	-66.966	kN · m

- Stress

Top Flange

Left	y_1	-250.000	mm	z_1	488.954	mm	σ_1	-29.263	MPa
	y_2	-8.000	mm	z_2	488.954	mm	σ_2	-25.105	MPa
Right	y_1	250.000	mm	z_1	488.954	mm	σ_1	-20.671	MPa
	y_2	8.000	mm	z_2	488.954	mm	σ_2	-24.830	MPa

Bottom Flange

Left	y_1	-300.000	mm	z_1	-471.046	mm	σ_1	-12.190	MPa
	y_2	-8.000	mm	z_2	-471.046	mm	σ_2	-7.172	MPa
Right	y_1	300.000	mm	z_1	-471.046	mm	σ_1	-1.880	MPa
	y_2	8.000	mm	z_2	-471.046	mm	σ_2	-6.897	MPa

Web

Right	y_1	0.000	mm	z_1	448.954	mm	σ_1	-24.220	MPa
	y_2	0.000	mm	z_2	-431.046	mm	σ_2	-7.782	MPa

■ Classification of sections

Part	Class
Top flange	1
Web	2
Bottom flange	1
Section	2

- Plastic resistance moment, $M_{pl,Rd}$

Plastic NA = 428.566 mm

$N_{slab} = 0.000$ kN
 $N_{rebar,t} = 795.913$ kN (Upper side of PNA)
 $N_{rebar,b} = 0.000$ kN (Lower side of PNA)
 $N_{g,top} = 9420.329$ kN (Upper side of PNA)
 $N_{g,bot} = 10216.242$ kN (Lower side of PNA)

$M_{pl,Rd} = 8385.405$ kN · m
 $M_{Rd} = M_{pl,Rd} = 8385.405$ kN · m

$M_{Rd} = 8385.405$ kN · m > $M_{Ed} = 184.504$ kN · m ...OK

3 Resistance to Vertical Shear

■ Design load

Load combination name : SLU

$N_{Ed} = -224.528$ kN
 $M_{a,Ed} = 251.470$ kN · m
 $M_{c,Ed} = -66.966$ kN · m
 $V_{Ed,a} = -379.902$ kN
 $V_{Ed,c} = -381.354$ kN
 $V_{Ed} = -761.257$ kN

$M_{Ed} = \max(M_{Ed,t}, M_{Ed,b}) = 219.301$ kN · m
 $M_{Ed,t} = 219.301$ kN · m
 $M_{Ed,b} = 193.388$ kN · m

- Stress

Top Flange

Left	y_1	-250.000	mm	z_1	488.954	mm	σ_1	-29.263	MPa
	y_2	-8.000	mm	z_2	488.954	mm	σ_2	-25.105	MPa
Right	y_1	250.000	mm	z_1	488.954	mm	σ_1	-20.671	MPa
	y_2	8.000	mm	z_2	488.954	mm	σ_2	-24.830	MPa

Bottom Flange

Left	y_1	-300.000	mm	z_1	-471.046	mm	σ_1	-12.190	MPa
	y_2	-8.000	mm	z_2	-471.046	mm	σ_2	-7.172	MPa
Right	y_1	300.000	mm	z_1	-471.046	mm	σ_1	-1.880	MPa
	y_2	8.000	mm	z_2	-471.046	mm	σ_2	-6.897	MPa

Web

Right	y ₁	0.000	mm	z ₁	448.954	mm	σ ₁	-24.220	MPa
	y ₂	0.000	mm	z ₂	-431.046	mm	σ ₂	-7.782	MPa

■ Classification of sections

Part	Class
Top flange	1
Web	2
Bottom flange	1
Section	2

■ Plastic resistance moment, M_{pl,Rd}

Plastic NA = 428.566 mm

N_{slab} = 0.000 kN
 N_{rebar,t} = 795.913 kN (Upper side of PNA)
 N_{rebar,b} = 0.000 kN (Lower side of PNA)
 N_{g,top} = 9420.329 kN (Upper side of PNA)
 N_{g,bot} = 10216.242 kN (Lower side of PNA)

M_{pl,Rd} = 8385.405 kN · m

■ Calculation. V_{bw,Rd}

Web

■ Contribution from the web

λ_w = h_w / (86.4 · t · ε) = 0.782

X_w = 0.83 / λ_w = 1.061 0.83/η ≤ λ_w < 1.08

V_{bw,Rd} = $\frac{X_w \cdot f_{yw} \cdot h_w \cdot t}{\sqrt{3} \cdot \gamma_{M1}}$ = 2783.086 kN

V_{Rd} = 2783.086 kN

V_{Edi} = V_{Ed} / Num. of Web = -761.257 kN

η'₃ = V_{Edi} / V_{bw,Rd} = 0.274 ≤ 1.0

■ Contribution from the flange

M_{f,Rd0} = 7107.204 kN · m

M_{f,Rd0} is calculated as M_{pl,Rd} but neglecting the web contribution.

Reduction factor for N_{Ed} = $1 - \frac{N_{Ed}}{(A_{f1} + A_{f2}) \cdot f_{yf} / \gamma_{M0}}$ = 0.985

M_{f,Rd} = Reduction factor for N_{Ed} · M_{f,Rd0} = 6999.935 kN · m

V_{bf,Rd} = $\frac{b_f \cdot t_f^2 \cdot f_{yf}}{c \cdot \gamma_{M1}} \left(1 - \left(\frac{M_{Ed}}{M_{f,Rd}} \right)^2 \right)$ = 0.000 kN

where, M_{f,Rd} = 6999.935 kN · m

M_{Ed} = 219.301 kN · m (Taken as the greatest value of (Σσ_i)W)

c = a · (0.25 + $\frac{1.6 \cdot b_f \cdot t_f^2 \cdot f_{yf}}{t \cdot h_w^2 \cdot f_{yw}}$) = 0.000

■ Check Shear Resistance

$$V_{Edi} / (V_{bw,Rd} + V_{bf,Rd}) = 0.274 < 1.0 \quad \dots \text{OK}$$

4 Resistance to Lateral Torsional Buckling

- Design load

Load combination name : SLU

$$\begin{aligned} N_{Ed} &= -894.566 \text{ kN} \\ M_{Ed} &= 184.504 \text{ kN} \cdot \text{m} \\ V_1 &= -761.257 \text{ kN} \\ V_2 &= -755.247 \text{ kN} \\ M_1 &= 598.161 \text{ kN} \cdot \text{m} \\ M_2 &= 184.504 \text{ kN} \cdot \text{m} \\ M_{pl,Rd} &= 8385.405 \text{ kN} \cdot \text{m} \\ M_{el,Rd} &= 6147.537 \text{ kN} \cdot \text{m} \end{aligned}$$

- $M_{b,Rd}$ Buckling resistance moment

$$\begin{aligned} L &= 0.962 \text{ m} \\ c &= C_d / I = 0.000 \text{ kN/m}^2 \\ \gamma &= c \cdot L^4 / (E \cdot I) = 0.000 \\ \mu &= V_2 / V_1 = 0.992 \\ \Phi &= 2 \cdot (1 - M_2 / M_1) / (1 + \mu) = 0.694 \\ m_1 &= 1 + 0.44 \cdot (1 + \mu) \cdot \Phi^{1.5} + (3 + 2 \cdot \Phi) \cdot \gamma / (350 - 50 \cdot \mu) = 1.507 \\ m_2 &= 1 + 0.44 \cdot (1 + \mu) \cdot \Phi^{1.5} + (0.195 + (0.05 + \mu / 100) \cdot \Phi) \cdot \gamma^{0.5} = 1.507 \\ m &= \min(m_1, m_2) = 1.507 \\ \alpha_{LT} &= 0.490 \\ \lambda_{LT} &= 1.103 \cdot L / b \cdot \sqrt{f_y / E_m} \cdot \sqrt{(1 + A_{wc} / (3 \cdot A))} = 0.062 \\ \Phi_{LT} &= 0.5 \cdot (1 + \alpha_{LT} \cdot (\lambda_{LT} - 0.2) + \lambda_{LT}^2) = 0.468 \\ X_{LT} &= \frac{1}{\Phi_{LT} + \sqrt{(\Phi_{LT}^2 - \lambda_{LT}^2)}} = 1 \\ M_{Rd} &= 8385.405 \text{ kN} \cdot \text{m} \\ M_{b,Rd} &= X_{LT} \cdot M_{Rd} = 8385.405 \text{ kN} \cdot \text{m} \end{aligned}$$

- $N_{b,Rd}$ Axial buckling resistance

$$\begin{aligned} X_{LT,N} &= 1.000 \\ N_{b,Rd} &= X_{LT} \cdot \text{Area} \cdot f_{yd} = 20324.257 \text{ kN} \end{aligned}$$

$$\text{Combined Ratio} = \frac{N_{Ed}}{N_{b,Rd}} + \frac{M_{Ed}}{M_{b,Rd}} = 0.066017628$$

6 Resistance to Longitudinal Shear

- Design load

Load combination name : SLU

$$\begin{aligned} N_{c,el} &= 0.000 \text{ kN} \\ N_{c,f} &= 0.000 \text{ kN} \\ M_{Ed} &= 184.504 \text{ kN} \cdot \text{m} \\ V_{Ed} &= -381.354 \text{ kN} \\ M_{pl,Rd} &= 8385.405 \text{ kN} \cdot \text{m} \\ M_{el,Rd} &= 6147.537 \text{ kN} \cdot \text{m} \end{aligned}$$

- Shear resistance of a single connector

$$\begin{aligned} P_{Rd,1} &= 0.8 \cdot f_u \cdot \pi \cdot d^2 / 4 / \gamma_V = 109.478 \text{ kN} \\ P_{Rd,2} &= 0.29 \cdot \alpha \cdot d^2 \cdot \sqrt{(f_{ck} \cdot E_{cm})} / \gamma_V = 98.852 \text{ kN} \\ P_{Rd} &= \min(P_{Rd,1}, P_{Rd,2}) = 98.852 \text{ kN} \end{aligned}$$

$$\begin{aligned} \text{where, } f_u &= 450.000 \text{ MPa} \\ \alpha &= 1 \quad \text{for } h_{sc}/d > 4 \\ \text{Num.} &= 2 \\ d &= 22.000 \text{ mm} \\ h_{sc} &= 175.000 \text{ mm} \\ \text{Space} &= 100.000 \text{ mm} \end{aligned}$$

- Verification

$$\begin{aligned} V_{L,Ed} &= V_{Ed} \cdot (A \cdot z / l) = 307.035 \text{ kN/m} \\ V_{L,Rd} &= P_{Rd} \cdot \text{Num.} / \text{Space} = 1977.034 \text{ kN/m} \\ V_{L,Ed} &< V_{L,Rd} \quad \dots \text{ OK} \end{aligned}$$

8 Longitudinal Shear for SLS(Serviceability limit state)

- Shear resistance of a single connector

Load combination name : Rara

$$\begin{aligned} P_{Rd,1} &= 0.8 \cdot f_u \cdot \pi \cdot d^2 / 4 / \gamma_V = 109.478 \text{ kN} \\ P_{Rd,2} &= 0.29 \cdot \alpha \cdot d^2 \cdot \sqrt{(f_{ck} \cdot E_{cm})} / \gamma_V = 98.852 \text{ kN} \\ P_{Rd} &= \min(P_{Rd,1}, P_{Rd,2}) = 98.852 \text{ kN} \\ P_{Rd,ser} &= k_s \cdot P_{Rd} = 74.139 \text{ kN} \end{aligned}$$

$$\begin{aligned} \text{where, } f_u &= 450.000 \text{ MPa} \\ \alpha &= 1 \quad \text{for } h_{sc}/d > 4 \\ \text{Num.} &= 2 \\ d &= 22.000 \text{ mm} \\ h_{sc} &= 175.000 \text{ mm} \\ \text{Space} &= 100.000 \text{ mm} \\ k_s &= 0.750 \end{aligned}$$

- Verification

$$\begin{aligned} V_{L,Ed} &= V_{Ed} \cdot (A \cdot z / l) = 228.216 \text{ kN/m} \\ V_{L,Rd} &= P_{Rd,ser} \cdot \text{Num.} / \text{Space} = 1482.776 \text{ kN/m} \\ V_{L,Ed} &< V_{L,Rd} \quad \dots \text{ OK} \end{aligned}$$

Element Number	491
Position Information	J

1 Design Condition

1.1 Design Parameters

■ Partial factors

γ_C for concrete	1.50	γ_V for headed stud	1.25
γ_S for reinforcing steel	1.15	γ_{Ff} for equivalent constant Amplitude stress range	1.00
γ_{M0} for structural steel	1.05	γ_{Mf} for fatigue strength	1.00
γ_{M1} for structural steel	1.10	$\gamma_{Mf,s}$ for fatigue strength of studs in shear	1.15

1.2 Material Information

■ Structural steel

$$f_{sk} = 355.000 \text{ MPa} \quad E_s = 210000.000 \text{ MPa}$$

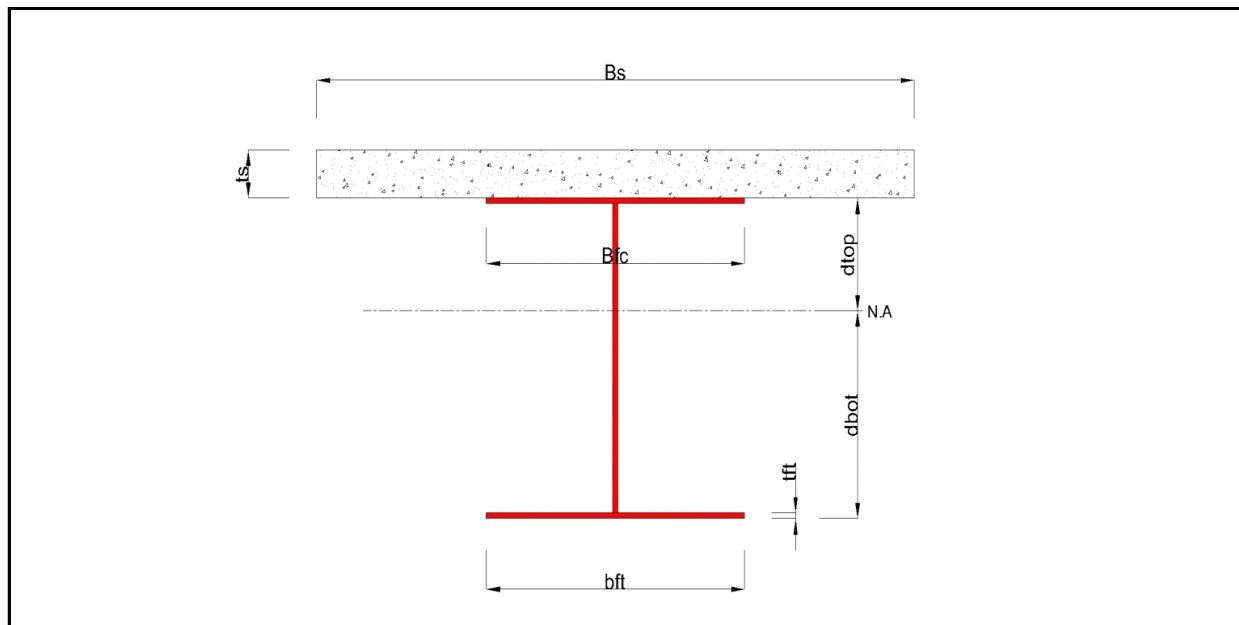
■ Concrete

$$f_{ck} = 25.000 \text{ MPa} \quad E_{cm} = 31000.000 \text{ MPa}$$

■ Reinforcement

$$f_{yk} = 450.000 \text{ MPa} \quad E_r = 210000.000 \text{ MPa}$$

1.3 Sectional Information



■ Section Dimensions

Slab

B_c	1785.000	mm	t_c	180.000	mm	H_h	70.000	mm
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Girder

H_w	880.000	mm	B_1	500.000	mm	B_2	600.000	mm
t_w	16.000	mm	t_{f1}	40.000	mm	t_{f2}	40.000	mm

■ Section Stiffness

Before

$A_{,a}$	58080.000	mm ²
$I_{y,a}$	10166603988.981	mm ⁴
$I_{z,a}$	1136967040.000	mm ⁴
$C_{y,a}$	300.000	mm
$C_{z,a}$	448.320	mm

After

$A_{,c}$	109097.816	mm ²
$I_{y,c}$	22557786117.381	mm ⁴
$I_{z,c}$	14683153704.391	mm ⁴
$C_{y,c}$	300.000	mm
$C_{z,c}$	762.420	mm

Crack

$A_{,c}$	60114.000	mm ²
$I_{y,c}$	11059374356.650	mm ⁴
$I_{z,c}$	1679385361.768	mm ⁴
$C_{y,c}$	300.000	mm
$C_{z,c}$	471.046	mm

2 Bending Resistance

2.1 Positive Moment

■ Design load

Load combination name : SLU

$N_{a,Ed}$	-2913.553	kN
$N_{c,Ed}$	481.545	kN
$M_{a,Ed}$	3244.673	kN · m
$M_{c,Ed}$	1476.499	kN · m

- Stress

Top Flange

Left	y_1	-250.000	mm	z_1	197.580	mm	σ_1	-201.219	MPa
	y_2	-8.000	mm	z_2	197.580	mm	σ_2	-221.321	MPa
Right	y_1	250.000	mm	z_1	197.580	mm	σ_1	-242.752	MPa
	y_2	8.000	mm	z_2	197.580	mm	σ_2	-222.650	MPa

Bottom Flange

Left	y_1	-300.000	mm	z_1	-762.420	mm	σ_1	172.154	MPa
	y_2	-8.000	mm	z_2	-762.420	mm	σ_2	147.899	MPa
Right	y_1	300.000	mm	z_1	-762.420	mm	σ_1	122.314	MPa
	y_2	8.000	mm	z_2	-762.420	mm	σ_2	146.570	MPa

Web

Right	y_1	0.000	mm	z_1	157.580	mm	σ_1	-206.602	MPa
	y_2	0.000	mm	z_2	-722.420	mm	σ_2	131.850	MPa

■ Classification of sections

Part	Class
Top flange	1
Web	1
Bottom flange	1
Section	1

- Plastic resistance moment, $M_{pl,Rd}$

Plastic NA = 775.716 mm

N_{slab} = 4551.750 kN

$N_{g,top}$ = 7542.411 kN (Upper side of PNA)

$N_{g,bot}$ = 12094.161 kN (Lower side of PNA)

$M_{pl,Rd}$ = 10330.399 kN · m

x_{pl} = 434.284 mm

M_{Rd} = $\beta M_{pl,Rd}$ = 10330.399 kN · m

here, β = 1.000

M_{Rd} = 10330.399 kN · m > M_{Ed} = 4721.171 kN · m ...OK

2 Bending Resistance

2.2 Negative Moment

■ Design load

Load combination name : SLU

$N_{a,Ed}$	-2913.553	kN
$N_{c,Ed}$	-638.355	kN
$M_{a,Ed}$	3244.673	kN · m
$M_{c,Ed}$	-83.696	kN · m

- Stress

Top Flange

Left	y_1	-250.000	mm	z_1	488.954	mm	σ_1	-231.729	MPa
	y_2	-8.000	mm	z_2	488.954	mm	σ_2	-220.749	MPa
Right	y_1	250.000	mm	z_1	488.954	mm	σ_1	-209.043	MPa
	y_2	8.000	mm	z_2	488.954	mm	σ_2	-220.023	MPa

Bottom Flange

Left	y_1	-300.000	mm	z_1	-471.046	mm	σ_1	65.121	MPa
	y_2	-8.000	mm	z_2	-471.046	mm	σ_2	78.370	MPa
Right	y_1	300.000	mm	z_1	-471.046	mm	σ_1	92.344	MPa
	y_2	8.000	mm	z_2	-471.046	mm	σ_2	79.096	MPa

Web

Right	y_1	0.000	mm	z_1	448.954	mm	σ_1	-207.923	MPa
	y_2	0.000	mm	z_2	-431.046	mm	σ_2	66.270	MPa

■ Classification of sections

Part	Class
Top flange	1
Web	2
Bottom flange	1
Section	2

- Plastic resistance moment, $M_{pl,Rd}$

Plastic NA = 428.566 mm

$N_{slab} = 0.000$ kN
 $N_{rebar,t} = 795.913$ kN (Upper side of PNA)
 $N_{rebar,b} = 0.000$ kN (Lower side of PNA)
 $N_{g,top} = 9420.329$ kN (Upper side of PNA)
 $N_{g,bot} = 10216.242$ kN (Lower side of PNA)

$M_{pl,Rd} = 8385.405$ kN · m
 $M_{Rd} = M_{pl,Rd} = 8385.405$ kN · m

$M_{Rd} = 8385.405$ kN · m > $M_{Ed} = 3160.976$ kN · m ...OK

3 Resistance to Vertical Shear

■ Design load

Load combination name : SLU

$N_{Ed} = -638.355$ kN
 $M_{a,Ed} = 3244.673$ kN · m
 $M_{c,Ed} = -83.696$ kN · m
 $V_{Ed,a} = -126.884$ kN
 $V_{Ed,c} = -157.362$ kN
 $V_{Ed} = -284.246$ kN

$M_{Ed} = \max(M_{Ed,t}, M_{Ed,b}) = 3609.962$ kN · m
 $M_{Ed,t} = 3609.962$ kN · m
 $M_{Ed,b} = 3275.610$ kN · m

- Stress

Top Flange

Left	y_1	-250.000	mm	z_1	488.954	mm	σ_1	-231.729	MPa
	y_2	-8.000	mm	z_2	488.954	mm	σ_2	-220.749	MPa
Right	y_1	250.000	mm	z_1	488.954	mm	σ_1	-209.043	MPa
	y_2	8.000	mm	z_2	488.954	mm	σ_2	-220.023	MPa

Bottom Flange

Left	y_1	-300.000	mm	z_1	-471.046	mm	σ_1	65.121	MPa
	y_2	-8.000	mm	z_2	-471.046	mm	σ_2	78.370	MPa
Right	y_1	300.000	mm	z_1	-471.046	mm	σ_1	92.344	MPa
	y_2	8.000	mm	z_2	-471.046	mm	σ_2	79.096	MPa

Web

Right	y ₁	0.000	mm	z ₁	448.954	mm	σ ₁	-207.923	MPa
	y ₂	0.000	mm	z ₂	-431.046	mm	σ ₂	66.270	MPa

■ Classification of sections

Part	Class
Top flange	1
Web	2
Bottom flange	1
Section	2

■ Plastic resistance moment, M_{pl,Rd}

Plastic NA = 428.566 mm

N_{slab} = 0.000 kN
 N_{rebar,t} = 795.913 kN (Upper side of PNA)
 N_{rebar,b} = 0.000 kN (Lower side of PNA)
 N_{g,top} = 9420.329 kN (Upper side of PNA)
 N_{g,bot} = 10216.242 kN (Lower side of PNA)

M_{pl,Rd} = 8385.405 kN · m

■ Calculation. V_{bw,Rd}

Web

■ Contribution from the web

λ_w = h_w / (86.4 · t · ε) = 0.782

X_w = 0.83 / λ_w = 1.061 0.83/η ≤ λ_w < 1.08

V_{bw,Rd} = $\frac{X_w \cdot f_{yw} \cdot h_w \cdot t}{\sqrt{3} \cdot \gamma_{M1}}$ = 2783.086 kN

V_{Rd} = 2783.086 kN

V_{Edi} = V_{Ed} / Num. of Web = -284.246 kN

η₃' = V_{Edi} / V_{bw,Rd} = 0.102 ≤ 1.0

■ Contribution from the flange

M_{f,Rd0} = 7107.204 kN · m

M_{f,Rd0} is calculated as M_{pl,Rd} but neglecting the web contribution.

Reduction factor for N_{Ed} = $1 - \frac{N_{Ed}}{(A_{f1} + A_{f2}) \cdot f_{yf} / \gamma_{M0}}$ = 0.957

M_{f,Rd} = Reduction factor for N_{Ed} · M_{f,Rd0} = 6802.226 kN · m

V_{bf,Rd} = $\frac{b_f \cdot t_f^2 \cdot f_{yf}}{c \cdot \gamma_{M1}} \left(1 - \left(\frac{M_{Ed}}{M_{f,Rd}} \right)^2 \right)$ = 0.000 kN

where, M_{f,Rd} = 6802.226 kN · m

M_{Ed} = 3609.962 kN · m (Taken as the greatest value of (Σσ_i)W)

$$c = a \cdot \left(0.25 + \frac{1.6 \cdot b_f \cdot t_f^2 \cdot f_{yf}}{t \cdot h_w^2 \cdot f_{yw}} \right) = 0.000$$

■ Check Shear Resistance

$$V_{Edi} / (V_{bw,Rd} + V_{bf,Rd}) = 0.102 < 1.0 \quad \dots \text{OK}$$

4 Resistance to Lateral Torsional Buckling

- Design load

Load combination name : SLU

$$\begin{aligned} N_{Ed} &= -3551.909 \text{ kN} \\ M_{Ed} &= 3160.976 \text{ kN} \cdot \text{m} \\ V_1 &= -290.256 \text{ kN} \\ V_2 &= -284.246 \text{ kN} \\ M_1 &= 3160.976 \text{ kN} \cdot \text{m} \\ M_2 &= 3032.440 \text{ kN} \cdot \text{m} \\ M_{pl,Rd} &= 8385.405 \text{ kN} \cdot \text{m} \\ M_{el,Rd} &= 6147.537 \text{ kN} \cdot \text{m} \end{aligned}$$

- $M_{b,Rd}$ Buckling resistance moment

$$\begin{aligned} L &= 0.962 \text{ m} \\ c &= C_d / I = 0.000 \text{ kN/m}^2 \\ \gamma &= c \cdot L^4 / (E \cdot I) = 0.000 \\ \mu &= V_2 / V_1 = 0.979 \\ \Phi &= 2 \cdot (1 - M_2 / M_1) / (1 + \mu) = 0.041 \\ m_1 &= 1 + 0.44 \cdot (1 + \mu) \cdot \Phi^{1.5} + (3 + 2 \cdot \Phi) \cdot \gamma / (350 - 50 \cdot \mu) = 1.007 \\ m_2 &= 1 + 0.44 \cdot (1 + \mu) \cdot \Phi^{1.5} + (0.195 + (0.05 + \mu / 100) \cdot \Phi) \cdot \gamma^{0.5} = 1.007 \\ m &= \min(m_1, m_2) = 1.007 \\ \alpha_{LT} &= 0.490 \\ \lambda_{LT} &= 1.103 \cdot L / b \cdot \sqrt{f_y / E_m} \cdot \sqrt{1 + A_{wc} / (3 \cdot A)} = 0.076 \\ \Phi_{LT} &= 0.5 \cdot (1 + \alpha_{LT} \cdot (\lambda_{LT} - 0.2) + \lambda_{LT}^2) = 0.472 \\ X_{LT} &= \frac{1}{\Phi_{LT} + \sqrt{(\Phi_{LT}^2 - \lambda_{LT}^2)}} = 1 \end{aligned}$$

$$\begin{aligned} M_{Rd} &= 8385.405 \text{ kN} \cdot \text{m} \\ M_{b,Rd} &= X_{LT} \cdot M_{Rd} = 8385.405 \text{ kN} \cdot \text{m} \end{aligned}$$

- $N_{b,Rd}$ Axial buckling resistance

$$\begin{aligned} X_{LT,N} &= 1.000 \\ N_{b,Rd} &= X_{LT} \cdot \text{Area} \cdot f_{yd} = 20324.257 \text{ kN} \end{aligned}$$

$$\text{Combined Ratio} = \frac{N_{Ed}}{N_{b,Rd}} + \frac{M_{Ed}}{M_{b,Rd}} = 0.55172373$$

6 Resistance to Longitudinal Shear

- Design load

Load combination name : SLU

$$\begin{aligned} N_{c,el} &= 4278.209 \text{ kN} \\ N_{c,f} &= 4551.750 \text{ kN} \\ M_{Ed} &= 4721.171 \text{ kN} \cdot \text{m} \end{aligned}$$

$$\begin{aligned} V_{Ed} &= 168.635 \text{ kN} \\ M_{pl,Rd} &= 10330.399 \text{ kN} \cdot \text{m} \\ M_{el,Rd} &= 5690.260 \text{ kN} \cdot \text{m} \end{aligned}$$

- Shear resistance of a single connector

$$\begin{aligned} P_{Rd,1} &= 0.8 \cdot f_u \cdot \pi \cdot d^2 / 4 / \gamma_V = 109.478 \text{ kN} \\ P_{Rd,2} &= 0.29 \cdot \alpha \cdot d^2 \cdot \sqrt{f_{ck} \cdot E_{cm}} / \gamma_V = 98.852 \text{ kN} \\ P_{Rd} &= \min(P_{Rd,1}, P_{Rd,2}) = 98.852 \text{ kN} \end{aligned}$$

$$\begin{aligned} \text{where, } f_u &= 450.000 \text{ MPa} \\ \alpha &= 1 && \text{for } h_{sc}/d > 4 \\ \text{Num.} &= 2 \\ d &= 22.000 \text{ mm} \\ h_{sc} &= 175.000 \text{ mm} \\ \text{Space} &= 200.000 \text{ mm} \end{aligned}$$

- Verification

$$\begin{aligned} v_{L,Ed} &= V_{Ed} \cdot (A \cdot z / I) = 135.771 \text{ kN/m} \\ v_{L,Rd} &= P_{Rd} \cdot \text{Num.} / \text{Space} = 988.517 \text{ kN/m} \\ v_{L,Ed} &< v_{L,Rd} \quad \dots \text{ OK} \end{aligned}$$

8 Longitudinal Shear for SLS(Serviceability limit state)

- Shear resistance of a single connector

Load combination name : Rara

$$\begin{aligned} P_{Rd,1} &= 0.8 \cdot f_u \cdot \pi \cdot d^2 / 4 / \gamma_V = 109.478 \text{ kN} \\ P_{Rd,2} &= 0.29 \cdot \alpha \cdot d^2 \cdot \sqrt{f_{ck} \cdot E_{cm}} / \gamma_V = 98.852 \text{ kN} \\ P_{Rd} &= \min(P_{Rd,1}, P_{Rd,2}) = 98.852 \text{ kN} \\ P_{Rd,ser} &= k_s \cdot P_{Rd} = 74.139 \text{ kN} \end{aligned}$$

$$\begin{aligned} \text{where, } f_u &= 450.000 \text{ MPa} \\ \alpha &= 1 && \text{for } h_{sc}/d > 4 \\ \text{Num.} &= 2 \\ d &= 22.000 \text{ mm} \\ h_{sc} &= 175.000 \text{ mm} \\ \text{Space} &= 200.000 \text{ mm} \\ k_s &= 0.750 \end{aligned}$$

- Verification

$$\begin{aligned} v_{L,Ed} &= V_{Ed} \cdot (A \cdot z / I) = 100.643 \text{ kN/m} \\ v_{L,Rd} &= P_{Rd,ser} \cdot \text{Num.} / \text{Space} = 741.388 \text{ kN/m} \\ v_{L,Ed} &< v_{L,Rd} \quad \dots \text{ OK} \end{aligned}$$

Element Number	501
Position Information	I

1 Design Condition

1.1 Design Parameters

■ Partial factors

γ_C for concrete	1.50	γ_V for headed stud	1.25
γ_S for reinforcing steel	1.15	γ_{Ff} for equivalent constant Amplitude stress range	1.00
γ_{M0} for structural steel	1.05	γ_{Mf} for fatigue strength	1.00
γ_{M1} for structural steel	1.10	$\gamma_{Mf,s}$ for fatigue strength of studs in shear	1.15

1.2 Material Information

■ Structural steel

$$f_{sk} = 355.000 \text{ MPa} \quad E_s = 210000.000 \text{ MPa}$$

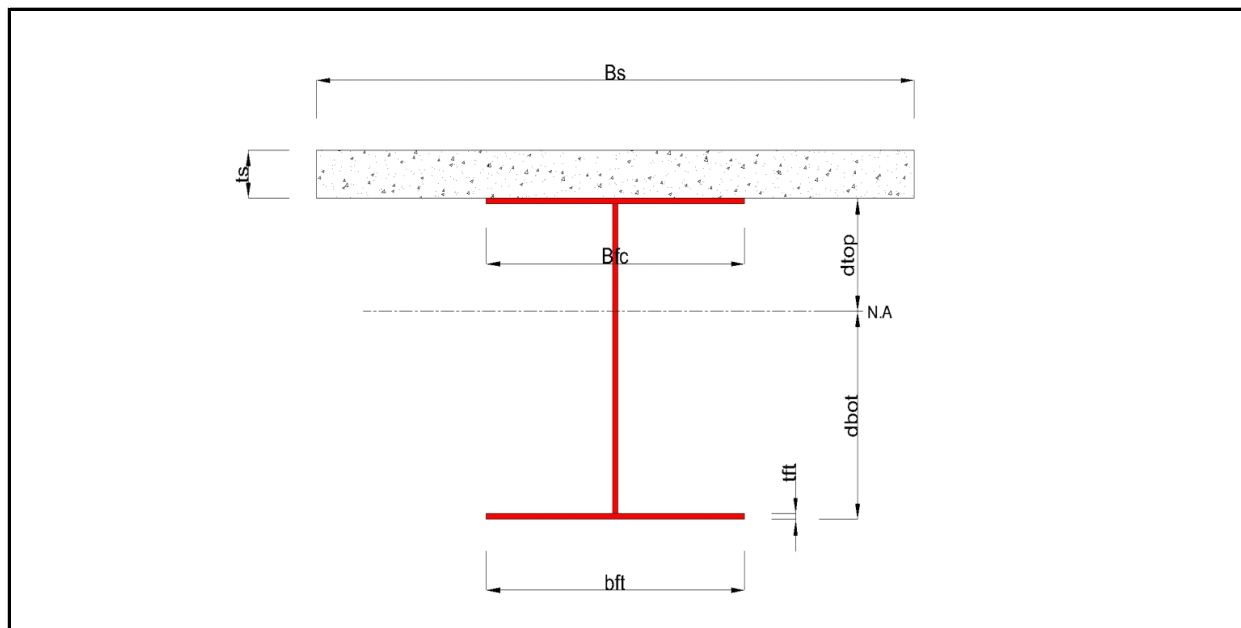
■ Concrete

$$f_{ck} = 25.000 \text{ MPa} \quad E_{cm} = 31000.000 \text{ MPa}$$

■ Reinforcement

$$f_{yk} = 450.000 \text{ MPa} \quad E_r = 210000.000 \text{ MPa}$$

1.3 Sectional Information



■ Section Dimensions

Slab

B_c	1785.000	mm	t_c	180.000	mm	H_h	70.000	mm
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Girder

H_w	880.000	mm	B_1	500.000	mm	B_2	600.000	mm
t_w	16.000	mm	t_{f1}	40.000	mm	t_{f2}	40.000	mm

■ Section Stiffness

Before

$A_{,a}$	58080.000	mm ²
$I_{y,a}$	10166603988.981	mm ⁴
$I_{z,a}$	1136967040.000	mm ⁴
$C_{y,a}$	300.000	mm
$C_{z,a}$	448.320	mm

After

$A_{,c}$	109097.816	mm ²
$I_{y,c}$	22557786117.381	mm ⁴
$I_{z,c}$	14683153704.391	mm ⁴
$C_{y,c}$	300.000	mm
$C_{z,c}$	762.420	mm

Crack

$A_{,c}$	60114.000	mm ²
$I_{y,c}$	11059374356.650	mm ⁴
$I_{z,c}$	1679385361.768	mm ⁴
$C_{y,c}$	300.000	mm
$C_{z,c}$	471.046	mm

2 Bending Resistance

2.1 Positive Moment

■ Design load

Load combination name : SLU

$N_{a,Ed}$	-3205.244	kN
$N_{c,Ed}$	566.523	kN
$M_{a,Ed}$	3714.625	kN · m
$M_{c,Ed}$	1726.769	kN · m

- Stress

Top Flange

Left	y_1	-250.000	mm	z_1	197.580	mm	σ_1	-248.997	MPa
	y_2	-8.000	mm	z_2	197.580	mm	σ_2	-251.975	MPa
Right	y_1	250.000	mm	z_1	197.580	mm	σ_1	-255.150	MPa
	y_2	8.000	mm	z_2	197.580	mm	σ_2	-252.172	MPa

Bottom Flange

Left	y_1	-300.000	mm	z_1	-762.420	mm	σ_1	175.865	MPa
	y_2	-8.000	mm	z_2	-762.420	mm	σ_2	172.272	MPa
Right	y_1	300.000	mm	z_1	-762.420	mm	σ_1	168.482	MPa
	y_2	8.000	mm	z_2	-762.420	mm	σ_2	172.075	MPa

Web

Right	y_1	0.000	mm	z_1	157.580	mm	σ_1	-234.397	MPa
	y_2	0.000	mm	z_2	-722.420	mm	σ_2	154.496	MPa

■ Classification of sections

Part	Class
Top flange	1
Web	2
Bottom flange	1
Section	2

- Plastic resistance moment, $M_{pl,Rd}$

Plastic NA = 428.566 mm

$N_{slab} = 0.000$ kN
 $N_{rebar,t} = 795.913$ kN (Upper side of PNA)
 $N_{rebar,b} = 0.000$ kN (Lower side of PNA)
 $N_{g,top} = 9420.329$ kN (Upper side of PNA)
 $N_{g,bot} = 10216.242$ kN (Lower side of PNA)

$M_{pl,Rd} = 8385.405$ kN · m
 $M_{Rd} = M_{pl,Rd} = 8385.405$ kN · m

$M_{Rd} = 8385.405$ kN · m > $M_{Ed} = 3622.532$ kN · m ...OK

3 Resistance to Vertical Shear

■ Design load

Load combination name : SLU

$N_{Ed} = -778.372$ kN
 $M_{a,Ed} = 3714.625$ kN · m
 $M_{c,Ed} = -92.092$ kN · m
 $V_{Ed,a} = -8.981$ kN
 $V_{Ed,c} = -146.502$ kN
 $V_{Ed} = -155.483$ kN

$M_{Ed} = \max(M_{Ed,t}, M_{Ed,b}) = 4136.548$ kN · m
 $M_{Ed,t} = 4136.548$ kN · m
 $M_{Ed,b} = 3753.769$ kN · m

- Stress

Top Flange

Left	y_1	-250.000	mm	z_1	488.954	mm	σ_1	-260.199	MPa
	y_2	-8.000	mm	z_2	488.954	mm	σ_2	-251.313	MPa
Right	y_1	250.000	mm	z_1	488.954	mm	σ_1	-241.838	MPa
	y_2	8.000	mm	z_2	488.954	mm	σ_2	-250.725	MPa

Bottom Flange

Left	y_1	-300.000	mm	z_1	-471.046	mm	σ_1	80.731	MPa
	y_2	-8.000	mm	z_2	-471.046	mm	σ_2	91.454	MPa
Right	y_1	300.000	mm	z_1	-471.046	mm	σ_1	102.764	MPa
	y_2	8.000	mm	z_2	-471.046	mm	σ_2	92.041	MPa

Web

Right	y ₁	0.000	mm	z ₁	448.954	mm	σ ₁	-236.737	MPa
	y ₂	0.000	mm	z ₂	-431.046	mm	σ ₂	77.465	MPa

■ Classification of sections

Part	Class
Top flange	1
Web	2
Bottom flange	1
Section	2

■ Plastic resistance moment, M_{pl,Rd}

Plastic NA = 428.566 mm

N_{slab} = 0.000 kN
 N_{rebar,t} = 795.913 kN (Upper side of PNA)
 N_{rebar,b} = 0.000 kN (Lower side of PNA)
 N_{g,top} = 9420.329 kN (Upper side of PNA)
 N_{g,bot} = 10216.242 kN (Lower side of PNA)

M_{pl,Rd} = 8385.405 kN · m

■ Calculation. V_{bw,Rd}

Web

■ Contribution from the web

λ_w = h_w / (86.4 · t · ε) = 0.782

X_w = 0.83 / λ_w = 1.061 0.83/η ≤ λ_w < 1.08

V_{bw,Rd} = $\frac{X_w \cdot f_{yw} \cdot h_w \cdot t}{\sqrt{3} \cdot \gamma_{M1}}$ = 2783.086 kN

V_{Rd} = 2783.086 kN

V_{Edi} = V_{Ed} / Num. of Web = -155.483 kN

η₃' = V_{Edi} / V_{bw,Rd} = 0.056 ≤ 1.0

■ Contribution from the flange

M_{f,Rd0} = 7107.204 kN · m

M_{f,Rd0} is calculated as M_{pl,Rd} but neglecting the web contribution.

Reduction factor for N_{Ed} = $1 - \frac{N_{Ed}}{(A_{f1} + A_{f2}) \cdot f_{yf} / \gamma_{M0}}$ = 0.948

M_{f,Rd} = Reduction factor for N_{Ed} · M_{f,Rd0} = 6735.332 kN · m

V_{bf,Rd} = $\frac{b_f \cdot t_f^2 \cdot f_{yf}}{c \cdot \gamma_{M1}} (1 - (\frac{M_{Ed}}{M_{f,Rd}})^2)$ = 0.000 kN

where, M_{f,Rd} = 6735.332 kN · m

M_{Ed} = 4136.548 kN · m (Taken as the greatest value of (Σσ_i)W)

$$c = a \cdot \left(0.25 + \frac{1.6 \cdot b_f \cdot t_f^2 \cdot f_{yf}}{t \cdot h_w^2 \cdot f_{yw}} \right) = 0.000$$

■ Check Shear Resistance

$$V_{Edi} / (V_{bw,Rd} + V_{bf,Rd}) = 0.056 < 1.0 \quad \dots \text{OK}$$

4 Resistance to Lateral Torsional Buckling

- Design load

Load combination name : SLU

$$\begin{aligned} N_{Ed} &= -3983.617 \text{ kN} \\ M_{Ed} &= 3622.532 \text{ kN} \cdot \text{m} \\ V_1 &= -155.483 \text{ kN} \\ V_2 &= -149.473 \text{ kN} \\ M_1 &= 3628.419 \text{ kN} \cdot \text{m} \\ M_2 &= 3622.532 \text{ kN} \cdot \text{m} \\ M_{pl,Rd} &= 8385.405 \text{ kN} \cdot \text{m} \\ M_{el,Rd} &= 6147.537 \text{ kN} \cdot \text{m} \end{aligned}$$

- $M_{b,Rd}$ Buckling resistance moment

$$\begin{aligned} L &= 0.962 \text{ m} \\ c &= C_d / I = 0.000 \text{ kN/m}^2 \\ \gamma &= c \cdot L^4 / (E \cdot I) = 0.000 \\ \mu &= V_2 / V_1 = 0.961 \\ \Phi &= 2 \cdot (1 - M_2 / M_1) / (1 + \mu) = 0.002 \\ m_1 &= 1 + 0.44 \cdot (1 + \mu) \cdot \Phi^{1.5} + (3 + 2 \cdot \Phi) \cdot \gamma / (350 - 50 \cdot \mu) = 1.000 \\ m_2 &= 1 + 0.44 \cdot (1 + \mu) \cdot \Phi^{1.5} + (0.195 + (0.05 + \mu / 100) \cdot \Phi) \cdot \gamma^{0.5} = 1.000 \\ m &= \min(m_1, m_2) = 1.000 \\ \alpha_{LT} &= 0.490 \\ \lambda_{LT} &= 1.103 \cdot L / b \cdot \sqrt{f_y / E_m} \cdot \sqrt{1 + A_{wc} / (3 \cdot A)} = 0.076 \\ \Phi_{LT} &= 0.5 \cdot (1 + \alpha_{LT} \cdot (\lambda_{LT} - 0.2) + \lambda_{LT}^2) = 0.473 \\ X_{LT} &= \frac{1}{\Phi_{LT} + \sqrt{(\Phi_{LT}^2 - \lambda_{LT}^2)}} = 1 \end{aligned}$$

$$\begin{aligned} M_{Rd} &= 8385.405 \text{ kN} \cdot \text{m} \\ M_{b,Rd} &= X_{LT} \cdot M_{Rd} = 8385.405 \text{ kN} \cdot \text{m} \end{aligned}$$

- $N_{b,Rd}$ Axial buckling resistance

$$\begin{aligned} X_{LT,N} &= 1.000 \\ N_{b,Rd} &= X_{LT} \cdot \text{Area} \cdot f_{yd} = 20324.257 \text{ kN} \end{aligned}$$

$$\text{Combined Ratio} = \frac{N_{Ed}}{N_{b,Rd}} + \frac{M_{Ed}}{M_{b,Rd}} = 0.628007514$$

6 Resistance to Longitudinal Shear

- Design load

Load combination name : SLU

$$\begin{aligned} N_{c,el} &= 3877.087 \text{ kN} \\ N_{c,f} &= 4551.750 \text{ kN} \\ M_{Ed} &= 5441.394 \text{ kN} \cdot \text{m} \end{aligned}$$

$$\begin{aligned} V_{Ed} &= 158.945 \text{ kN} \\ M_{pl,Rd} &= 10330.399 \text{ kN} \cdot \text{m} \\ M_{el,Rd} &= 8871.370 \text{ kN} \cdot \text{m} \end{aligned}$$

- Shear resistance of a single connector

$$\begin{aligned} P_{Rd,1} &= 0.8 \cdot f_u \cdot \pi \cdot d^2 / 4 / \gamma_V = 109.478 \text{ kN} \\ P_{Rd,2} &= 0.29 \cdot \alpha \cdot d^2 \cdot \sqrt{f_{ck} \cdot E_{cm}} / \gamma_V = 98.852 \text{ kN} \\ P_{Rd} &= \min(P_{Rd,1}, P_{Rd,2}) = 98.852 \text{ kN} \end{aligned}$$

$$\begin{aligned} \text{where, } f_u &= 450.000 \text{ MPa} \\ \alpha &= 1 && \text{for } h_{sc}/d > 4 \\ \text{Num.} &= 2 \\ d &= 22.000 \text{ mm} \\ h_{sc} &= 175.000 \text{ mm} \\ \text{Space} &= 200.000 \text{ mm} \end{aligned}$$

- Verification

$$\begin{aligned} V_{L,Ed} &= V_{Ed} \cdot (A \cdot z / l) = 127.969 \text{ kN/m} \\ V_{L,Rd} &= P_{Rd} \cdot \text{Num.} / \text{Space} = 988.517 \text{ kN/m} \\ V_{L,Ed} &< V_{L,Rd} \quad \dots \text{ OK} \end{aligned}$$

8 Longitudinal Shear for SLS(Serviceability limit state)

- Shear resistance of a single connector

Load combination name : Rara

$$\begin{aligned} P_{Rd,1} &= 0.8 \cdot f_u \cdot \pi \cdot d^2 / 4 / \gamma_V = 109.478 \text{ kN} \\ P_{Rd,2} &= 0.29 \cdot \alpha \cdot d^2 \cdot \sqrt{f_{ck} \cdot E_{cm}} / \gamma_V = 98.852 \text{ kN} \\ P_{Rd} &= \min(P_{Rd,1}, P_{Rd,2}) = 98.852 \text{ kN} \\ P_{Rd,ser} &= k_s \cdot P_{Rd} = 74.139 \text{ kN} \end{aligned}$$

$$\begin{aligned} \text{where, } f_u &= 450.000 \text{ MPa} \\ \alpha &= 1 && \text{for } h_{sc}/d > 4 \\ \text{Num.} &= 2 \\ d &= 22.000 \text{ mm} \\ h_{sc} &= 175.000 \text{ mm} \\ \text{Space} &= 200.000 \text{ mm} \\ k_s &= 0.750 \end{aligned}$$

- Verification

$$\begin{aligned} V_{L,Ed} &= V_{Ed} \cdot (A \cdot z / l) = 94.729 \text{ kN/m} \\ V_{L,Rd} &= P_{Rd,ser} \cdot \text{Num.} / \text{Space} = 741.388 \text{ kN/m} \\ V_{L,Ed} &< V_{L,Rd} \quad \dots \text{ OK} \end{aligned}$$

7.3 VERIFICA TRAVE ESISTENTE IN CAP

Element Number	176
Position Information	I

1.Design Condition

1.1 Design Parameters

- Partial factors for ultimate limit states

(EN 1992-1-1:2004, 2.4.2.4)

Design Situations	γ_c for concrete	γ_s for reinforcing steel	γ_s for prestressing steel
Persistent & Transient	1.500	1.150	1.150
Accidental	1.200	1.000	1.000

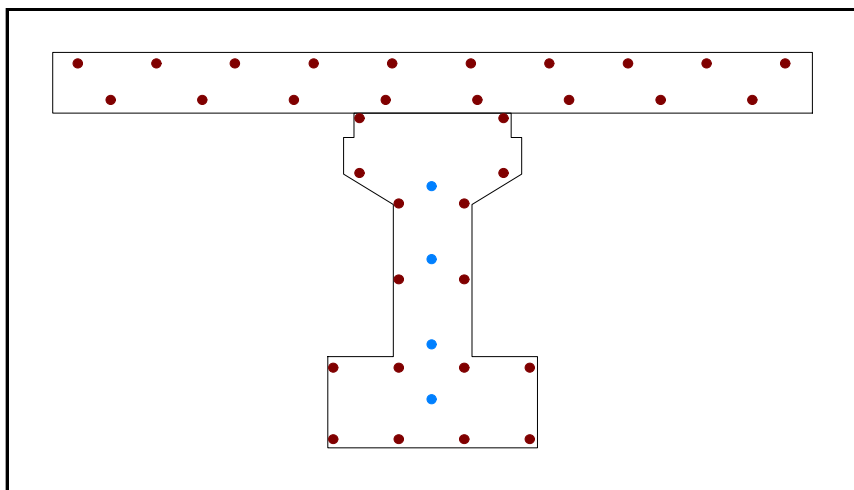
- factor α_{cc} , α_{ct} : Coefficient for long term effects on Compression and Tensile Strength.

α_{cc} = 0.850 (for the Compressive strength)

α_{ct} = 0.850 (for the Tensile strength)

1.2 Sectional Information

Section Information	EquvInt sect(tdn, reinfmnt) (Girder)	EquvInt sect (After Comp) (Girder + Slab)
A (mm ²)	609421.150	1196595.329
I_y (mm ⁴)	77464624579.735	224629726954.271
y_{st} (mm)	-	454.809
y_{sb} (mm)	-	254.809
y_t (mm)	596.743	254.809
y_b (mm)	503.257	845.191
Z_{st} (mm ³)	-	309913188.806
Z_{sb} (mm ³)	-	361766663.775
Z_t (mm ³)	69805166.534	361766663.775
Z_b (mm ³)	52353874.901	4535616873.906



1.3 Material Information

■ Girder

(EN 1992-1-1:2004, Table 3.1)

- Concrete Material Information

$$\begin{aligned} f_{ck(g)} &= 35.000 \text{ MPa} \\ E_{c(g)} &= 34077.000 \text{ MPa} \\ f_{cm} &= f_{ck} + 8 = 43.000 \text{ MPa} \\ f_{ctm} &= 0.30 \cdot f_{ck}^{(2/3)} = 3.210 \text{ MPa} \quad (f_{ck} \leq C50/60) \\ f_{ctk;0.05} &= 0.7 \cdot f_{ctm} = 2.247 \text{ MPa} \end{aligned}$$

- Reinforcement Material Information

$$f_{yk(g)} = 450.000 \text{ MPa}, \quad E_{s(g)} = 206000.000 \text{ MPa}$$

■ Slab

(EN 1992-1-1:2004, Table 3.1)

- Concrete Material Information

$$\begin{aligned} f_{ck(s)} &= 20.000 \text{ MPa} \\ E_{c(s)} &= 29961.000 \text{ MPa} \\ f_{cm} &= f_{ck} + 8 = 28.000 \text{ MPa} \\ f_{ctm} &= 0.30 \cdot f_{ck}^{(2/3)} = 2.210 \text{ MPa} \quad (f_{ck} \leq C50/60) \\ f_{ctk;0.05} &= 0.7 \cdot f_{ctm} = 1.547 \text{ MPa} \end{aligned}$$

- Reinforcement Material Information

$$f_{yk(s)} = 450.000 \text{ MPa}, \quad E_{s(s)} = 206000.000 \text{ MPa}$$

1.4 Tendon Profile Information

Type	Tendon Name	Location (mm)	Area (mm ²)	Strength (MPa)		E _p (MPa)
				f _{pk}	f _{p0.1k}	
1	ab	443.3	1385.442	1670.000	1470.000	195000.000
2	cd	683.3	1385.442	1670.000	1470.000	195000.000
3	ef	963.3	1385.442	1670.000	1470.000	195000.000
4	gh	1143.3	1385.442	1670.000	1470.000	195000.000

2.Ultimate Moment Resistance

■ Positive Moment

1 Check Moment Resistance, M_{R,d}

- Design Load

Load Combination Name : SLU
Design Situations : Persistent & Transient
Load Combination Type : FX-MAX
M_{Ed} = 86.482 kN · m

- factor λ, and factor η

$$\begin{aligned} \lambda_{(g)} &= 0.800 \quad (f_{ck} \leq 50 \text{ MPa}) \\ \lambda_{(s)} &= 0.800 \quad (f_{ck} \leq 50 \text{ MPa}) \\ \eta_{(g)} &= 1.000 \quad (f_{ck} \leq 50 \text{ MPa}) \\ \eta_{(s)} &= 1.000 \quad (f_{ck} \leq 50 \text{ MPa}) \end{aligned}$$

- Design strength of concrete

(EN 1992-1-1:2004, 3.1.6(1))

$$\begin{aligned} \text{Girder : } f_{cd(g)} &= \alpha_{cc} \cdot f_{ck(g)} / \gamma_c = 19.833 \text{ MPa} \\ \text{Slab : } f_{cd(s)} &= \alpha_{cc} \cdot f_{ck(s)} / \gamma_c = 11.333 \text{ MPa} \end{aligned}$$

- Design strength of Reinforcement

(EN 1992-1-1:2004, 3.2.7)

$$\begin{aligned} \text{Girder : } f_{yd(g)} &= f_{yk(g)} / \gamma_{s_rebar} = 391.304 \text{ MPa} \\ \text{Slab : } f_{yd(s)} &= f_{yk(s)} / \gamma_{s_rebar} = 391.304 \text{ MPa} \end{aligned}$$

- Calculate Neutral Axis

- 1) Assume neutral axis depth.
- 2) Calculate the strain of steel and tendon.
- 3) Calculate the stress of steel and tendon.
- 4) Calculate the axial force in concrete, steel, and tendon.
- 5) Check if the resultant force of cross-section is zero.
- 6) Repeat step 1 through 5 until the resultant force becomes zero.

Num.	Neutral depth (mm)	Compression Force (C) (kN)		Tension Force (T) (kN)		Ratio (C/T)
		Concrete	Reinforcement	Concrete	Tendon	
1	650.0	10234.567	741.913	950.870	4926.025	1.86773
2	325.0	7287.333	618.261	1074.522	6970.173	0.98271
3	487.5	9008.867	680.087	1012.696	5257.375	1.54527
4	406.3	8132.233	680.087	1012.696	6712.206	1.14077
5	365.6	7693.917	618.261	1074.522	6826.858	1.05199
6	345.3	7480.708	618.261	1074.522	6894.301	1.01633
7	335.2	7384.021	618.261	1074.522	6931.087	0.99958

- Calculate $F_{c(g)}$, $F_{c(s)}$, F_s , F_p (EN 1992-1-1:2004, Fig 3.5, Fig 6.1)

$$\begin{aligned}
 F_{c(g)} &= (\eta_{(g)} \cdot f_{cd(g)}) \cdot A_{ca(g)} = 810.688 \text{ kN} && : \text{Compression Force for Girder} \\
 F_{c(s)} &= (\eta_{(s)} \cdot f_{cd(s)}) \cdot A_{ca(s)} = 6573.333 \text{ kN} && : \text{Compression Force for Slab} \\
 F_{s'} &= f_{s'} \cdot A_{s'} = 618.261 \text{ kN} && : \text{Compression reinforcement Force} \\
 F_s &= f_s \cdot A_s = 1074.522 \text{ kN} && : \text{Tension Force in reinforcement} \\
 F_p &= \sum F_{pi} = 6931.087 \text{ kN} && : \text{Tension Force in Tendon} \\
 \text{where, } a &= \lambda \cdot x = 268.125 \text{ mm} \\
 x &= 335.156 \text{ mm} && : \text{neutral axis depth} \\
 A_{ca(g)} &= 40875.000 \text{ mm}^2 && : \text{Area of rectangular con'c stress block for girder part} \\
 A_{ca(s)} &= 580000.000 \text{ mm}^2 && : \text{Area of rectangular con'c stress block for slab part} \\
 A_{s'} &= 1580.000 \text{ mm}^2 && : \text{Compression reinforcement areas} \\
 A_s &= 2746.000 \text{ mm}^2 && : \text{Tension reinforcement areas}
 \end{aligned}$$

Num.	Stress _{Eff} (MPa)	$\Delta \epsilon_{pi}$	$\epsilon_{p(0)i}$	ϵ_{pi}	f_{pi} (MPa)	A_{pi} (mm ²)	F_{pi} (kN)
ab	947.735	0.00113	0.00486	0.00599	1168.016	1385.442	1618.219
cd	964.044	0.00364	0.00494	0.00858	1278.261	1385.442	1770.956
ef	974.976	0.00656	0.00500	0.01156	1278.261	1385.442	1770.956
gh	985.365	0.00844	0.00505	0.01349	1278.261	1385.442	1770.956
$F_p = \sum (F_{pi}) =$							6931.087

where, Stress_Eff = $\epsilon_{p(0)i} \cdot E_{pi}$

$$\begin{aligned}
 \Delta \epsilon_{pi} &: \text{concrete strain at tendon depth under fracture state} \\
 \epsilon_{p(0)i} &: \text{tendon strain under the effective Prestressing stress} \\
 \epsilon_{pi} &= \Delta \epsilon_{pi} + \epsilon_{p(0)i} \\
 f_{pi} &= \min(\epsilon_{pi} E_{pi}, f_{pd}) \\
 f_{pd} &= f_{p0,1k} / \gamma_s \\
 F_{pi} &= f_{pi} \cdot A_{pi}
 \end{aligned}$$

- Calculate moment resistance, M_{Rd}

$$\begin{aligned}
 M_{Rd} &= F_{c(g)} \cdot a_{c(g)} + F_{c(s)} \cdot a_{c(s)} + F_s \cdot a_s + \sum (F_{pi} \cdot a_{pi}) \\
 &= 5886.735 \text{ kN} \cdot \text{m} \geq M_{Ed} = 86.482 \text{ kN} \cdot \text{m}
 \end{aligned}$$

where,

$a_{c(g)}$, $a_{c(s)}$, a_s , a_p is the distance from the neutral axis to the centroid of the stress block in concrete,

■ Negative Moment

1 Check Moment Resistance, $M_{R,d}$

- Design Load

Load Combination Name : SLU

Design Situations : Persistent & Transient

Load Combination Type : FX-MIN

$M_{Ed} = -23.267 \text{ kN} \cdot \text{m}$

- factor λ , and factor η

$\lambda_{(g)} = 0.800 \quad (f_{ck} \leq 50 \text{ MPa})$

$\lambda_{(s)} = 0.800 \quad (f_{ck} \leq 50 \text{ MPa})$

$\eta_{(g)} = 1.000 \quad (f_{ck} \leq 50 \text{ MPa})$

$\eta_{(s)} = 1.000 \quad (f_{ck} \leq 50 \text{ MPa})$

- Design strength of concrete

(EN 1992-1-1:2004, 3.1.6(1))

Girder : $f_{cd(g)} = \alpha_{cc} \cdot f_{ck(g)} / \gamma_c = 19.833 \text{ MPa}$

Slab : $f_{cd(s)} = \alpha_{cc} \cdot f_{ck(s)} / \gamma_c = 11.333 \text{ MPa}$

- Design strength of Reinforcement

(EN 1992-1-1:2004, 3.2.7)

Girder : $f_{yd(g)} = f_{yk(g)} / \gamma_{s_rebar} = 391.304 \text{ MPa}$

Slab : $f_{yd(s)} = f_{yk(s)} / \gamma_{s_rebar} = 391.304 \text{ MPa}$

- Calculate Neutral Axis

- 1) Assume neutral axis depth.
- 2) Calculate the strain of steel and tendon.
- 3) Calculate the stress of steel and tendon.
- 4) Calculate the axial force in concrete, steel, and tendon.
- 5) Check if the resultant force of cross-section is zero.
- 6) Repeat step 1 through 5 until the resultant force becomes zero.

Num.	Neutral depth (mm)	Compression Force (C) (kN)		Tension Force (T) (kN)		Ratio (C/T)
		Concrete	Reinforcement	Concrete	Tendon	
1	650.0	6069.000	950.870	741.913	1613.678	2.98009
2	325.0	4125.333	889.043	803.739	4926.638	0.87505
3	487.5	5295.500	889.043	803.739	3357.124	1.48636
4	406.3	4908.750	889.043	803.739	3541.913	1.33416
5	365.6	4641.000	889.043	803.739	3541.913	1.27255
6	345.3	4383.167	889.043	803.739	3541.913	1.21322
7	335.2	4254.250	889.043	803.739	4896.956	0.90222
8	340.2	4318.708	889.043	803.739	3541.913	1.19838
9	337.7	4286.479	889.043	803.739	3541.913	1.19097
10	336.4	4270.365	889.043	803.739	4893.372	0.90562
11	337.1	4278.422	889.043	803.739	3541.913	1.18911
12	336.7	4274.393	889.043	803.739	3541.913	1.18818
13	336.6	4272.379	889.043	803.739	4892.925	0.90604
14	336.7	4273.386	889.043	803.739	4892.703	0.90626
15	336.7	4273.890	889.043	803.739	3541.913	1.18807
16	336.7	4273.638	889.043	803.739	3541.913	1.18801
17	336.7	4273.512	889.043	803.739	3541.913	1.18798
18	336.7	4273.449	889.043	803.739	4892.689	0.90627
19	336.7	4273.480	889.043	803.739	3541.913	1.18797
20	336.7	4273.449	889.043	803.739	4892.689	0.90627

- Calculate $F_{c(g)}$, $F_{c(s)}$, F_s , F_p (EN 1992-1-1:2004, Fig 3.5, Fig 6.1)

$$\begin{aligned} F_{c(g)} &= (\eta_{(g)} \cdot f_{cd(g)}) \cdot A_{ca(g)} = 4273.449 \text{ kN} && : \text{Compression Force for Girder} \\ F_{c(s)} &= (\eta_{(s)} \cdot f_{cd(s)}) \cdot A_{ca(s)} = 0.000 \text{ kN} && : \text{Compression Force for Slab} \\ F_{s'} &= f_{s'} \cdot A_{s'} = 889.043 \text{ kN} && : \text{Compression reinforcement Force} \\ F_s &= f_s \cdot A_s = 803.739 \text{ kN} && : \text{Tension Force in reinforcement} \\ F_p &= \sum F_{pi} = 4892.689 \text{ kN} && : \text{Tension Force in Tendon} \\ \text{where, } a &= \lambda \cdot x = 269.336 \text{ mm} \\ x &= 336.669 \text{ mm} && : \text{neutral axis depth} \\ A_{ca(g)} &= 215468.018 \text{ mm}^2 && : \text{Area of rectangular con'c stress block for girder part} \\ A_{ca(s)} &= 0.000 \text{ mm}^2 && : \text{Area of rectangular con'c stress block for slab part} \\ A_{s'} &= 2272.000 \text{ mm}^2 && : \text{Compression reinforcement areas} \\ A_s &= 2054.000 \text{ mm}^2 && : \text{Tension reinforcement areas} \end{aligned}$$

Num.	Stress _{Eff} (MPa)	$\Delta \epsilon_{pi}$	$\epsilon_{p(0)i}$	ϵ_{pi}	f_{pi} (MPa)	A_{pi} (mm ²)	F_{pi} (kN)
ab	947.735	0.00541	0.00486	0.01027	1278.261	1385.442	1770.956
cd	964.044	0.00291	0.00494	0.00785	1278.261	1385.442	1770.956
$F_p = \sum (F_{pi}) =$							4892.689

where, Stress_Eff = $\epsilon_{p(0)i} \cdot E_{pi}$

$\Delta \epsilon_{pi}$: concrete strain at tendon depth under fracture state

$\epsilon_{p(0)i}$: tendon strain under the effective Prestressing stress

$$\epsilon_{pi} = \Delta \epsilon_{pi} + \epsilon_{p(0)i}$$

$$f_{pi} = \min(\epsilon_{pi} E_{pi}, f_{pd})$$

$$f_{pd} = f_{p0,1k} / \gamma_s$$

$$F_{pi} = f_{pi} \cdot A_{pi}$$

- Calculate moment resistance, M_{Rd}

$$\begin{aligned} M_{Rd} &= F_{c(g)} \cdot a_{c(g)} + F_{c(s)} \cdot a_{c(s)} + F_s \cdot a_s + \sum (F_{pi} \cdot a_{pi}) \\ &= 3070.391 \text{ kN} \cdot \text{m} \geq M_{Ed} = -23.267 \text{ kN} \cdot \text{m} \end{aligned}$$

where,

$a_{c(g)}$, $a_{c(s)}$, a_s , a_p is the distance from the neutral axis to the centroid of the stress block in concrete,

3. Shear Resistance

■ Maximum Shear For ce

1) Check shear resistance of Concrete, $V_{Rd,c}$

- Design Load

$$\begin{aligned} \text{Load Combination Name : } & \text{SLU} \\ \text{Design Situations : } & \text{Persistent \& Transient} \\ \text{Load Combination Type : } & \text{FZ-MAX} \\ N_{Ed} &= -10710.296 \text{ kN} \\ V_{Ed} &= 68.120 \text{ kN} \\ M_{Ed} &= 52.809 \text{ kN} \cdot \text{m} \\ V_p &= 0.000 \text{ kN} \end{aligned}$$

- Design strength of concrete

$$\begin{aligned} \text{Girder : } f_{cd(g)} &= \alpha_{cc} \cdot f_{ck(g)} / \gamma_c = 23.333 \text{ MPa} \\ \text{Slab : } f_{cd(s)} &= \alpha_{cc} \cdot f_{ck(s)} / \gamma_c = 13.333 \text{ MPa} \end{aligned}$$

- Design strength of Reinforcement

$$\begin{aligned} \text{Girder : } f_{yd(g)} &= f_{yk(g)} / \gamma_{s_rebar} = 391.304 \text{ MPa} \\ \text{Slab : } f_{yd(s)} &= f_{yk(s)} / \gamma_{s_rebar} = 391.304 \text{ MPa} \end{aligned}$$

- Check whether the section is cracked in bending.

$$f_b = -13.329 \text{ MPa} < f_{ctd} = 1.273 \text{ MPa}$$

(The section is uncracked.)

where, f_b : Flexural tensile stress (Tension is taken as positive.)
 $f_{ctd} = \alpha_{ct} \cdot f_{ctk,0.05} / \gamma_c$: Design tensile strength of concrete.

- Total stress at composite centroid from actions on the girder alone

$$\sigma_{tot} = \sigma_1 + \sigma_2 = 8.675 \text{ MPa} \quad (\text{DESIGNER'S GUIDE TO EN 1992-2, 6.2.7})$$

where,

$$\sigma_1 = (M_{non} \cdot y') / I_g = 0.237 \text{ MPa}$$

$$\sigma_2 = P / A_g + (P \cdot e \cdot y') / I_g = 8.438 \text{ MPa}$$

σ_1 : stress at the composite centroid due to the moment acting on the girder alone

σ_2 : stress at the composite centroid due to prestress

$$M_{non} = 53.643 \text{ kN} \cdot \text{m}$$

: Bending Moment in girder alone

$$y_{non} = 503.257 \text{ mm}$$

: Height to Centroid in girder alone

$$y_{com} = 845.191 \text{ mm}$$

: Height to Centroid in Composite section

$$y' = y_{com} - y_{non} = 341.935 \text{ mm}$$

$$A_g = 609421.150 \text{ mm}^2$$

: Area Girder alone

$$I_g = 7.7465 \text{E}+10 \text{ mm}^4$$

: Moment of inertia in Girder alone

$$P = 5364.598 \text{ kN}$$

: A factored prestressing force after all losses

$$P \cdot e = -82.649 \text{ kN} \cdot \text{m}$$

: Moment of prestressing force

- Shear stress in girder alone at the height of the composite centroid

$$\tau_s = (V_{c1} / b_w) (Q_n / I_g) = 0.022 \text{ MPa}$$

where,

$$V_{c1} = 25.024 \text{ kN} \quad \text{: Shear force on the precast girder alone}$$

$$Q_n = 2.0596 \text{E}+07 \text{ mm}^3 \quad \text{: First moment of Area in centroid of Girder alone}$$

$$I_g = 7.7465 \text{E}+10 \text{ mm}^4 \quad \text{: Moment of inertia in Girder alone}$$

$$b_w = 300.000 \text{ mm} \quad \text{: Girder width}$$

- Additional shear force acting on the composite section

$$V_{c2} = (I_c \cdot b_w / Q_c) \cdot \{ \sqrt{((f_{ctd})^2 + f_{ctd} \cdot \sigma_{tot})} - \tau_s \} = 1052.827 \text{ kN}$$

where,

$$Q_c = 2.2639 \text{E}+08 \text{ mm}^3 \quad \text{: First moment of Area in centroid of Composite section}$$

$$I_c = 2.2463 \text{E}+11 \text{ mm}^4 \quad \text{: Moment of inertia in Composite section}$$

$$b_w = 300.000 \text{ mm} \quad \text{: Girder width}$$

- Total shear resistance of the composite section (regions Un-cracked in bending)

$$V_{Rd,c} = V_{c1} + V_{c2} = 1077.851 \text{ kN} > V_{Ed} = 68.120 \text{ kN} \quad \text{OK}$$

\therefore No shear reinforcement is required

- 2) Check minimum shear reinforcement (EN 1992-1-1:2004, 9.2.2(5))

- Check ratio of shear reinforcement

$$\rho_{w, \min} = 0.08 \cdot \sqrt{f_{ck} / f_{yk}} = 0.00105$$

$$\rho_w = A_{sw} / (s \cdot b_w \cdot \sin \alpha) = 0.00803 \geq \rho_{w, \min} = 0.00105 \quad \text{OK}$$

where, $\rho_{w, \min}$ is the minimum ratio of shear reinforcement

$$A_{sw} = 602.000 \text{ mm}^2 \quad \text{: Area of diagonal reinforcement}$$

- Check Spacing of stirrups

$$S_{l, \max} = 0.75 \cdot d \cdot (1 + \cot \alpha) = 828.750 \text{ mm}$$

$$s = 250.000 \text{ mm} \leq S_{l,max} = 828.750 \text{ mm} \quad \text{OK}$$

where, s is the spacing of the stirrups

$$d = 1105.000 \text{ mm} : \text{effective depth}$$

3) Check additional tension force in the longitudinal reinforcement due to shear force (EN 1992-1-1;2004, 6.2.3.(7))

$$\Delta F_{td} = 0.5 \cdot V_{Ed} \cdot (\cot\theta - \cot\alpha) = 85.156 \text{ kN}$$

$$(M_{Rd} - M_{Ed}) / z = 7933.793 \text{ kN}$$

$$\Delta F_{td} \leq (M_{Rd} - M_{Ed}) / z \quad \text{OK}$$

where, $M_{Rd} = 5886.735 \text{ kN} : \text{The moment resistance}$

$$z = 735.326 \text{ mm} : \text{Lever arm from the ultimate bending resistance analysis}$$

■ Minimum Shear Force

1) Check shear resistance of Concrete, $V_{Rd,c}$

- Design Load

Load Combination Name : SLU
Design Situations : Persistent & Transient
Load Combination Type : FX-MIN

$$N_{Ed} = -10783.689 \text{ kN}$$

$$V_{Ed} = -838.180 \text{ kN}$$

$$M_{Ed} = -23.267 \text{ kN} \cdot \text{m}$$

$$V_p = 0.000 \text{ kN}$$

- Design strength of concrete

Girder : $f_{cd(g)} = \alpha_{cc} \cdot f_{ck(g)} / \gamma_c = 23.333 \text{ MPa}$

Slab : $f_{cd(s)} = \alpha_{cc} \cdot f_{ck(s)} / \gamma_c = 13.333 \text{ MPa}$

- Design strength of Reinforcement

Girder : $f_{yd(g)} = f_{yk(g)} / \gamma_{s_rebar} = 391.304 \text{ MPa}$

Slab : $f_{yd(s)} = f_{yk(s)} / \gamma_{s_rebar} = 391.304 \text{ MPa}$

- Check whether the section is cracked in bending.

$$f_b = -26.729 \text{ MPa} < f_{ctd} = 1.273 \text{ MPa}$$

(The section is uncracked.)

where, f_b : Flexural tensile stress (Tension is taken as positive.)

$$f_{ctd} = \alpha_{ct} \cdot f_{ctk,0.05} / \gamma_c : \text{Design tensile strength of concrete.}$$

- Total stress at composite centroid from actions on the girder alone

$$\sigma_{tot} = \sigma_1 + \sigma_2 = 8.675 \text{ MPa} \quad (\text{DESIGNER'S GUIDE TO EN 1992-2, 6.2.7})$$

where,

$$\sigma_1 = (M_{non} \cdot y') / I_g = 0.237 \text{ MPa}$$

$$\sigma_2 = P / A_g + (P \cdot e \cdot y') / I_g = 8.438 \text{ MPa}$$

σ_1 : stress at the composite centroid due to the moment acting on the girder alone

σ_2 : stress at the composite centroid due to prestress

$$M_{non} = 53.643 \text{ kN} \cdot \text{m} : \text{Bending Moment in girder alone}$$

$$y_{non} = 503.257 \text{ mm} : \text{Height to Centroid in girder alone}$$

$$y_{com} = 845.191 \text{ mm} : \text{Height to Centroid in Composite section}$$

$$y' = y_{com} - y_{non} = 341.935 \text{ mm}$$

$$A_g = 609421.150 \text{ mm}^2 : \text{Area Girder alone}$$

$$I_g = 7.7465E+10 \text{ mm}^4 : \text{Moment of inertia in Girder alone}$$

$$P = 5364.598 \text{ kN} : \text{A factored prestressing force after all losses}$$

$$P \cdot e = -82.649 \text{ kN} \cdot \text{m} : \text{Moment of prestressing force}$$

- Shear stress in girder alone at the height of the composite centroid

$$\tau_s = (V_{c1} / b_w) (Q_n / I_g) = 0.022 \text{ MPa}$$

where,

$$\begin{aligned} V_{c1} &= 25.024 \text{ kN} && \text{: Shear force on the precast girder alone} \\ Q_n &= 2.0596\text{E}+07 \text{ mm}^3 && \text{: First moment of Area in centroid of Girder alone} \\ I_g &= 7.7465\text{E}+10 \text{ mm}^4 && \text{: Moment of inertia in Girder alone} \\ b_w &= 300.000 \text{ mm} && \text{: Girder width} \end{aligned}$$

- Additional shear force acting on the composite section

$$V_{c2} = (I_c \cdot b_w / Q_c) \cdot \{ \sqrt{((f_{ctd})^2 + f_{ctd} \cdot \sigma_{tot})} - \tau_s \} = 1052.827 \text{ kN}$$

where,

$$\begin{aligned} Q_c &= 2.2639\text{E}+08 \text{ mm}^3 && \text{: First moment of Area in centroid of Composite section} \\ I_c &= 2.2463\text{E}+11 \text{ mm}^4 && \text{: Moment of inertia in Composite section} \\ b_w &= 300.000 \text{ mm} && \text{: Girder width} \end{aligned}$$

- Total shear resistance of the composite section (regions Un-cracked in bending)

$$V_{Rd,c} = V_{c1} + V_{c2} = 1077.851 \text{ kN} > V_{Ed} = -838.180 \text{ kN} \quad \text{OK}$$

∴ No shear reinforcement is required

2) Check minimum shear reinforcement (EN 1992-1-1:2004, 9.2.2(5))

- Check ratio of shear reinforcement

$$\begin{aligned} \rho_{w, \min} &= 0.08 \cdot \sqrt{f_{ck} / f_{yk}} = 0.00105 \\ \rho_w &= A_{sw} / (s \cdot b_w \cdot \sin \alpha) = 0.00803 \geq \rho_{w, \min} = 0.00105 \quad \text{OK} \end{aligned}$$

where, $\rho_{w, \min}$ is the minimum ratio of shear reinforcement

$$A_{sw} = 602.000 \text{ mm}^2 \quad \text{: Area of diagonal reinforcement}$$

- Check Spacing of stirrups

$$\begin{aligned} S_{l, \max} &= 0.75 \cdot d \cdot (1 + \cot \alpha) = 875.455 \text{ mm} \\ s &= 250.000 \text{ mm} \leq S_{l, \max} = 875.455 \text{ mm} \quad \text{OK} \end{aligned}$$

where, s is the spacing of the stirrups

$$d = 1167.273 \text{ mm} \quad \text{: effective depth}$$

3) Check additional tension force in the longitudinal reinforcement due to shear force (EN 1992-1-1:2004, 6.2.3.(7))

$$\begin{aligned} \Delta F_{td} &= 0.5 \cdot V_{Ed} \cdot (\cot \theta - \cot \alpha) = 1047.799 \text{ kN} \\ (M_{Rd} - M_{Ed}) / z &= 5123.388 \text{ kN} \\ \Delta F_{td} &\leq (M_{Rd} - M_{Ed}) / z \quad \text{OK} \end{aligned}$$

where, $M_{Rd} = 3070.391 \text{ kN}$: The moment resistance

$$z = 594.748 \text{ mm} \quad \text{: Lever arm from the ultimate bending resistance analysis}$$

Element Number	183
Position Information	J

1.Design Condition

1.1 Design Parameters

- Partial factors for ultimate limit states

(EN 1992-1-1:2004, 2.4.2.4)

Design Situations	γ_c for concrete	γ_s for reinforcing steel	γ_s for prestressing steel
Persistent & Transient	1.500	1.150	1.150
Accidental	1.200	1.000	1.000

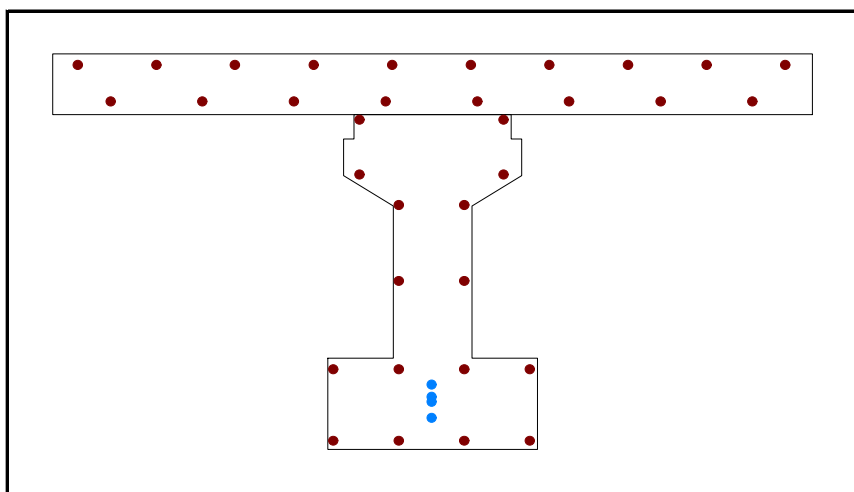
- factor α_{cc} , α_{ct} : Coefficient for long term effects on Compression and Tensile Strength.

α_{cc} = 0.850 (for the Compressive strength)

α_{ct} = 0.850 (for the Tensile strength)

1.2 Sectional Information

Section Information	EqvInt sect(tdn, reinfmnt) (Girder)	EqvInt sect (After Comp) (Girder + Slab)
A (mm ²)	609421.150	1196595.329
I_y (mm ⁴)	78627973127.371	231823448435.582
y_{st} (mm)	-	462.103
y_{sb} (mm)	-	262.103
y_t (mm)	611.066	262.103
y_b (mm)	488.934	837.897
Z_{st} (mm ³)	-	308777238.528
Z_{sb} (mm ³)	-	360127298.997
Z_t (mm ³)	72029409.475	360127298.997
Z_b (mm ³)	54022057.106	4219774961.243



1.3 Material Information

■ Girder

(EN 1992-1-1:2004, Table 3.1)

- Concrete Material Information

$f_{ck(g)}$ = 35.000 MPa

$E_{c(g)}$ = 34077.000 MPa

f_{cm} = $f_{ck} + 8$ = 43.000 MPa

f_{ctm} = $0.30 \cdot f_{ck}^{(2/3)}$ = 3.210 MPa ($f_{ck} \leq C50/60$)

$f_{ctk;0.05}$ = $0.7 \cdot f_{ctm}$ = 2.247 MPa

- Reinforcement Material Information

$$f_{yk(g)} = 450.000 \text{ MPa} , \quad E_{s(g)} = 206000.000 \text{ MPa}$$

■ Slab

(EN 1992-1-1:2004, Table 3.1)

- Concrete Material Information

$$f_{ck(s)} = 20.000 \text{ MPa}$$

$$E_{c(s)} = 29961.000 \text{ MPa}$$

$$f_{cm} = f_{ck} + 8 = 28.000 \text{ MPa}$$

$$f_{ctm} = 0.30 \cdot f_{ck}^{(2/3)} = 2.210 \text{ MPa} \quad (f_{ck} \leq C50/60)$$

$$f_{ctk;0.05} = 0.7 \cdot f_{ctm} = 1.547 \text{ MPa}$$

- Reinforcement Material Information

$$f_{yk(s)} = 450.000 \text{ MPa} , \quad E_{s(s)} = 206000.000 \text{ MPa}$$

1.4 Tendon Profile Information

Type	Tendon Name	Location (mm)	Area (mm ²)	Strength (MPa)		E _p (MPa)
				f _{pk}	f _{p0.1k}	
1	ab	1090.2	1385.442	1670.000	1470.000	195000.000
2	cd	1131.0	1385.442	1670.000	1470.000	195000.000
3	ef	1146.5	1385.442	1670.000	1470.000	195000.000
4	gh	1199.7	1385.442	1670.000	1470.000	195000.000

2. Ultimate Moment Resistance

■ Positive Moment

1 Check Moment Resistance, M_{R,d}

- Design Load

Load Combination Name : SLU

Design Situations : Persistent & Transient

Load Combination Type : FX-MAX

$$M_{Ed} = 4690.593 \text{ kN} \cdot \text{m}$$

- factor λ, and factor η

$$\lambda_{(g)} = 0.800 \quad (f_{ck} \leq 50 \text{ MPa})$$

$$\lambda_{(s)} = 0.800 \quad (f_{ck} \leq 50 \text{ MPa})$$

$$\eta_{(g)} = 1.000 \quad (f_{ck} \leq 50 \text{ MPa})$$

$$\eta_{(s)} = 1.000 \quad (f_{ck} \leq 50 \text{ MPa})$$

- Design strength of concrete

(EN 1992-1-1:2004, 3.1.6(1))

$$\text{Girder : } f_{cd(g)} = \alpha_{cc} \cdot f_{ck(g)} / \gamma_c = 19.833 \text{ MPa}$$

$$\text{Slab : } f_{cd(s)} = \alpha_{cc} \cdot f_{ck(s)} / \gamma_c = 11.333 \text{ MPa}$$

- Design strength of Reinforcement

(EN 1992-1-1:2004, 3.2.7)

$$\text{Girder : } f_{yd(g)} = f_{yk(g)} / \gamma_{s_rebar} = 391.304 \text{ MPa}$$

$$\text{Slab : } f_{yd(s)} = f_{yk(s)} / \gamma_{s_rebar} = 391.304 \text{ MPa}$$

- Calculate Neutral Axis

1) Assume neutral axis depth.

2) Calculate the strain of steel and tendon.

3) Calculate the stress of steel and tendon.

4) Calculate the axial force in concrete, steel, and tendon.

5) Check if the resultant force of cross-section is zero.

6) Repeat step 1 through 5 until the resultant force becomes zero.

Num.	Neutral depth (mm)	Compression Force (C) (kN)		Tension Force (T) (kN)		Ratio (C/T)
		Concrete	Reinforcement	Concrete	Tendon	
1	650.0	10234.567	741.913	950.870	7083.825	1.36614
2	325.0	7287.333	618.261	1074.522	7083.825	0.96902
3	487.5	9008.867	680.087	1012.696	7083.825	1.19668
4	406.3	8132.233	680.087	1012.696	7083.825	1.08841
5	365.6	7693.917	618.261	1074.522	7083.825	1.01886
6	345.3	7480.708	618.261	1074.522	7083.825	0.99272
7	355.5	7584.338	618.261	1074.522	7083.825	1.00542
8	350.4	7529.548	618.261	1074.522	7083.825	0.99871
9	352.9	7556.943	618.261	1074.522	7083.825	1.00207
10	351.7	7543.245	618.261	1074.522	7083.825	1.00039

- Calculate $F_{c(g)}$, $F_{c(s)}$, F_s , F_p (EN 1992-1-1:2004, Fig 3.5, Fig 6.1)

$$\begin{aligned}
 F_{c(g)} &= (\eta_{(g)} \cdot f_{cd(g)}) \cdot A_{ca(g)} = 969.912 \text{ kN} && : \text{Compression Force for Girder} \\
 F_{c(s)} &= (\eta_{(s)} \cdot f_{cd(s)}) \cdot A_{ca(s)} = 6573.333 \text{ kN} && : \text{Compression Force for Slab} \\
 F_{s'} &= f_{s'} \cdot A_{s'} = 618.261 \text{ kN} && : \text{Compression reinforcement Force} \\
 F_s &= f_s \cdot A_s = 1074.522 \text{ kN} && : \text{Tension Force in reinforcement} \\
 F_p &= \sum F_{pi} = 7083.825 \text{ kN} && : \text{Tension Force in Tendon} \\
 \text{where, } a &= \lambda \cdot x = 281.328 \text{ mm} \\
 x &= 351.660 \text{ mm} && : \text{neutral axis depth} \\
 A_{ca(g)} &= 48903.125 \text{ mm}^2 && : \text{Area of rectangular con'c stress block for girder part} \\
 A_{ca(s)} &= 580000.000 \text{ mm}^2 && : \text{Area of rectangular con'c stress block for slab part} \\
 A_{s'} &= 1580.000 \text{ mm}^2 && : \text{Compression reinforcement areas} \\
 A_s &= 2746.000 \text{ mm}^2 && : \text{Tension reinforcement areas}
 \end{aligned}$$

Num.	Stress _{Eff} (MPa)	$\Delta \epsilon_{pi}$	$\epsilon_{p(0)i}$	ϵ_{pi}	f_{pi} (MPa)	A_{pi} (mm ²)	F_{pi} (kN)
ab	998.275	0.00735	0.00512	0.01247	1278.261	1385.442	1770.956
cd	1002.571	0.00776	0.00514	0.01290	1278.261	1385.442	1770.956
ef	1001.155	0.00791	0.00513	0.01305	1278.261	1385.442	1770.956
gh	1006.114	0.00844	0.00516	0.01360	1278.261	1385.442	1770.956
$F_p = \sum (F_{pi}) =$							7083.825

where, $\text{Stress_Eff} = \epsilon_{p(0)i} \cdot E_{pi}$

$\Delta \epsilon_{pi}$: concrete strain at tendon depth under fracture state

$\epsilon_{p(0)i}$: tendon strain under the effective Prestressing stress

$$\begin{aligned}
 \epsilon_{pi} &= \Delta \epsilon_{pi} + \epsilon_{p(0)i} \\
 f_{pi} &= \min(\epsilon_{pi} E_{pi}, f_{pd}) \\
 f_{pd} &= f_{p0,1k} / \gamma_s \\
 F_{pi} &= f_{pi} \cdot A_{pi}
 \end{aligned}$$

- Calculate moment resistance, M_{Rd}

$$\begin{aligned}
 M_{Rd} &= F_{c(g)} \cdot a_{c(g)} + F_{c(s)} \cdot a_{c(s)} + F_s \cdot a_s + \sum (F_{pi} \cdot a_{pi}) \\
 &= 8275.536 \text{ kN} \cdot \text{m} \geq M_{Ed} = 4690.593 \text{ kN} \cdot \text{m}
 \end{aligned}$$

where,

$a_{c(g)}$, $a_{c(s)}$, a_s , a_p is the distance from the neutral axis to the centroid of the stress block in concrete,

■ Negative Moment

1 Check Moment Resistance, $M_{R,d}$

- Design Load

Load Combination Name : SLU
Design Situations : Persistent & Transient
Load Combination Type : MY-MIN
 $M_{Ed} = 0.000 \text{ kN} \cdot \text{m}$

- factor λ , and factor η

$\lambda_{(g)} = 0.800 \quad (f_{ck} \leq 50 \text{ MPa})$
 $\lambda_{(s)} = 0.800 \quad (f_{ck} \leq 50 \text{ MPa})$
 $\eta_{(g)} = 1.000 \quad (f_{ck} \leq 50 \text{ MPa})$
 $\eta_{(s)} = 1.000 \quad (f_{ck} \leq 50 \text{ MPa})$

- Design strength of concrete (EN 1992-1-1:2004, 3.1.6(1))

Girder : $f_{cd(g)} = \alpha_{cc} \cdot f_{ck(g)} / \gamma_c = 19.833 \text{ MPa}$
Slab : $f_{cd(s)} = \alpha_{cc} \cdot f_{ck(s)} / \gamma_c = 11.333 \text{ MPa}$

- Design strength of Reinforcement (EN 1992-1-1:2004, 3.2.7)

Girder : $f_{yd(g)} = f_{yk(g)} / \gamma_{s_rebar} = 391.304 \text{ MPa}$
Slab : $f_{yd(s)} = f_{yk(s)} / \gamma_{s_rebar} = 391.304 \text{ MPa}$

- Calculate Neutral Axis

- 1) Assume neutral axis depth.
- 2) Calculate the strain of steel and tendon.
- 3) Calculate the stress of steel and tendon.
- 4) Calculate the axial force in concrete, steel, and tendon.
- 5) Check if the resultant force of cross-section is zero.
- 6) Repeat step 1 through 5 until the resultant force becomes zero.

Num.	Neutral depth (mm)	Compression Force (C) (kN)		Tension Force (T) (kN)		Ratio (C/T)
		Concrete	Reinforcement	Concrete	Tendon	
1	650.0	6069.000	950.870	741.913	0.000	9.46185
2	325.0	4125.333	889.043	803.739	0.000	6.23881
3	162.5	2062.667	491.478	1201.304	3085.064	0.59588
4	243.8	3094.000	491.478	1201.304	0.000	2.98465
5	203.1	2578.333	491.478	1201.304	1414.282	1.17366
6	182.8	2320.500	491.478	1201.304	1522.815	1.03225
7	172.7	2191.583	491.478	1201.304	1586.657	0.96237
8	177.7	2256.042	491.478	1201.304	1553.824	0.99724
9	180.3	2288.271	491.478	1201.304	1538.101	1.01473
10	179.0	2272.156	491.478	1201.304	1545.907	1.00598
11	178.4	2264.099	491.478	1201.304	1549.851	1.00161
12	178.1	2260.070	491.478	1201.304	1551.834	0.99942

- Calculate $F_{c(g)}$, $F_{c(s)}$, F_s , F_p (EN 1992-1-1:2004, Fig 3.5, Fig 6.1)

$F_{c(g)} = (\eta_{(g)} \cdot f_{cd(g)}) \cdot A_{ca(g)} = 2260.070 \text{ kN}$: Compression Force for Girder
 $F_{c(s)} = (\eta_{(s)} \cdot f_{cd(s)}) \cdot A_{ca(s)} = 0.000 \text{ kN}$: Compression Force for Slab
 $F_s = f_s \cdot A_s = 491.478 \text{ kN}$: Compression reinforcement Force
 $F_s = f_s \cdot A_s = 1201.304 \text{ kN}$: Tension Force in reinforcement
 $F_p = \sum F_{pi} = 1551.834 \text{ kN}$: Tension Force in Tendon
 where, $a = \lambda \cdot x = 142.441 \text{ mm}$

$x = 178.052 \text{ mm}$: neutral axis depth
 $A_{ca(g)} = 113953.125 \text{ mm}^2$: Area of rectangular con'c stress block for girder part
 $A_{ca(s)} = 0.000 \text{ mm}^2$: Area of rectangular con'c stress block for slab part

$A_{s'} = 1256.000 \text{ mm}^2$: Compression reinforcement areas
 $A_s = 3070.000 \text{ mm}^2$: Tension reinforcement areas

Num.	Stress _{Eff} (MPa)	$\Delta \epsilon_{pi}$	$\epsilon_{p(0)i}$	ϵ_{pi}	f_{pi} (MPa)	A_{pi} (mm ²)	F_{pi} (kN)
ab	998.275	0.00062	0.00512	0.00574	1120.100	1385.442	1551.834
$F_p = \sum (F_{pi}) =$							1551.834

where, $\text{Stress}_{\text{Eff}} = \epsilon_{p(0)i} \cdot E_{pi}$

$\Delta \epsilon_{pi}$: concrete strain at tendon depth under fracture state

$\epsilon_{p(0)i}$: tendon strain under the effective Prestressing stress

$\epsilon_{pi} = \Delta \epsilon_{pi} + \epsilon_{p(0)i}$

$f_{pi} = \min(\epsilon_{pi} E_{pi}, f_{pd})$

$f_{pd} = f_{p0,1k} / \gamma_s$

$F_{pi} = f_{pi} \cdot A_{pi}$

- Calculate moment resistance, M_{Rd}

$$M_{Rd} = F_{c(g)} \cdot a_{c(g)} + F_{c(s)} \cdot a_{c(s)} + F_s \cdot a_s + \sum (F_{pi} \cdot a_{pi})$$

$$= 1132.773 \text{ kN} \cdot \text{m} \geq M_{Ed} = 0.000 \text{ kN} \cdot \text{m} \quad \text{OK}$$

where,

$a_{c(g)}$, $a_{c(s)}$, a_s , a_p is the distance from the neutral axis to the centroid of the stress block in concrete,

3. Shear Resistance

Maximum Shear Force

1) Check shear resistance of Concrete, $V_{Rd,c}$

- Design Load

Load Combination Name : SLU
Design Situations : Persistent & Transient
Load Combination Type : FX-MAX
 $N_{Ed} = -10929.056 \text{ kN}$
 $V_{Ed} = 468.198 \text{ kN}$
 $M_{Ed} = 4690.593 \text{ kN} \cdot \text{m}$
 $V_p = 0.000 \text{ kN}$

- Design strength of concrete

Girder : $f_{cd(g)} = \alpha_{cc} \cdot f_{ck(g)} / \gamma_c = 23.333 \text{ MPa}$
Slab : $f_{cd(s)} = \alpha_{cc} \cdot f_{ck(s)} / \gamma_c = 13.333 \text{ MPa}$

- Design strength of Reinforcement

Girder : $f_{yd(g)} = f_{yk(g)} / \gamma_{s_rebar} = 391.304 \text{ MPa}$
Slab : $f_{yd(s)} = f_{yk(s)} / \gamma_{s_rebar} = 391.304 \text{ MPa}$

- Check whether the section is cracked in bending.

$f_b = -8.009 \text{ MPa} < f_{ctd} = 1.273 \text{ MPa}$
(The section is uncracked.)

where, f_b : Flexural tensile stress (Tension is taken as positive.)
 $f_{ctd} = \alpha_{ct} \cdot f_{ctk,0.05} / \gamma_c$: Design tensile strength of concrete.

- Total stress at composite centroid from actions on the girder alone

$\sigma_{tot} = \sigma_1 + \sigma_2 = 3.979 \text{ MPa}$ (DESIGNER'S GUIDE TO EN 1992-2, 6.2.7)
where,
 $\sigma_1 = (M_{non} \cdot y') / I_g = 3.022 \text{ MPa}$

$$\sigma_2 = P / A_g + (P \cdot e \cdot y') / I_g = 0.957 \text{ MPa}$$

σ_1 : stress at the composite centroid due to the moment acting on the girder alone

σ_2 : stress at the composite centroid due to prestress

M_{non}	=	680.983 kN · m	: Bending Moment in girder alone
y_{non}	=	488.934 mm	: Height to Centroid in girder alone
y_{com}	=	837.897 mm	: Height to Centroid in Composite section
y'	=	$y_{com} - y_{non}$	= 348.963 mm
A_g	=	609421.150 mm ²	: Area Girder alone
I_g	=	7.8628E+10 mm ⁴	: Moment of inertia in Girder alone
P	=	5553.012 kN	: A factored prestressing force after all losses
$P \cdot e$	=	-1837.447 kN · m	: Moment of prestressing force

- Shear stress in girder alone at the height of the composite centroid

$$\tau_s = (V_{c1} / b_w) (Q_n / I_g) = 0.093 \text{ MPa}$$

where,

V_{c1}	=	100.796 kN	: Shear force on the precast girder alone
Q_n	=	2.1784E+07 mm ³	: First moment of Area in centroid of Girder alone
I_g	=	7.8628E+10 mm ⁴	: Moment of inertia in Girder alone
b_w	=	300.000 mm	: Girder width

- Additional shear force acting on the composite section

$$V_{c2} = (I_c \cdot b_w / Q_c) \cdot \{ \sqrt{((f_{ctd})^2 + f_{ctd} \cdot \sigma_{tot})} - \tau_s \} = 747.981 \text{ kN}$$

where,

Q_c	=	2.3180E+08 mm ³	: First moment of Area in centroid of Composite section
I_c	=	2.3182E+11 mm ⁴	: Moment of inertia in Composite section
b_w	=	300.000 mm	: Girder width

- Total shear resistance of the composite section (regions Un-cracked in bending)

$$V_{Rd,c} = V_{c1} + V_{c2} = 848.777 \text{ kN} > V_{Ed} = 468.198 \text{ kN} \quad \text{OK}$$

∴ No shear reinforcement is required

2) Check minimum shear reinforcement (EN 1992-1-1:2004, 9.2.2(5))

- Check ratio of shear reinforcement

$$\rho_{w, \min} = 0.08 \cdot \sqrt{f_{ck}} / f_{yk} = 0.00105$$

$$\rho_w = A_{sw} / (s \cdot b_w \cdot \sin \alpha) = 0.00803 \geq \rho_{w, \min} = 0.00105 \quad \text{OK}$$

where, $\rho_{w, \min}$ is the minimum ratio of shear reinforcement

$$A_{sw} = 602.000 \text{ mm}^2 \quad \text{: Area of diagonal reinforcement}$$

- Check Spacing of stirrups

$$S_{l, \max} = 0.75 \cdot d \cdot (1 + \cot \alpha) = 856.390 \text{ mm}$$

$$s = 250.000 \text{ mm} \leq S_{l, \max} = 856.390 \text{ mm} \quad \text{OK}$$

where, s is the spacing of the stirrups

$$d = 1141.853 \text{ mm} \quad \text{: effective depth}$$

3) Check additional tension force in the longitudinal reinforcement due to shear force (EN 1992-1-1:2004, 6.2.3.(7))

$$\Delta F_{td} = 0.5 \cdot V_{Ed} \cdot (\cot \theta - \cot \alpha) = 585.289 \text{ kN}$$

$$(M_{Rd} - M_{Ed}) / z = 3535.546 \text{ kN}$$

$$\Delta F_{td} \leq (M_{Rd} - M_{Ed}) / z \quad \text{OK}$$

where, M_{Rd} = 8275.536 kN : The moment resistance

$$z = 1013.972 \text{ mm} \quad \text{: Lever arm from the ultimate bending resistance analysis}$$

■ Minimum Shear Force

1) Check shear resistance of Concrete, $V_{Rd,c}$

- Design Load

Load Combination Name : SLU
Design Situations : Persistent & Transient
Load Combination Type : FX-MIN
 $N_{Ed} = -11410.447 \text{ kN}$
 $V_{Ed} = -299.363 \text{ kN}$
 $M_{Ed} = 223.852 \text{ kN} \cdot \text{m}$
 $V_p = 0.000 \text{ kN}$

- Design strength of concrete

Girder : $f_{cd(g)} = \alpha_{cc} \cdot f_{ck(g)} / \gamma_c = 23.333 \text{ MPa}$
Slab : $f_{cd(s)} = \alpha_{cc} \cdot f_{ck(s)} / \gamma_c = 13.333 \text{ MPa}$

- Design strength of Reinforcement

Girder : $f_{yd(g)} = f_{yk(g)} / \gamma_{s_rebar} = 391.304 \text{ MPa}$
Slab : $f_{yd(s)} = f_{yk(s)} / \gamma_{s_rebar} = 391.304 \text{ MPa}$

- Check whether the section is cracked in bending.

$f_b = -29.485 \text{ MPa} < f_{ctd} = 1.273 \text{ MPa}$
(The section is uncracked.)
where, f_b : Flexural tensile stress (Tension is taken as positive.)
 $f_{ctd} = \alpha_{ct} \cdot f_{ctk,0.05} / \gamma_c$: Design tensile strength of concrete.

- Total stress at composite centroid from actions on the girder alone

$\sigma_{tot} = \sigma_1 + \sigma_2 = 3.979 \text{ MPa}$ (DESIGNER'S GUIDE TO EN 1992-2, 6.2.7)

where,

$\sigma_1 = (M_{non} \cdot y') / I_g = 3.022 \text{ MPa}$
 $\sigma_2 = P / A_g + (P \cdot e \cdot y') / I_g = 0.957 \text{ MPa}$
 σ_1 : stress at the composite centroid due to the moment acting on the girder alone
 σ_2 : stress at the composite centroid due to prestress

$M_{non} = 680.983 \text{ kN} \cdot \text{m}$: Bending Moment in girder alone
 $y_{non} = 488.934 \text{ mm}$: Height to Centroid in girder alone
 $y_{com} = 837.897 \text{ mm}$: Height to Centroid in Composite section
 $y' = y_{com} - y_{non} = 348.963 \text{ mm}$
 $A_g = 609421.150 \text{ mm}^2$: Area Girder alone
 $I_g = 7.8628E+10 \text{ mm}^4$: Moment of inertia in Girder alone
 $P = 5553.012 \text{ kN}$: A factored prestressing force after all losses
 $P \cdot e = -1837.447 \text{ kN} \cdot \text{m}$: Moment of prestressing force

- Shear stress in girder alone at the height of the composite centroid

$\tau_s = (V_{c1} / b_w) (Q_n / I_g) = 0.093 \text{ MPa}$
where,
 $V_{c1} = 100.796 \text{ kN}$: Shear force on the precast girder alone
 $Q_n = 2.1784E+07 \text{ mm}^3$: First moment of Area in centroid of Girder alone
 $I_g = 7.8628E+10 \text{ mm}^4$: Moment of inertia in Girder alone
 $b_w = 300.000 \text{ mm}$: Girder width

- Additional shear force acting on the composite section

$V_{c2} = (I_c \cdot b_w / Q_c) \cdot \{ \sqrt{((f_{ctd})^2 + f_{ctd} \cdot \sigma_{tot})} - \tau_s \} = 747.981 \text{ kN}$

where,

$$\begin{aligned} Q_c &= 2.3180E+08 \text{ mm}^3 && : \text{First moment of Area in centroid of Composite section} \\ I_c &= 2.3182E+11 \text{ mm}^4 && : \text{Moment of inertia in Composite section} \\ b_w &= 300.000 \text{ mm} && : \text{Girder width} \end{aligned}$$

- Total shear resistance of the composite section (regions Un-cracked in bending)

$$V_{Rd,c} = V_{c1} + V_{c2} = 848.777 \text{ kN} > V_{Ed} = -299.363 \text{ kN} \quad \text{OK}$$

∴ No shear reinforcement is required

2) Check minimum shear reinforcement (EN 1992-1-1:2004, 9.2.2(5))

- Check ratio of shear reinforcement

$$\begin{aligned} \rho_{w, \min} &= 0.08 \cdot \sqrt{f_{ck}} / f_{yk} = 0.00105 \\ \rho_w &= A_{sw} / (s \cdot b_w \cdot \sin \alpha) = 0.00803 \geq \rho_{w, \min} = 0.00105 \quad \text{OK} \\ \text{where, } \rho_{w, \min} &\text{ is the minimum ratio of shear reinforcement} \\ A_{sw} &= 602.000 \text{ mm}^2 && : \text{Area of diagonal reinforcement} \end{aligned}$$

- Check Spacing of stirrups

$$\begin{aligned} S_{l, \max} &= 0.75 \cdot d \cdot (1 + \cot \alpha) = 856.390 \text{ mm} \\ s &= 250.000 \text{ mm} \leq S_{l, \max} = 856.390 \text{ mm} \quad \text{OK} \\ \text{where, } s &\text{ is the spacing of the stirrups} \\ d &= 1141.853 \text{ mm} && : \text{effective depth} \end{aligned}$$

3) Check additional tension force in the longitudinal reinforcement due to shear force (EN 1992-1-1:2004, 6.2.3.(7))

$$\begin{aligned} \Delta F_{td} &= 0.5 \cdot V_{Ed} \cdot (\cot \theta - \cot \alpha) = 374.230 \text{ kN} \\ (M_{Rd} - M_{Ed}) / z &= 7940.739 \text{ kN} \\ \Delta F_{td} &\leq (M_{Rd} - M_{Ed}) / z \quad \text{OK} \\ \text{where, } M_{Rd} &= 8275.536 \text{ kN} && : \text{The moment resistance} \\ z &= 1013.972 \text{ mm} && : \text{Lever arm from the ultimate bending resistance analysis} \end{aligned}$$

Element Number	187
Position Information	J

1.Design Condition

1.1 Design Parameters

- Partial factors for ultimate limit states

(EN 1992-1-1:2004, 2.4.2.4)

Design Situations	γ_c for concrete	γ_s for reinforcing steel	γ_s for prestressing steel
Persistent & Transient	1.500	1.150	1.150
Accidental	1.200	1.000	1.000

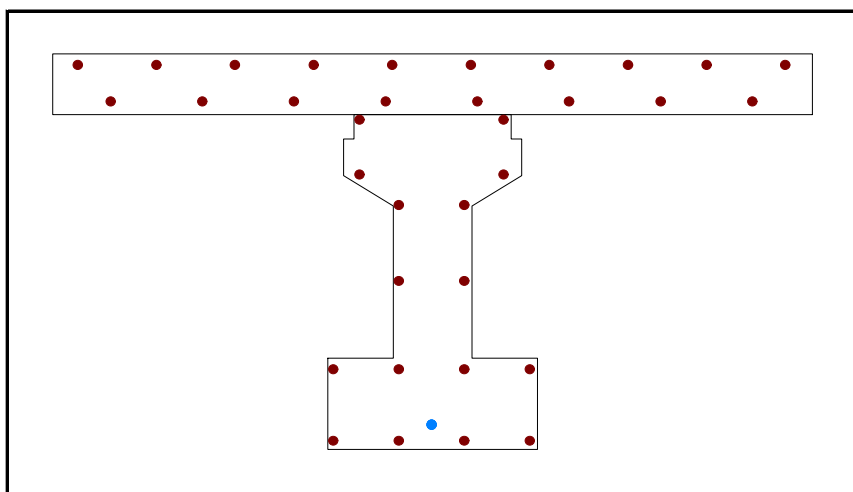
- factor α_{cc} , α_{ct} : Coefficient for long term effects on Compression and Tensile Strength.

$\alpha_{cc} = 0.850$ (for the Compressive strength)

$\alpha_{ct} = 0.850$ (for the Tensile strength)

1.2 Sectional Information

Section Information	EqvInt sect(tdn, reinfmnt) (Girder)	EqvInt sect (After Comp) (Girder + Slab)
A (mm ²)	609421.150	1196595.329
I _y (mm ⁴)	80139499847.381	234805209912.176
y _{st} (mm)	-	463.859
y _{sb} (mm)	-	263.859
y _t (mm)	614.514	263.859
y _b (mm)	485.486	836.141
Z _{st} (mm ³)	-	308702397.693
Z _{sb} (mm ³)	-	359965152.640
Z _t (mm ³)	73486657.966	359965152.640
Z _b (mm ³)	55114993.475	4152972538.400



1.3 Material Information

■ Girder

(EN 1992-1-1:2004, Table 3.1)

- Concrete Material Information

$f_{ck(g)} = 35.000$ MPa

$E_{c(g)} = 34077.000$ MPa

$f_{cm} = f_{ck} + 8 = 43.000$ MPa

$f_{ctm} = 0.30 \cdot f_{ck}^{(2/3)} = 3.210$ MPa ($f_{ck} \leq C50/60$)

$f_{ctk;0.05} = 0.7 \cdot f_{ctm} = 2.247$ MPa

- Reinforcement Material Information

$$f_{yk(g)} = 450.000 \text{ MPa} , \quad E_{s(g)} = 206000.000 \text{ MPa}$$

■ Slab

(EN 1992-1-1:2004, Table 3.1)

- Concrete Material Information

$$f_{ck(s)} = 20.000 \text{ MPa}$$

$$E_{c(s)} = 29961.000 \text{ MPa}$$

$$f_{cm} = f_{ck} + 8 = 28.000 \text{ MPa}$$

$$f_{ctm} = 0.30 \cdot f_{ck}^{(2/3)} = 2.210 \text{ MPa} \quad (f_{ck} \leq 50/60)$$

$$f_{ctk;0.05} = 0.7 \cdot f_{ctm} = 1.547 \text{ MPa}$$

- Reinforcement Material Information

$$f_{yk(s)} = 450.000 \text{ MPa} , \quad E_{s(s)} = 206000.000 \text{ MPa}$$

1.4 Tendon Profile Information

Type	Tendon Name	Location (mm)	Area (mm ²)	Strength (MPa)		E _p (MPa)
				f _{pk}	f _{p0.1k}	
1	ab	1221.5	1385.442	1670.000	1470.000	195000.000
2	cd	1222.1	1385.442	1670.000	1470.000	195000.000
3	ef	1222.1	1385.442	1670.000	1470.000	195000.000
4	gh	1223.0	1385.442	1670.000	1470.000	195000.000

2. Ultimate Moment Resistance

■ Positive Moment

1 Check Moment Resistance, M_{R,d}

- Design Load

Load Combination Name : SLU

Design Situations : Persistent & Transient

Load Combination Type : FX-MAX

$$M_{Ed} = 5008.693 \text{ kN} \cdot \text{m}$$

- factor λ, and factor η

$$\lambda_{(g)} = 0.800 \quad (f_{ck} \leq 50 \text{ MPa})$$

$$\lambda_{(s)} = 0.800 \quad (f_{ck} \leq 50 \text{ MPa})$$

$$\eta_{(g)} = 1.000 \quad (f_{ck} \leq 50 \text{ MPa})$$

$$\eta_{(s)} = 1.000 \quad (f_{ck} \leq 50 \text{ MPa})$$

- Design strength of concrete

(EN 1992-1-1:2004, 3.1.6(1))

$$\text{Girder : } f_{cd(g)} = \alpha_{cc} \cdot f_{ck(g)} / \gamma_c = 19.833 \text{ MPa}$$

$$\text{Slab : } f_{cd(s)} = \alpha_{cc} \cdot f_{ck(s)} / \gamma_c = 11.333 \text{ MPa}$$

- Design strength of Reinforcement

(EN 1992-1-1:2004, 3.2.7)

$$\text{Girder : } f_{yd(g)} = f_{yk(g)} / \gamma_{s_rebar} = 391.304 \text{ MPa}$$

$$\text{Slab : } f_{yd(s)} = f_{yk(s)} / \gamma_{s_rebar} = 391.304 \text{ MPa}$$

- Calculate Neutral Axis

1) Assume neutral axis depth.

2) Calculate the strain of steel and tendon.

3) Calculate the stress of steel and tendon.

4) Calculate the axial force in concrete, steel, and tendon.

5) Check if the resultant force of cross-section is zero.

6) Repeat step 1 through 5 until the resultant force becomes zero.

Num.	Neutral depth (mm)	Compression Force (C) (kN)		Tension Force (T) (kN)		Ratio (C/T)
		Concrete	Reinforcement	Concrete	Tendon	
1	650.0	10234.567	741.913	950.870	7083.825	1.36614
2	325.0	7287.333	618.261	1074.522	7083.825	0.96902
3	487.5	9008.867	680.087	1012.696	7083.825	1.19668
4	406.3	8132.233	680.087	1012.696	7083.825	1.08841
5	365.6	7693.917	618.261	1074.522	7083.825	1.01886
6	345.3	7480.708	618.261	1074.522	7083.825	0.99272
7	355.5	7584.338	618.261	1074.522	7083.825	1.00542
8	350.4	7529.548	618.261	1074.522	7083.825	0.99871
9	352.9	7556.943	618.261	1074.522	7083.825	1.00207
10	351.7	7543.245	618.261	1074.522	7083.825	1.00039

- Calculate $F_{c(g)}$, $F_{c(s)}$, F_s , F_p (EN 1992-1-1:2004, Fig 3.5, Fig 6.1)

$$\begin{aligned}
 F_{c(g)} &= (\eta_{(g)} \cdot f_{cd(g)}) \cdot A_{ca(g)} = 969.912 \text{ kN} && : \text{Compression Force for Girder} \\
 F_{c(s)} &= (\eta_{(s)} \cdot f_{cd(s)}) \cdot A_{ca(s)} = 6573.333 \text{ kN} && : \text{Compression Force for Slab} \\
 F_{s'} &= f_{s'} \cdot A_{s'} = 618.261 \text{ kN} && : \text{Compression reinforcement Force} \\
 F_s &= f_s \cdot A_s = 1074.522 \text{ kN} && : \text{Tension Force in reinforcement} \\
 F_p &= \sum F_{pi} = 7083.825 \text{ kN} && : \text{Tension Force in Tendon} \\
 \text{where, } a &= \lambda \cdot x = 281.328 \text{ mm} \\
 x &= 351.660 \text{ mm} && : \text{neutral axis depth} \\
 A_{ca(g)} &= 48903.125 \text{ mm}^2 && : \text{Area of rectangular con'c stress block for girder part} \\
 A_{ca(s)} &= 580000.000 \text{ mm}^2 && : \text{Area of rectangular con'c stress block for slab part} \\
 A_{s'} &= 1580.000 \text{ mm}^2 && : \text{Compression reinforcement areas} \\
 A_s &= 2746.000 \text{ mm}^2 && : \text{Tension reinforcement areas}
 \end{aligned}$$

Num.	Stress _{Eff} (MPa)	$\Delta \epsilon_{pi}$	$\epsilon_{p(0)i}$	ϵ_{pi}	f_{pi} (MPa)	A_{pi} (mm ²)	F_{pi} (kN)
ab	1010.368	0.00866	0.00518	0.01384	1278.261	1385.442	1770.956
cd	1014.907	0.00866	0.00520	0.01387	1278.261	1385.442	1770.956
ef	1012.695	0.00866	0.00519	0.01386	1278.261	1385.442	1770.956
gh	1013.065	0.00867	0.00520	0.01387	1278.261	1385.442	1770.956
$F_p = \sum (F_{pi}) =$							7083.825

where, $\text{Stress}_{\text{Eff}} = \epsilon_{p(0)i} \cdot E_{pi}$

$\Delta \epsilon_{pi}$: concrete strain at tendon depth under fracture state

$\epsilon_{p(0)i}$: tendon strain under the effective Prestressing stress

$$\begin{aligned}
 \epsilon_{pi} &= \Delta \epsilon_{pi} + \epsilon_{p(0)i} \\
 f_{pi} &= \min(\epsilon_{pi} E_{pi}, f_{pd}) \\
 f_{pd} &= f_{p0,1k} / \gamma_s \\
 F_{pi} &= f_{pi} \cdot A_{pi}
 \end{aligned}$$

- Calculate moment resistance, M_{Rd}

$$\begin{aligned}
 M_{Rd} &= F_{c(g)} \cdot a_{c(g)} + F_{c(s)} \cdot a_{c(s)} + F_s \cdot a_s + \sum (F_{pi} \cdot a_{pi}) \\
 &= 8844.374 \text{ kN} \cdot \text{m} \geq M_{Ed} = 5008.693 \text{ kN} \cdot \text{m}
 \end{aligned}$$

where,

$a_{c(g)}$, $a_{c(s)}$, a_s , a_p is the distance from the neutral axis to the centroid of the stress block in concrete,

■ Negative Moment

1 Check Moment Resistance, $M_{R,d}$

- Design Load

Load Combination Name : SLU
Design Situations : Persistent & Transient
Load Combination Type : MY-MIN
 $M_{Ed} = -128.832 \text{ kN} \cdot \text{m}$

- factor λ , and factor η

$\lambda_{(g)} = 0.800 \quad (f_{ck} \leq 50 \text{ MPa})$
 $\lambda_{(s)} = 0.800 \quad (f_{ck} \leq 50 \text{ MPa})$
 $\eta_{(g)} = 1.000 \quad (f_{ck} \leq 50 \text{ MPa})$
 $\eta_{(s)} = 1.000 \quad (f_{ck} \leq 50 \text{ MPa})$

- Design strength of concrete

(EN 1992-1-1:2004, 3.1.6(1))

Girder : $f_{cd(g)} = \alpha_{cc} \cdot f_{ck(g)} / \gamma_c = 19.833 \text{ MPa}$
Slab : $f_{cd(s)} = \alpha_{cc} \cdot f_{ck(s)} / \gamma_c = 11.333 \text{ MPa}$

- Design strength of Reinforcement

(EN 1992-1-1:2004, 3.2.7)

Girder : $f_{yd(g)} = f_{yk(g)} / \gamma_{s_rebar} = 391.304 \text{ MPa}$
Slab : $f_{yd(s)} = f_{yk(s)} / \gamma_{s_rebar} = 391.304 \text{ MPa}$

- Calculate Neutral Axis

- 1) Assume neutral axis depth.
- 2) Calculate the strain of steel and tendon.
- 3) Calculate the stress of steel and tendon.
- 4) Calculate the axial force in concrete, steel, and tendon.
- 5) Check if the resultant force of cross-section is zero.
- 6) Repeat step 1 through 5 until the resultant force becomes zero.

Num.	Neutral depth (mm)	Compression Force (C) (kN)		Tension Force (T) (kN)		Ratio (C/T)
		Concrete	Reinforcement	Concrete	Tendon	
1	650.0	6069.000	950.870	741.913	0.000	9.46185
2	325.0	4125.333	889.043	803.739	0.000	6.23881
3	162.5	2062.667	491.478	1201.304	0.000	2.12614
4	81.3	1031.333	491.478	1201.304	0.000	1.26763
5	40.6	515.667	348.298	1201.304	7083.825	0.10428
6	60.9	773.500	491.478	1201.304	6661.962	0.16087
7	71.1	902.417	491.478	1201.304	5971.713	0.19432
8	76.2	966.875	491.478	1201.304	5695.613	0.21145
9	78.7	999.104	491.478	1201.304	0.000	1.24080
10	77.4	982.990	491.478	1201.304	4233.561	0.27130
11	78.1	991.047	491.478	1201.304	1405.068	0.56881
12	78.4	995.076	491.478	1201.304	1401.218	0.57120
13	78.6	997.090	491.478	1201.304	0.000	1.23913
14	78.5	996.083	491.478	1201.304	1400.261	0.57179
15	78.5	996.586	491.478	1201.304	0.000	1.23871
16	78.5	996.334	491.478	1201.304	1400.022	0.57194
17	78.5	996.460	491.478	1201.304	1399.902	0.57202
18	78.5	996.523	491.478	1201.304	1399.842	0.57206
19	78.5	996.555	491.478	1201.304	1399.812	0.57207
20	78.5	996.571	491.478	1201.304	0.000	1.23869

- Calculate $F_{c(g)}$, $F_{c(s)}$, F_s , F_p

(EN 1992-1-1:2004, Fig 3.5, Fig 6.1)

$F_{c(g)} = (\eta_{(g)} \cdot f_{cd(g)}) \cdot A_{ca(g)} = 996.571 \text{ kN}$: Compression Force for Girder

$$\begin{aligned}
 F_{c(s)} &= (\eta_{(s)} \cdot f_{cd(s)}) \cdot A_{ca(s)} = 0.000 \text{ kN} && : \text{Compression Force for Slab} \\
 F_{s'} &= f_{s'} \cdot A_{s'} = 491.478 \text{ kN} && : \text{Compression reinforcement Force} \\
 F_s &= f_s \cdot A_s = 1201.304 \text{ kN} && : \text{Tension Force in reinforcement} \\
 F_p &= \sum F_{pi} = 0.000 \text{ kN} && : \text{Tension Force in Tendon} \\
 \text{where, } a &= \lambda \cdot x = 62.809 \text{ mm} \\
 x &= 78.511 \text{ mm} && : \text{neutral axis depth} \\
 A_{ca(g)} &= 50247.253 \text{ mm}^2 && : \text{Area of rectangular con'c stress block for girder part} \\
 A_{ca(s)} &= 0.000 \text{ mm}^2 && : \text{Area of rectangular con'c stress block for slab part} \\
 A_{s'} &= 1256.000 \text{ mm}^2 && : \text{Compression reinforcement areas} \\
 A_s &= 3070.000 \text{ mm}^2 && : \text{Tension reinforcement areas}
 \end{aligned}$$

- Calculate moment resistance, M_{Rd}

$$\begin{aligned}
 M_{Rd} &= F_{c(g)} \cdot a_{c(g)} + F_{c(s)} \cdot a_{c(s)} + F_s \cdot a_s + \sum (F_{pi} \cdot a_{pi}) \\
 &= 959.608 \text{ kN} \cdot \text{m} \geq M_{Ed} = -128.832 \text{ kN} \cdot \text{m}
 \end{aligned}$$

OK

where,

$a_{c(g)}$, $a_{c(s)}$, a_s , a_p is the distance from the neutral axis to the centroid of the stress block in concrete,

3. Shear Resistance

■ Maximum Shear Force

1) Check shear resistance of Concrete, $V_{Rd,c}$

- Design Load

$$\begin{aligned}
 \text{Load Combination Name : } & \text{SLU} \\
 \text{Design Situations : } & \text{Persistent \& Transient} \\
 \text{Load Combination Type : } & \text{FX-MAX} \\
 N_{Ed} &= -11060.147 \text{ kN} \\
 V_{Ed} &= 381.459 \text{ kN} \\
 M_{Ed} &= 5008.693 \text{ kN} \cdot \text{m} \\
 V_p &= 0.000 \text{ kN}
 \end{aligned}$$

- Design strength of concrete

$$\begin{aligned}
 \text{Girder : } f_{cd(g)} &= \alpha_{cc} \cdot f_{ck(g)} / \gamma_c = 23.333 \text{ MPa} \\
 \text{Slab : } f_{cd(s)} &= \alpha_{cc} \cdot f_{ck(s)} / \gamma_c = 13.333 \text{ MPa}
 \end{aligned}$$

- Design strength of Reinforcement

$$\begin{aligned}
 \text{Girder : } f_{yd(g)} &= f_{yk(g)} / \gamma_{s_rebar} = 391.304 \text{ MPa} \\
 \text{Slab : } f_{yd(s)} &= f_{yk(s)} / \gamma_{s_rebar} = 391.304 \text{ MPa}
 \end{aligned}$$

- Check whether the section is cracked in bending.

$$f_b = -10.197 \text{ MPa} < f_{ctd} = 1.273 \text{ MPa}$$

(The section is uncracked.)

$$\begin{aligned}
 \text{where, } f_b &: \text{Flexural tensile stress} && (\text{Tension is taken as positive.}) \\
 f_{ctd} &= \alpha_{ct} \cdot f_{ctk,0.05} / \gamma_c && : \text{Design tensile strength of concrete.}
 \end{aligned}$$

- Total stress at composite centroid from actions on the girder alone

$$\sigma_{tot} = \sigma_1 + \sigma_2 = 3.262 \text{ MPa} \quad (\text{DESIGNER'S GUIDE TO EN 1992-2, 6.2.7})$$

where,

$$\begin{aligned}
 \sigma_1 &= (M_{non} \cdot y') / I_g = 4.063 \text{ MPa} \\
 \sigma_2 &= P / A_g + (P \cdot e \cdot y') / I_g = -0.801 \text{ MPa} \\
 \sigma_1 &: \text{stress at the composite centroid due to the moment acting on the girder alone} \\
 \sigma_2 &: \text{stress at the composite centroid due to prestress}
 \end{aligned}$$

$$\begin{aligned}
 M_{\text{non}} &= 928.633 \text{ kN} \cdot \text{m} && : \text{Bending Moment in girder alone} \\
 y_{\text{non}} &= 485.486 \text{ mm} && : \text{Height to Centroid in girder alone} \\
 y_{\text{com}} &= 836.141 \text{ mm} && : \text{Height to Centroid in Composite section} \\
 y' &= y_{\text{com}} - y_{\text{non}} = 350.655 \text{ mm} \\
 A_g &= 609421.150 \text{ mm}^2 && : \text{Area Girder alone} \\
 I_g &= 8.0139\text{E}+10 \text{ mm}^4 && : \text{Moment of inertia in Girder alone} \\
 P &= 5612.473 \text{ kN} && : \text{A factored prestressing force after all losses} \\
 P \cdot e &= -2287.870 \text{ kN} \cdot \text{m} && : \text{Moment of prestressing force}
 \end{aligned}$$

- Shear stress in girder alone at the height of the composite centroid

$$\tau_s = (V_{c1} / b_w) (Q_n / I_g) = 0.015 \text{ MPa}$$

where,

$$\begin{aligned}
 V_{c1} &= 16.401 \text{ kN} && : \text{Shear force on the precast girder alone} \\
 Q_n &= 2.2074\text{E}+07 \text{ mm}^3 && : \text{First moment of Area in centroid of Girder alone} \\
 I_g &= 8.0139\text{E}+10 \text{ mm}^4 && : \text{Moment of inertia in Girder alone} \\
 b_w &= 300.000 \text{ mm} && : \text{Girder width}
 \end{aligned}$$

- Additional shear force acting on the composite section

$$V_{c2} = (I_c \cdot b_w / Q_c) \cdot \{ \sqrt{((f_{ctd})^2 + f_{ctd} \cdot \sigma_{tot})} - \tau_s \} = 721.613 \text{ kN}$$

where,

$$\begin{aligned}
 Q_c &= 2.3311\text{E}+08 \text{ mm}^3 && : \text{First moment of Area in centroid of Composite section} \\
 I_c &= 2.3481\text{E}+11 \text{ mm}^4 && : \text{Moment of inertia in Composite section} \\
 b_w &= 300.000 \text{ mm} && : \text{Girder width}
 \end{aligned}$$

- Total shear resistance of the composite section (regions Un-cracked in bending)

$$V_{Rd,c} = V_{c1} + V_{c2} = 738.014 \text{ kN} > V_{Ed} = 381.459 \text{ kN} \quad \text{OK}$$

∴ No shear reinforcement is required

2) Check minimum shear reinforcement (EN 1992-1-1:2004, 9.2.2(5))

- Check ratio of shear reinforcement

$$\begin{aligned}
 \rho_{w, \min} &= 0.08 \cdot \sqrt{f_{ck}} / f_{yk} = 0.00105 \\
 \rho_w &= A_{sw} / (s \cdot b_w \cdot \sin \alpha) = 0.00803 \geq \rho_{w, \min} = 0.00105 \quad \text{OK} \\
 \text{where, } \rho_{w, \min} &\text{ is the minimum ratio of shear reinforcement} \\
 A_{sw} &= 602.000 \text{ mm}^2 && : \text{Area of diagonal reinforcement}
 \end{aligned}$$

- Check Spacing of stirrups

$$\begin{aligned}
 S_{l, \max} &= 0.75 \cdot d \cdot (1 + \cot \alpha) = 916.615 \text{ mm} \\
 s &= 250.000 \text{ mm} \leq S_{l, \max} = 916.615 \text{ mm} \quad \text{OK} \\
 \text{where, } s &\text{ is the spacing of the stirrups} \\
 d &= 1222.154 \text{ mm} && : \text{effective depth}
 \end{aligned}$$

3) Check additional tension force in the longitudinal reinforcement due to shear force (EN 1992-1-1:2004, 6.2.3.(7))

$$\begin{aligned}
 \Delta F_{td} &= 0.5 \cdot V_{Ed} \cdot (\cot \theta - \cot \alpha) = 476.857 \text{ kN} \\
 (M_{Rd} - M_{Ed}) / z &= 3539.531 \text{ kN} \\
 \Delta F_{td} &\leq (M_{Rd} - M_{Ed}) / z \quad \text{OK} \\
 \text{where, } M_{Rd} &= 8844.374 \text{ kN} && : \text{The moment resistance} \\
 z &= 1083.669 \text{ mm} && : \text{Lever arm from the ultimate bending resistance analysis}
 \end{aligned}$$

■ Minimum Shear Force

1) Check shear resistance of Concrete, $V_{Rd,c}$

- Design Load

Load Combination Name : SLU
Design Situations : Persistent & Transient
Load Combination Type : FX-MIN
 $N_{Ed} = -11685.716 \text{ kN}$
 $V_{Ed} = -342.745 \text{ kN}$
 $M_{Ed} = 19.299 \text{ kN} \cdot \text{m}$
 $V_p = 0.000 \text{ kN}$

- Design strength of concrete

Girder : $f_{cd(g)} = \alpha_{cc} \cdot f_{ck(g)} / \gamma_c = 23.333 \text{ MPa}$
Slab : $f_{cd(s)} = \alpha_{cc} \cdot f_{ck(s)} / \gamma_c = 13.333 \text{ MPa}$

- Design strength of Reinforcement

Girder : $f_{yd(g)} = f_{yk(g)} / \gamma_{s_rebar} = 391.304 \text{ MPa}$
Slab : $f_{yd(s)} = f_{yk(s)} / \gamma_{s_rebar} = 391.304 \text{ MPa}$

- Check whether the section is cracked in bending.

$f_b = -33.466 \text{ MPa} < f_{ctd} = 1.273 \text{ MPa}$
(The section is uncracked.)
where, f_b : Flexural tensile stress (Tension is taken as positive.)
 $f_{ctd} = \alpha_{ct} \cdot f_{ctk,0.05} / \gamma_c$: Design tensile strength of concrete.

- Total stress at composite centroid from actions on the girder alone

$\sigma_{tot} = \sigma_1 + \sigma_2 = 3.262 \text{ MPa}$ (DESIGNER'S GUIDE TO EN 1992-2, 6.2.7)
where,
 $\sigma_1 = (M_{non} \cdot y') / I_g = 4.063 \text{ MPa}$
 $\sigma_2 = P / A_g + (P \cdot e \cdot y') / I_g = -0.801 \text{ MPa}$
 σ_1 : stress at the composite centroid due to the moment acting on the girder alone
 σ_2 : stress at the composite centroid due to prestress

$M_{non} = 928.633 \text{ kN} \cdot \text{m}$: Bending Moment in girder alone
 $y_{non} = 485.486 \text{ mm}$: Height to Centroid in girder alone
 $y_{com} = 836.141 \text{ mm}$: Height to Centroid in Composite section
 $y' = y_{com} - y_{non} = 350.655 \text{ mm}$
 $A_g = 609421.150 \text{ mm}^2$: Area Girder alone
 $I_g = 8.0139E+10 \text{ mm}^4$: Moment of inertia in Girder alone
 $P = 5612.473 \text{ kN}$: A factored prestressing force after all losses
 $P \cdot e = -2287.870 \text{ kN} \cdot \text{m}$: Moment of prestressing force

- Shear stress in girder alone at the height of the composite centroid

$\tau_s = (V_{c1} / b_w) (Q_n / I_g) = 0.015 \text{ MPa}$
where,
 $V_{c1} = 16.401 \text{ kN}$: Shear force on the precast girder alone
 $Q_n = 2.2074E+07 \text{ mm}^3$: First moment of Area in centroid of Girder alone
 $I_g = 8.0139E+10 \text{ mm}^4$: Moment of inertia in Girder alone
 $b_w = 300.000 \text{ mm}$: Girder width

- Additional shear force acting on the composite section

$V_{c2} = (I_c \cdot b_w / Q_c) \cdot \{\sqrt{((f_{ctd})^2 + f_{ctd} \cdot \sigma_{tot})} - \tau_s\} = 721.613 \text{ kN}$
where,
 $Q_c = 2.3311E+08 \text{ mm}^3$: First moment of Area in centroid of Composite section
 $I_c = 2.3481E+11 \text{ mm}^4$: Moment of inertia in Composite section

$$b_w = 300.000 \text{ mm} : \text{Girder width}$$

- Total shear resistance of the composite section (regions Un-cracked in bending)

$$V_{Rd,c} = V_{c1} + V_{c2} = 738.014 \text{ kN} > V_{Ed} = -342.745 \text{ kN} \quad \text{OK}$$

∴ No shear reinforcement is required

2) Check minimum shear reinforcement (EN 1992-1-1:2004, 9.2.2(5))

- Check ratio of shear reinforcement

$$\rho_{w, \min} = 0.08 \cdot \sqrt{f_{ck}} / f_{yk} = 0.00105$$

$$\rho_w = A_{sw} / (s \cdot b_w \cdot \sin \alpha) = 0.00803 \geq \rho_{w, \min} = 0.00105 \quad \text{OK}$$

where, $\rho_{w, \min}$ is the minimum ratio of shear reinforcement

$$A_{sw} = 602.000 \text{ mm}^2 : \text{Area of diagonal reinforcement}$$

- Check Spacing of stirrups

$$S_{l, \max} = 0.75 \cdot d \cdot (1 + \cot \alpha) = 916.615 \text{ mm}$$

$$s = 250.000 \text{ mm} \leq S_{l, \max} = 916.615 \text{ mm} \quad \text{OK}$$

where, s is the spacing of the stirrups

$$d = 1222.154 \text{ mm} : \text{effective depth}$$

3) Check additional tension force in the longitudinal reinforcement due to shear force (EN 1992-1-1:2004, 6.2.3.(7))

$$\Delta F_{td} = 0.5 \cdot V_{Ed} \cdot (\cot \theta - \cot \alpha) = 428.461 \text{ kN}$$

$$(M_{Rd} - M_{Ed}) / z = 8143.698 \text{ kN}$$

$$\Delta F_{td} \leq (M_{Rd} - M_{Ed}) / z \quad \text{OK}$$

where, $M_{Rd} = 8844.374 \text{ kN} : \text{The moment resistance}$

$$z = 1083.669 \text{ mm} : \text{Lever arm from the ultimate bending resistance analysis}$$

8 APPOGGI

8.1 AZIONI SUGLI APPOGGI

Si riportano le reazioni sugli appoggi in prossimità dei ritegni e quelle sugli appoggi non in prossimità dei ritegni. Le forze sono riportate in kN e gli spostamenti in mm.

APPOGGI IN PROSSIMITA' DEI RITEGNI

SLU

Load case		Fx	Fy	Fz
Dead load	1.35	0	0	397
Permanenti	1.35	0	0	167
Precompressione	1.00	0	0	0
Traffico no psi	1.35	0	0	539
Traffico psi	0.00	0	0	0
Vento	0.90	27	237	0
Frenatura	0.00	0	0	0
Temperatura	0.72	186.93	0	0
Tot.		214	237	1103

SLU 2a

Load case		Fx	Fy	Fz
Dead load	1.35	0	0	397
Permanenti	1.35	0	0	167
Precompressione	1.00	0	0	0
Traffico no psi	0.00	0	0	0
Traffico psi	1.35	0	0	348
Vento	0.30	9	79	0
Frenatura	1.35	72	0	0
Temperatura	0.72	187	0	0
Tot.		268	79	912

Rara

Load case		Fx	Fy	Fz
Dead load	1.00	0	0	294
Permanenti	1.00	0	0	124
Precompressione	1.00	0	0	0
Traffico no psi	1.00	0	0	399
Traffico psi	0.00	0	0	0
Vento	0.60	18	158	0
Frenatura	0.00	0	0	0
Temperatura	0.60	0	0	0
Tot.		18	158	817

Frequente

Load case		Fx	Fy	Fz
Dead load	1.00	0	0	294
Permanenti	1.00	0	0	124
Precompressione	1.00	0	0	0
Traffico no psi	0.00	0	0	0
Traffico psi	1.00	0	0	258
Vento	0.00	0	0	0
Frenatura	0.00	0	0	0
Temperatura	0.50	0	0	0
Tot.		0	0	676

Quasi Permanente

Load case		Fx	Fy	Fz
Dead load	1.00	0	0	294
Permanenti	1.00	0	0	124
Precompressione	1.00	0	0	0
Traffico no psi	0.00	0	0	0
Traffico psi	0.00	0	0	0
Vento	0.00	0	0	0
Frenatura	0.00	0	0	0
Temperatura	0.50	0	0	0
Tot.		0	0	418

APPOGGI NON IN PROSSIMITA' DEI RITEGNI

SLU

Load case		Fx	Fy	Fz	Dx mm	Dy mm
Dead load	1.35	0	0	397		
Permanenti	1.35	0	0	167		
Precompressione	1.00	0	0	0		
Traffico no psi	1.35	0	0	539		
Traffico psi	0.00	0	0	0		
Vento	0.90	0	0	0		
Frenatura	0.00	0	0	0		
Temperatura	0.72	0	0	0		
Tot.		0	0	1103	20.8	10.59

SLU 2a

Load case		Fx	Fy	Fz	Dx	Dy
Dead load	1.35	0	0	397		
Permanenti	1.35	0	0	167		
Precompressione	1.00	0	0	0		
Traffico no psi	0.00	0	0	0		
Traffico psi	1.35	0	0	348		
Vento	0.30	0	0	0		
Frenatura	1.35	0	0	0		
Temperatura	0.72	0	0	0		
Tot.		0	0	912	19.36	8.88

Rara

Load case		Fx	Fy	Fz	Dx	Dy
Dead load	1.00	0	0	294		
Permanenti	1.00	0	0	124		
Precompressione	1.00	0	0	0		
Traffico no psi	1.00	0	0	399		
Traffico psi	0.00	0	0	0		
Vento	0.60	0	0	0		
Frenatura	0.00	0	0	0		
Temperatura	0.60	0	0	0		
Tot.		0	0	817	25.48	11.63

Frequente

Load case		Fx	Fy	Fz	Dx	Dy
Dead load	1.00	0	0	294		
Permanenti	1.00	0	0	124		
Precompressione	1.00	0	0	0		
Traffico no psi	0.00	0	0	0		
Traffico psi	1.00	0	0	258		

<i>Vento</i>	0.00	0	0	0		
<i>Frenatura</i>	0.00	0	0	0		
<i>Temperatura</i>	0.50	0	0	0		
Tot.		0	0	676	24.59	9.82

Quasi Permanente

Load case		Fx	Fy	Fz	Dx	Dy
<i>Dead load</i>	1.00	0	0	294		
<i>Permanenti</i>	1.00	0	0	124		
<i>Precompressione</i>	1.00	0	0	0		
<i>Traffico no psi</i>	0.00	0	0	0		
<i>Traffico psi</i>	0.00	0	0	0		
<i>Vento</i>	0.00	0	0	0		
<i>Frenatura</i>	0.00	0	0	0		
<i>Temperatura</i>	0.50	0	0	0		
Tot.		0	0	418	24.55	8.53