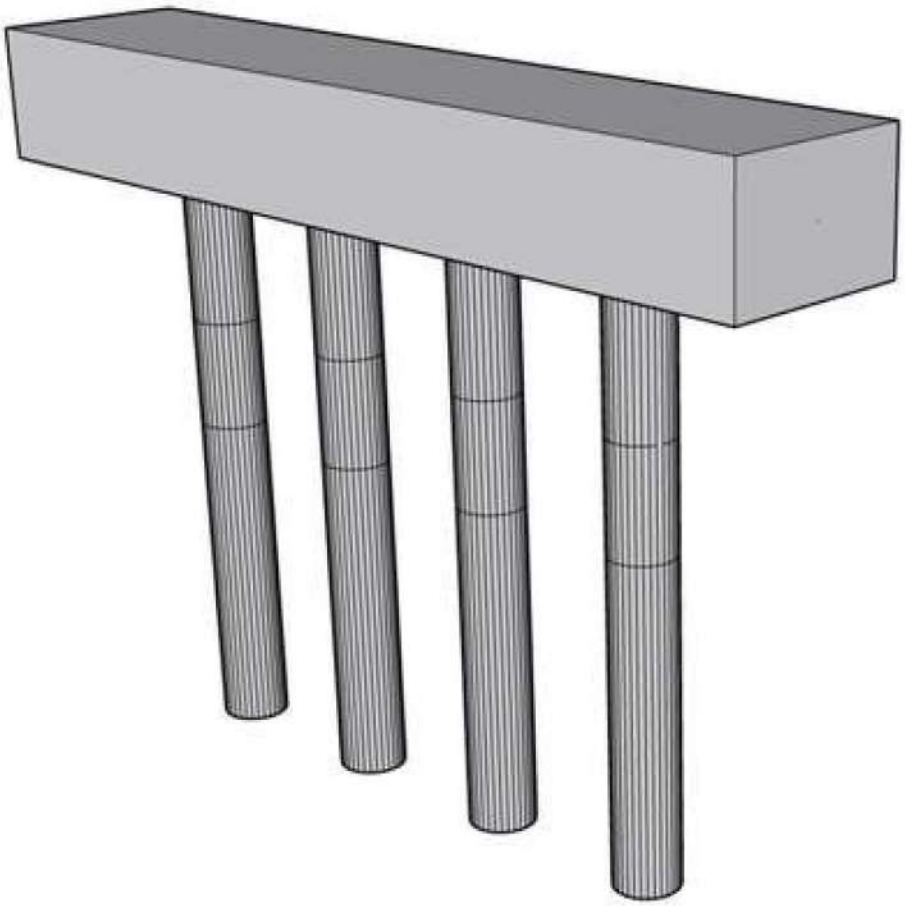


ANÁLISIS Y DISEÑO ESTRUCTURAL DE VIGA CABEZAL PARA PUENTE MILITAR.

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1. DATOS GENERALES

1.1 Nombre del proyecto.

"CONSTRUCCIÓN DE LAS OBRAS DE CIMENTACIÓN PARA EL PUENTE MILITAR EN EL CORREGIMIENTO DE EL CARITO, MUNICIPIO DE LORICA, DEPARTAMENTO DE CÓRDOBA."

1.2 Ubicación del proyecto.

Santa Cruz de Lorica, Córdoba.

1.3 Fecha.

Diciembre de 2025

1.4 Propiedad intelectual y licencia de uso.

Los planos y esta memoria de cálculo son propiedad intelectual del calculista. (Ley 22 de 1982) El solicitante tiene licencia para usar este diseño una vez. Cualquier uso adicional que haga del mismo deberá cancelarlo al calculista de acuerdo con la tarifa vigente en ese momento.

2. INFORMACIÓN GENERAL DE LA ESTRUCTURA

2.1 Descripción.

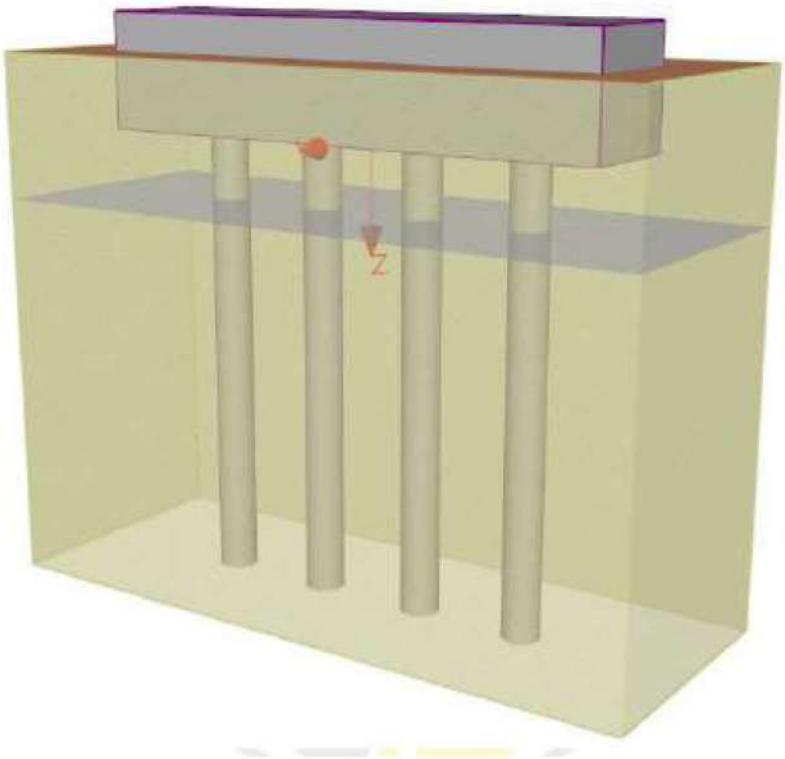
El proyecto consta de una estructura en la constitución de **la cimentación** para la infraestructura **tipo puente militar requerida para la vía que comunica el corregimiento El Carito.**

El sistema estructural es hiperestático. Se trata de una estructura espacial convencional no arriostrada, capaz de resistir las fuerzas verticales y horizontales causadas empujes laterales de tierra, hidrodinámicos y por sismos.

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2.2 Esquema estructural.

Ilustración 1. Esquema Super estructura.



Fuente: Estudio geotécnico presente consultoría.

2.3 Categoría operacional y obtención del nivel de amenaza sísmica:

Este paso consiste en localizar el lugar donde se construirá el puente dentro de los mapas de zonificación sísmica dados en la sección 3.10 de CCP-14 y en determinar el nivel de amenaza sísmica del lugar, de acuerdo con los valores de los parámetros PGA, Ss y S1 obtenidos en los mapas de zonificación sísmica de la sección 3.10. La zona de desempeño sísmico se clasificará como 1, 2, 3 ó 4, a partir del cálculo de SD1 obtenido aplicando la Ec. 3.10.4.2-6 de CCP-14.

De acuerdo con la descripción del proyecto y considerando su importancia con respecto a determinantes como aspectos sociales, de supervivencia, de seguridad, y de defensa. El proyecto se clasificará dentro de:

Categoría Operacional: Otros Puentes.

Zona de desempeño sísmico: 4 (Tabla 3.10.6-1)

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2.4 Especificaciones de materiales.

Las siguientes son las especificaciones establecidas para los materiales utilizables en la construcción:

(a) Concreto: El concreto debe tener una resistencia a la compresión a los 28 días, f´c, igual o superior a 28 Mpa, el cual será utilizado en la sub y superestructura.

(b) Acero estructural: El acero de refuerzo de 420 MPa, conforme a lo estipulado en la Norma Colombiana de Construcción Sismo Resistente NSR-10, Título C, es un material destinado para el refuerzo de concreto estructural. Esta norma exige que el acero cuente con una resistencia mínima a la tracción de 420 megapascales (MPa) y un límite de fluencia del mismo valor, garantizando su capacidad para soportar las tensiones en estructuras sometidas a cargas sismorresistentes. Además, la NSR-10 especifica que el acero de refuerzo debe tener alta ductilidad, permitiendo deformaciones considerables sin pérdida significativa de resistencia, lo cual es crucial para la absorción de energía durante eventos sísmicos. Este acero, suministrado en barras o varillas de distintos diámetros, es adecuado para su uso en estructuras críticas como edificios, puentes y carreteras, cumpliendo con los requisitos de resistencia y calidad que exige la normativa nacional

2.5 Módulos de elasticidad.

Según el título C en el artículo C.8.5 se puede determinar el módulo de elasticidad teniendo la consideración que es un concreto de densidad normal y con la resistencia a compresión f'c se calcula con la siguiente ecuación:

$$Ec = 4700\sqrt{f'c} \quad (Mpa)$$
$$Ec = 4700\sqrt{28}\ Mpa$$
$$Ec = \quad 24870.06\ Mpa$$
$$Ec = 2535174.55\ Ton/m^2$$

2.6 Características del suelo.

De acuerdo con el documento "*ESTUDIO GEOLÓGICO, GEOTÉCNICO Y DE SUELOS PARA LA CONSTRUCCIÓN DE LAS OBRAS DE CIMENTACIÓN PARA EL PUENTE MILITAR EN*

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EL CORREGIMIENTO DE EL CARITO, MUNICIPIO DE LORICA, DEPARTAMENTO DE CÓRDOBA.". para el proyecto, entregado por el ente contratante de este diseño, donde se describen lo siguiente:

De acuerdo a los parámetros obtenidos de las exploraciones en campo y los resultados de laboratorio, la cimentación para soportar el estribo requerido parael puente consta de un grupo de cuatro (4) pilotes, de geometría circular, condiámetro de 0.5 metros, una profundidad de desplante de 1 metro y una longitud de 6 metros, que se enlaza con el estribo requerido por el informe de diagnóstico. El método constructivo para el cual se encuentra diseñado es tipo excavado. Se destaca que dicha longitud hace referencia al empotramiento necesario para que la capacidad portante sea la satisfactoria frente a las solicitaciones y al efecto de la socavación.

Por otra parte, se recomienda emplear obras de protección del tipo muro en gavión, con las características como se recomienda en el capítulo del cálculo de estos. La longitud de extensión sobre la rivera debe ser mínimamente 15 metros aguas arriba y 15 metros aguas abajo, de acuerdo a la recomendación del estudio hidráulico. Se recomienda evaluarse que en la etapa constructiva se mantengan las condiciones bajo las cuales este ha sido diseñado. Lo establecido en esta consultoría presenta resultados significativos para las condiciones de diseño estipuladas según el Código Colombiano de Puentes – CCP14, con el cumplimiento de los estados de Límite de Resistencia, Evento Extremo y Límite de Servicio, por lo que, se garantiza la capacidad de soporte de la estructura de cimentación siempre y cuando se cumpla con las dimensiones planteadas y se conserven las condiciones de diseño. El tipo de concreto a emplear y la disposición del acero de refuerzo se realizará de acuerdo a las recomendaciones de la consultoría estructural."

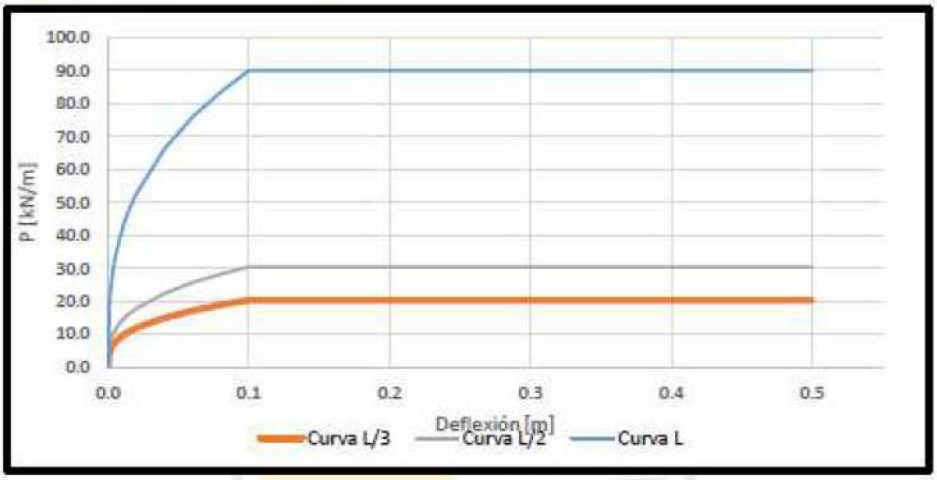
Tabla 1 Parametros de interacción suelo estructuras

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13. CURVAS P-Y'

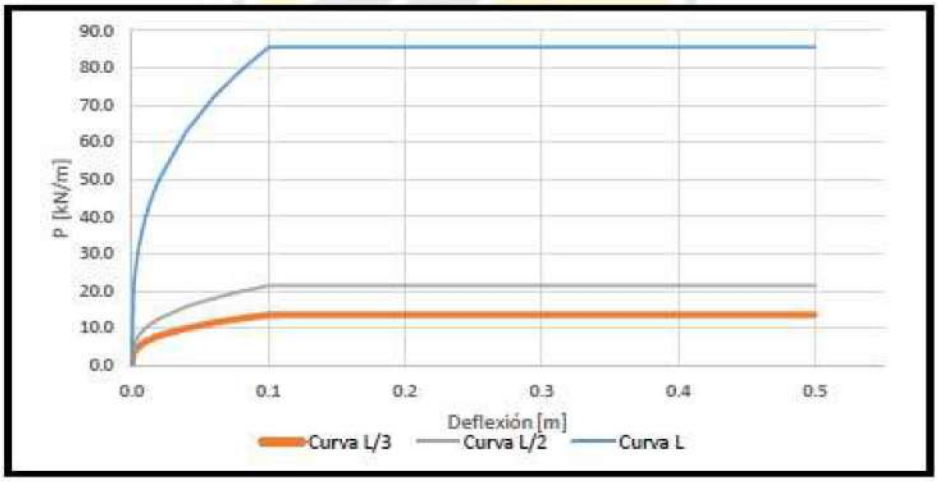
De la interacción suelo estructura, la resultante de las Curvas P-Y', a L/3, L/2 y L del pilote se representa a continuación:

Figura 17. *Curvas p-y' – Estribo izquierdo.*



Fuente: Consultoría.

Figura 18. *Curvas p-y' – Estribo derecho.*



Fuente: documento "ESTUDIO GEOLÓGICO, GEOTÉCNICO Y DE SUELOS PARA LA CONSTRUCCIÓN DE LAS OBRAS DE CIMENTACIÓN PARA EL PUENTE MILITAR EN EL CORREGIMIENTO DE EL CARITO, MUNICIPIO DE LORICA, DEPARTAMENTO DE CÓRDOBA."

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Gráfico 1 módulos de reacción de pilas en cada estaribo.

12. MÓDULOS DE REACCIÓN

En la longitud donde se desarrolla el pilote, la interacción Suelo-Estructura genera los siguientes módulos de reacción para el suelo:

Tabla 27. *Módulos de reacción vertical – Estribo izquierdo.*

Prof [m]	DL [m]	k_v [kN/m³]
0	0.50	6944
1	1.00	13887
2	1.00	13887
3	1.00	13887
4	1.00	13887
5	0.50	6944

Fuente: Consultoría.

Tabla 28. *Módulos de reacción horizontal – Estribo izquierdo.*

Prof [m]	DL [m]	k_v [kN/m³]
0	0.50	5555
1	1.00	11110
2	1.00	11110
3	1.00	11110
4	1.00	11110
5	0.50	5555

Fuente: Consultoría.

Tabla 29. *Módulos de reacción vertical – Estribo derecho.*

Prof [m]	DL [m]	k_v [kN/m³]
0	0.50	8165
1	1.00	16331
2	1.00	16331
3	1.00	16331
4	1.00	16331
5	0.50	8165

Fuente: Consultoría.

Tabla 30. *Módulos de reacción horizontal – Estribo derecho.*

Prof [m]	DL [m]	k_v [kN/m³]
0	0.50	6532
1	1.00	13065
2	1.00	13065
3	1.00	13065
4	1.00	13065
5	0.50	6532

Fuente: documento "ESTUDIO GEOLÓGICO, GEOTÉCNICO Y DE SUELOS PARA LA CONSTRUCCIÓN DE LAS OBRAS DE CIMENTACIÓN PARA EL PUENTE MILITAR EN EL CORREGIMIENTO DE EL CARITO, MUNICIPIO DE LORICA, DEPARTAMENTO DE CÓRDOBA."

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4.2.5 Alcance de las características del suelo según lo indicado en la NSR-10.

A.2.4.2 — TIPOS DE PERFIL DE SUELO — Se definen seis tipos de perfil de suelo los cuales se presentan en la tabla A.2.4-1. Los parámetros utilizados en la clasificación son los correspondientes a los 30 m superiores del perfil para los perfiles tipo A a E. Aquellos perfiles que tengan estratos claramente diferenciables deben subdividirse, asignándoles un subíndice **i** que va desde **1** en la superficie, hasta **n** en la parte inferior de los 30 m superiores del perfil. Para el perfil tipo **F** se aplican otros criterios y la respuesta no debe limitarse a los 30 m superiores del perfil en los casos de perfiles con espesor de suelo significativo.

A.2.4.3 — PARÁMETROS EMPLEADOS EN LA DEFINICIÓN DEL TIPO DE PERFIL DE SUELO — A continuación, se definen los parámetros que se utilizan para definir el tipo de perfil de suelo con base en los 30 m superiores del mismo y considerando ensayos realizados en muestras tomadas al menos cada 1.50 m de espesor del suelo. Estos parámetros son (a) la velocidad media de la onda de cortante, **vs** , en m/s, (b) el número medio de golpes del ensayo de penetración estándar, **N** , en golpes/píe a lo largo de todo el perfil, o, (c) cuando se trate de considerar por separado los estratos no cohesivos y los cohesivos del perfil, para los estratos de suelos no cohesivos se determinará el número medio de golpes del ensayo de penetración estándar, $\mathbf{N_{ch}}$, en golpes/píe, y para los cohesivos la resistencia media al corte obtenida del ensayo para determinar su resistencia no drenada, $\mathbf{s_u}$, en kPa. Además se emplean el Índice de Plasticidad (**IP**), y el contenido de agua en porcentaje, **w** .

A.2.4.4 — DEFINICIÓN DEL TIPO DE PERFIL DE SUELO — El procedimiento que se emplea para definir el tipo de perfil de suelo se basa en los valores de los parámetros del suelo de los 30 metros superiores del perfil, medidos en el sitio que se describieron en A.2.4.3. La clasificación se da en la tabla A.2.4-1.

Clasificación de los perfiles de suelo

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Ilustración 2. Tabla A.2.4-1. Clasificación de los perfiles de suelo.

Tipo de perfil	Descripción	Definición
A	Perfil de roca competente	$\overline{v}_s \geq 1500$ m/s
B	Perfil de roca de rigidez media	1500 m/s > $\overline{v}_s \geq 760$ m/s
C	Perfiles de suelos muy densos o roca blanda, que cumplan con el criterio de velocidad de la onda de cortante, o	760 m/s> $\overline{v}_s \geq 360$ m/s
	perfiles de suelos muy densos o roca blanda, que cumplan con cualquiera de los dos criterios	$\overline{N} \geq 50$, o $\overline{s}_u \geq 100$ kPa (≈1 kgf/cm²)
D	Perfiles de suelos rígidos que cumplan con el criterio de velocidad de la onda de cortante, o	360 m/s > $\overline{v}_s \geq 180$ m/s
	perfiles de suelos rígidos que cumplan cualquiera de las dos condiciones	50 > $\overline{N} \geq 15$, o 100 kPa (≈1 kgf/cm²) > $\overline{s}_u \geq 50$ kPa (≈0.5 kgf/cm²)
E	Perfil que cumpla el criterio de velocidad de la onda de cortante, o	180 m/s > $\overline{v}_s$
	perfil que contiene un espesor total H mayor de 3 m de arcillas blandas	$IP > 20$ $w \geq 40\%$ 50 kPa (≈0.50 kgf/cm²) > $\overline{s}_u$
F	Los perfiles de suelo tipo F requieren una evaluación realizada explícitamente en el sitio por un ingeniero geotecnista de acuerdo con el procedimiento de A.2.10. Se contemplan las siguientes subclases: F_1 — Suelos susceptibles a la falla o colapso causado por la excitación sísmica, tales como: suelos licuables, arcillas sensitivas, suelos dispersivos o débilmente cementados, etc. F_2 — Turba y arcillas orgánicas y muy orgánicas (H > 3 m para turba o arcillas orgánicas y muy orgánicas). F_3 — Arcillas de muy alta plasticidad (H > 7.5 m con Índice de Plasticidad IP > 75) F_4 — Perfiles de gran espesor de arcillas de rigidez mediana a blanda (H > 36 m)	

Fuente: NSR-10 Título A, Requisitos generales de diseño y construcción sismo resistente.

De acuerdo con el documento geotécnico

La clasificación de este suelo se aporta mediante la metodología designada por NSR-10, la cual, no es aplicable para este tipo de estructuras. Sin embargo, se aporta este insumo para que sea utilizado bajo cualquier motivo de ser necesario.

Para el perfil estipulado anteriormente, se realizó el análisis de determinación del tipo de suelo según el número de golpes del ensayo SPT, clasificándolo según la tabla 3.10.3.1-1 del CCP-14, que indica:

*Por lo que se tiene que el tipo de suelo **E**.*

4.2.4. Zona sísmica.

3.10.1 — Generalidades — Los puentes deben diseñarse para que tengan una baja probabilidad de colapso pero se admite que puedan sufrir daño significativo e interrupción del servicio cuando se sometan a movimientos sísmicos del terreno que tengan el siete por ciento (7%) de probabilidad de ser excedidos en 75 años, equivalente aproximadamente a mil años de período de retorno promedio y puede requerirse un reemplazo parcial o total del puente. Pueden usarse mayores niveles de amenaza sísmica si así lo requiere la entidad contratante del diseño y construcción del puente, o a quien revierta el puente cuando hace parte de un sistema de concesión.

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Las fuerzas sísmicas son los efectos causados por los movimientos sísmicos de diseño expresados como medio de su luz. Tales amortiguadores aerodinámicos de pletinas deberían estar a una distancia de cerca de 1/3 del diámetro del tubo por encima o por debajo del tubo para permitir el paso libre del viento. La anchura de las pletinas puede ser el diámetro del tubo.

El galope es una oscilación de gran amplitud asociada con cables cargados de hielo o con elementos largos y flexibles que tienen secciones transversales aerodinámicamente asimétricas. Los tirantes con secciones circulares, no galoparán a menos que sus circunferencias estén deformadas por hielo, agua, o acumulación de desechos.

Los tableros flexibles, como los de grandes luces o algunos puentes peatonales, pueden ser susceptibles de flameo inducido por el viento, oscilación excitada por el viento con amplitudes destructivas, o, en algunas ocasiones, divergencia, una torsión irreversible bajo vientos fuertes. Existen métodos de análisis, incluyendo estudios en túnel de viento que llevan a ajustes en la forma del tablero, que están disponibles para prevención de flameo y divergencia.

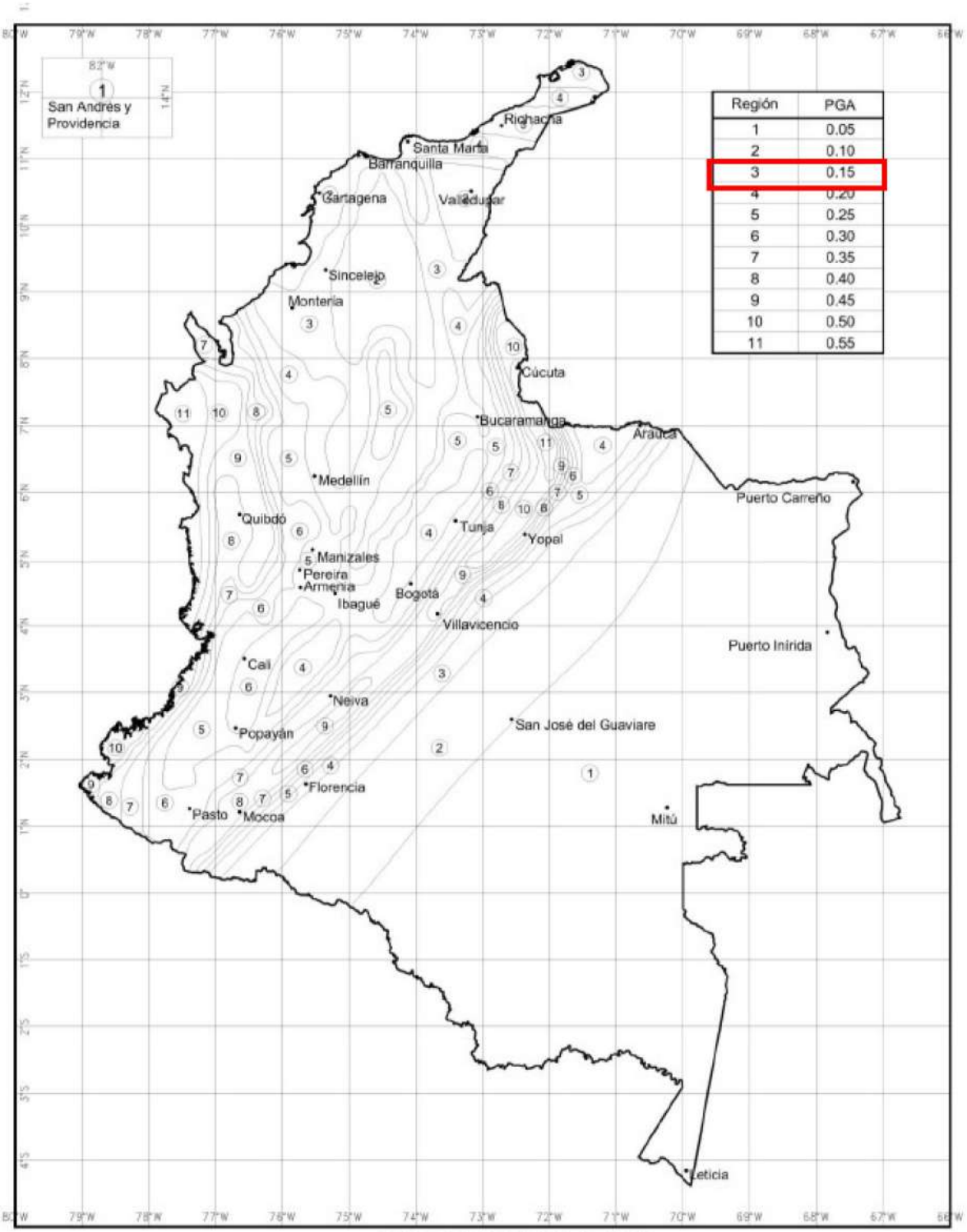
Amenaza Sísmica — La amenaza sísmica en el sitio del puente debe describirse por medio del espectro de aceleraciones para el sitio y los factores de sitio correspondientes al tipo de perfil de suelo en el sitio.

El espectro de aceleraciones debe determinarse usando el Procedimiento General especificado en 3.10.2.1 o el Procedimiento Particular de Sitio especificado en 3.10.2.2.

3.10.2.1 — Procedimiento General — El Procedimiento General debe usar el coeficiente de Aceleración Pico del General debe usar el coeficiente de Aceleración Pico del Terreno (PGA) y los coeficientes de periodo corto y periodo largo (Ss y S1 respectivamente) para calcular el espectro como se especifica en 3.10.4. Debe determinarse los valores de PGA, Ss y S1 de las Figuras 3.10.2.1-1 a 3.10.2.1-3 según corresponda, o de los valores, o mapas, especiales aprobados por la entidad contratante del diseño y construcción. Debe usarse interpolación lineal para sitios ubicados entre líneas de contorno o entre una línea de contorno y un valor mínimo local o un valor máximo local. Los efectos locales deben incluirse dentro de la descripción del sismo de diseño según el tipo de perfil de suelo como se especifica en 3.10.3.

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Ilustración 3. Figura 3.10.2.1-1 — Aceleración Pico Horizontal del Terreno con 7% de probabilidad de excedencia en 75 años (aproximadamente 1000 años de período promedio de retorno) expresada en la aceleración de la gravedad (g).



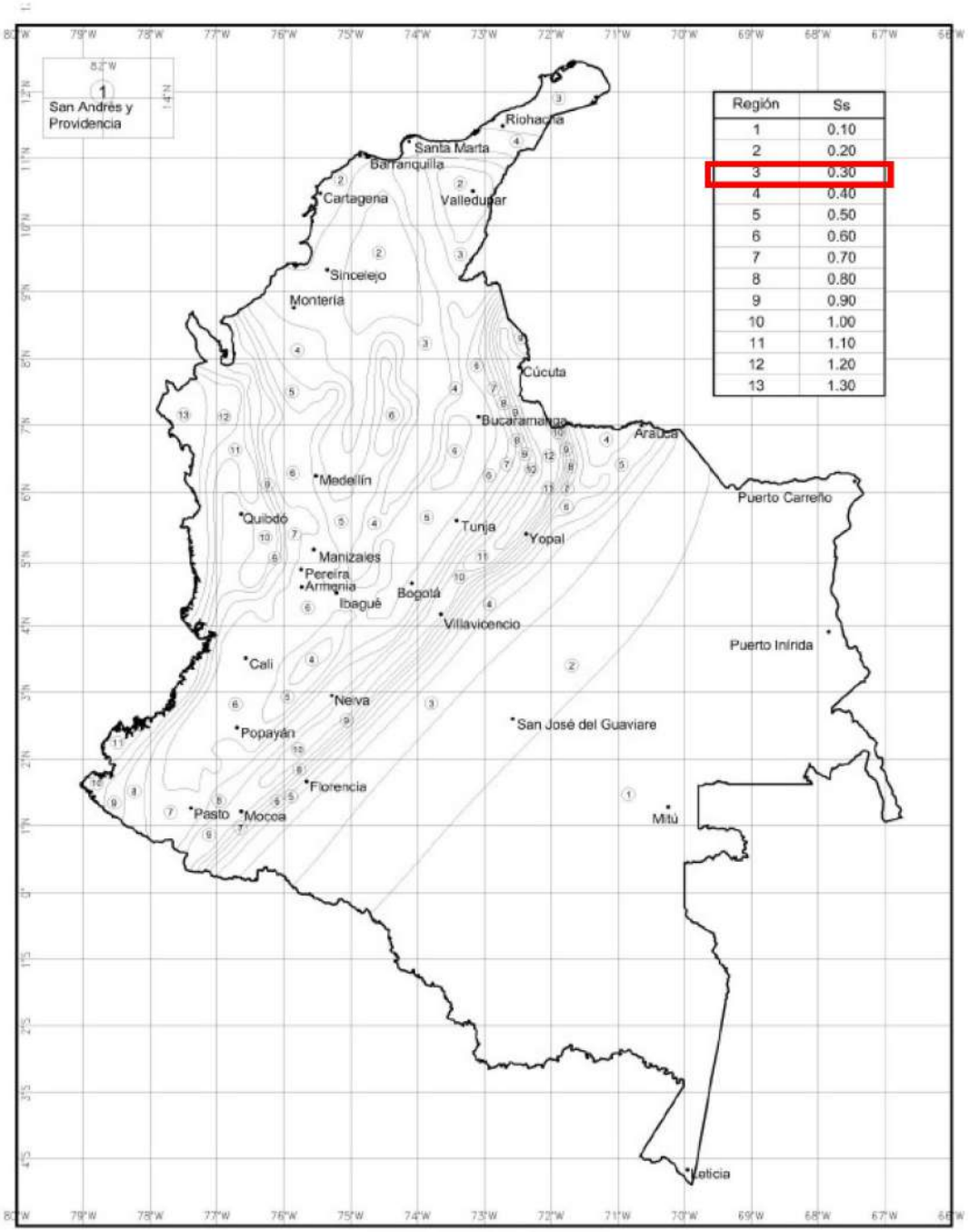
Región	PGA
1	0.05
2	0.10
3	0.15
4	0.20
5	0.25
6	0.30
7	0.35
8	0.40
9	0.45
10	0.50
11	0.55

MAPA DE VALORES PGA

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Fuente: CCP14 Sección 3, Cargas y Factores de Carga

Ilustración 4. Figura 3.10.2.1-2 — Coeficiente de Aceleración Espectral Horizontal para un período de vibración de 0.2 segundos (Ss) para 5% del amortiguamiento crítico y con 7% de probabilidad de excedencia en 75 años (Aproximadamadamente 1000 años de periodo promedio de retorno) expresada en la aceleración de la gravedad (g)



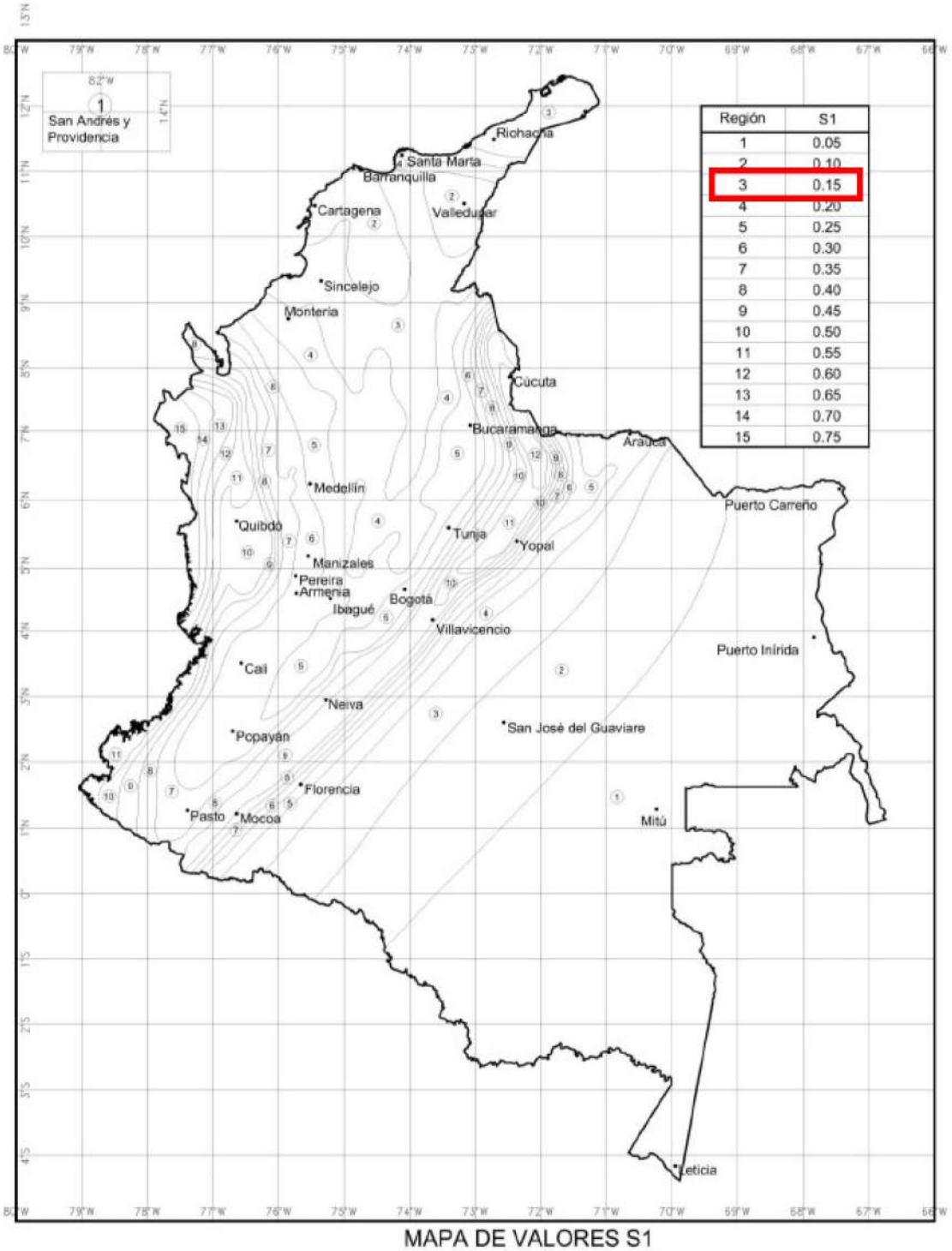
Región	Ss
1	0.10
2	0.20
3	0.30
4	0.40
5	0.50
6	0.60
7	0.70
8	0.80
9	0.90
10	1.00
11	1.10
12	1.20
13	1.30

MAPA DE VALORES Ss

Fuente: CCP14 Sección 3, Cargas y Factores de Carga.

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Ilustración 5. Figura 3.10.2.1-3 — Coeficiente de Aceleración Espectral Horizontal para un período de vibración de 1.0 segundos (S1) para 5% del amortiguamiento crítico y con 7% de probabilidad de excedencia en 75 años (Aproximadamente 1000 años de periodo promedio de retorno) expresada en la aceleración de la gravedad (g)



Región	S1
1	0.05
2	0.10
3	0.15
4	0.20
5	0.25
6	0.30
7	0.35
8	0.40
9	0.45
10	0.50
11	0.55
12	0.60
13	0.65
14	0.70
15	0.75

MAPA DE VALORES S1

Fuente: CCP14 Sección 3, Cargas y Factores de Carga

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En base a lo anterior fueron tomados los siguientes valores PGA = 0.15, Ss = 0.30, S1= 0.15.

Categoría Operacional: Otros Puentes.

Zona de desempeño sísmico: 3 (Tabla 3.10.6-1)

3. ANÁLISIS DE CARGAS

El presente estudio de cargas se desarrolla con el propósito de definir las acciones que actúan sobre los **elementos de apoyo del puente metálico modular tipo puente militar**, específicamente sobre la **viga cabezal y las pilas**, y se limita estrictamente a las condiciones establecidas por la información técnica oficial suministrada para el proyecto y por el **estudio geotécnico aprobado**.

En este sentido, las cargas consideradas en el diseño corresponden únicamente a:

- Las **cargas estructurales y vehiculares oficialmente definidas para el puente metálico modular**, correspondientes a una **carga dinámica de 52 toneladas** y una **carga estática de 95 toneladas**, de conformidad con el documento técnico emitido por la entidad responsable de la instalación del puente.
- Las **acciones geotécnicas** que actúan sobre la viga cabezal y las pilas, derivadas de las condiciones del suelo del sitio, tales como:
  - Presiones laterales del terreno,
  - Sobrecargas de suelo aplicables,
  - Empujes asociados al relleno,
  - Presión vertical del suelo,
  - Interacción suelo–estructura,

Las disposiciones de la Norma Colombiana de Puentes CCP-14 se emplean exclusivamente como referencia técnica general para la descripción conceptual de las acciones estructurales; sin embargo, no se adoptan esquemas de carga vehicular propios de puentes carreteros convencionales, ni combinaciones distintas a las oficialmente definidas para este tipo de estructura modular.

En consecuencia, el análisis y diseño estructural se circunscriben a la verificación de la estabilidad, resistencia y capacidad portante de la viga cabezal y las pilas, bajo las

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cargas y condiciones anteriormente descritas. Cualquier modificación en las cargas de servicio, tipo de tránsito, configuración estructural del puente o condiciones del terreno excede el alcance del presente estudio y requerirá una evaluación técnica adicional.

4. COMBINACIONES DE CARGA.

Se emplearon las consideraron los estados límites de Resistencia y Servicio.

5. ANÁLISIS Y DISENO ESTRUCTURAL.

El análisis y diseño estructural de la superestructura y subestructura se realizó a partir de las **reacciones, solicitaciones y combinaciones de carga definidas en el Estudio Geotécnico**, las cuales fueron empleadas como condiciones de entrada para la **modelación estructural en el software MIDAS Civil**.

La modelación estructural se desarrolló de manera integral, considerando la interacción suelo–estructura, con el fin de representar de forma adecuada el comportamiento real del sistema ante las diferentes acciones de carga, incluyendo efectos gravitacionales, empujes de suelo y solicitaciones sísmicas.

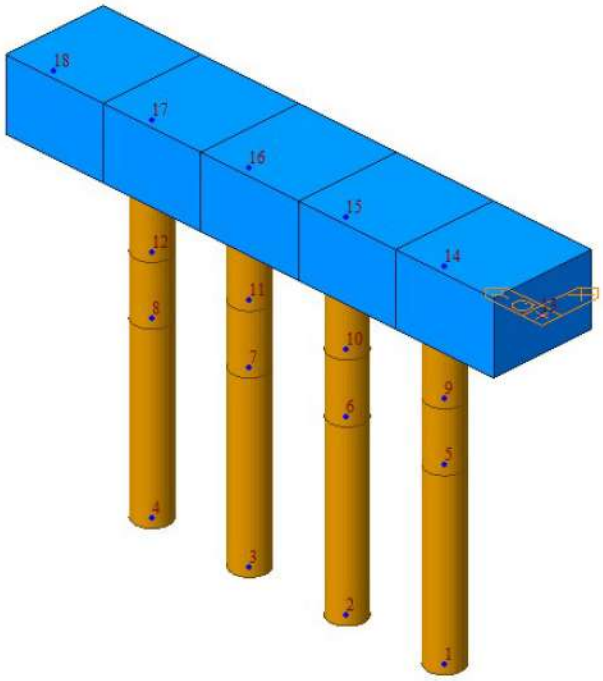
5.1 MODELO ESTRUCTURAL EN MIDAS CIVIL

El modelo estructural fue implementado en MIDAS Civil mediante elementos tipo frame para la representación de las pilas y la viga cabezal, mientras que las cargas provenientes de la superestructura fueron aplicadas como fuerzas concentradas y distribuidas, de acuerdo con las reacciones obtenidas del análisis global del box culvert y las combinaciones establecidas en el CCP-14.

La geometría, rigidez y propiedades mecánicas de los elementos estructurales fueron definidas conforme a los planos de diseño y a las propiedades del material estructural especificadas en el proyecto.

Figura 1 Modelo estructural

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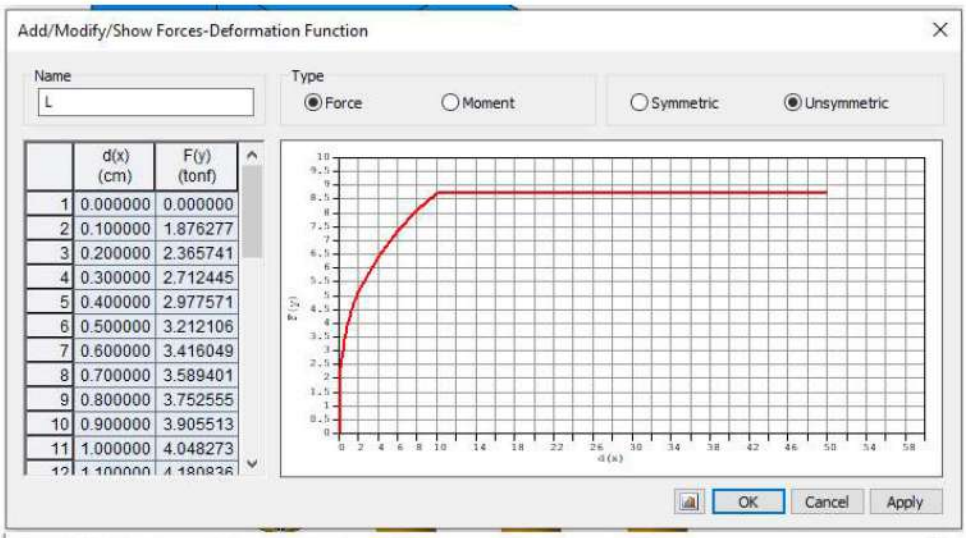
Fuente: Midas Civil

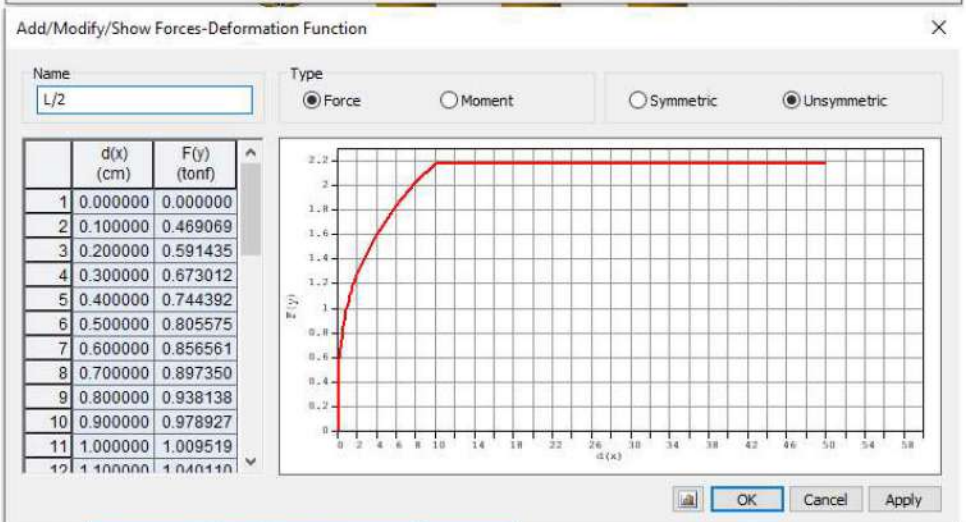
5.2INTERACCIÓN SUELO-ESTRUCTURA.

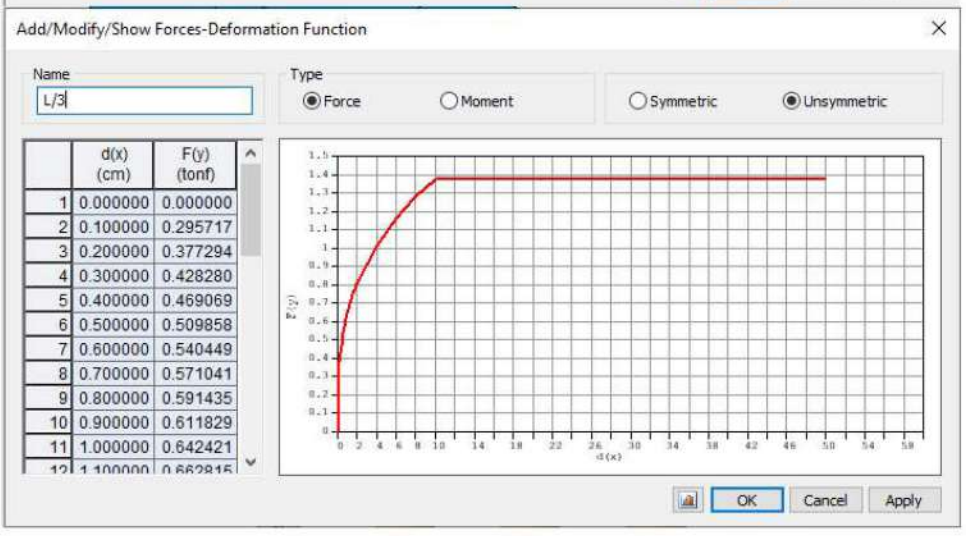
La interacción suelo–estructura fue modelada mediante el uso de curvas P-Y, conforme a los parámetros suministrados por el Estudio Geotécnico. Estas curvas permiten representar el comportamiento no lineal del suelo frente a desplazamientos laterales de las pilas, simulando la resistencia progresiva del terreno en función de la profundidad y las características del perfil estratigráfico.

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Figura 2 Definición de curvas P-Y







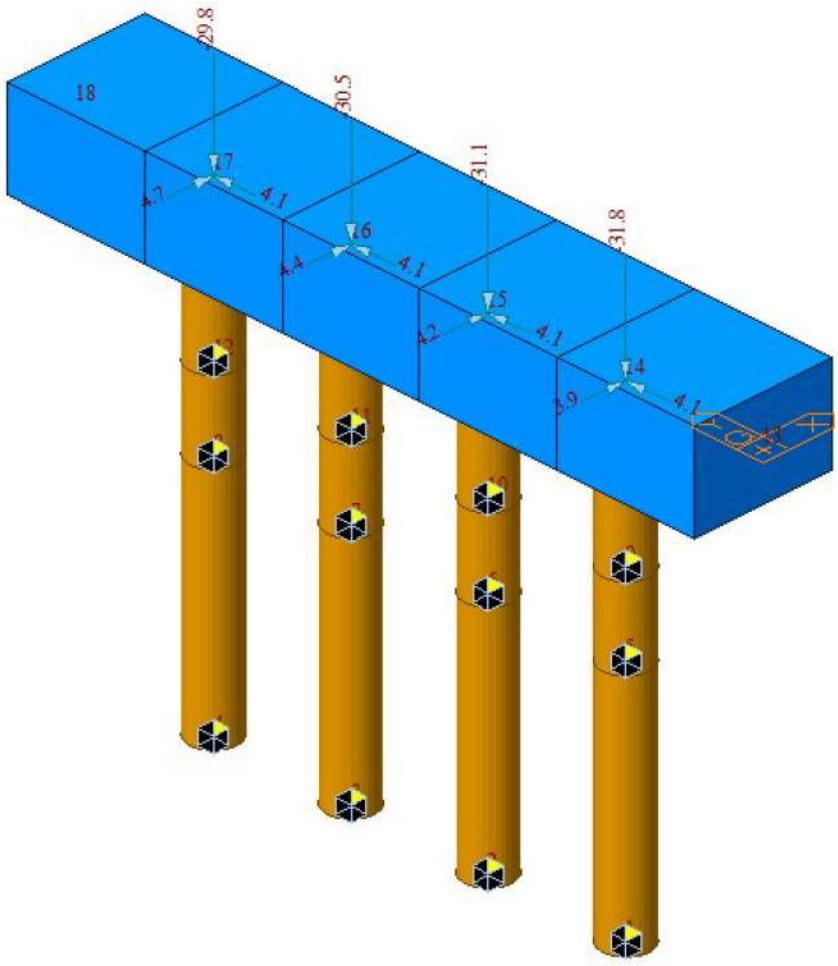
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Fuente: Midas Civil

5.3 APLICACIÓN DE CARGAS DE COMBINACIONES DE DISEÑO

Las cargas verticales y horizontales aplicadas al modelo corresponden a las reacciones obtenidas del análisis estructural y geotécnico. Las combinaciones de carga empleadas en el modelo estructural corresponden a los estados límites de Resistencia, Servicio y Evento Extremo, y son consistentes con las combinaciones indicadas en el numeral 4 del presente documento. Estas combinaciones permitieron identificar las solicitaciones más desfavorables para el diseño estructural.

Figura 3 Aplicación de cargas de estado límite de resistencia



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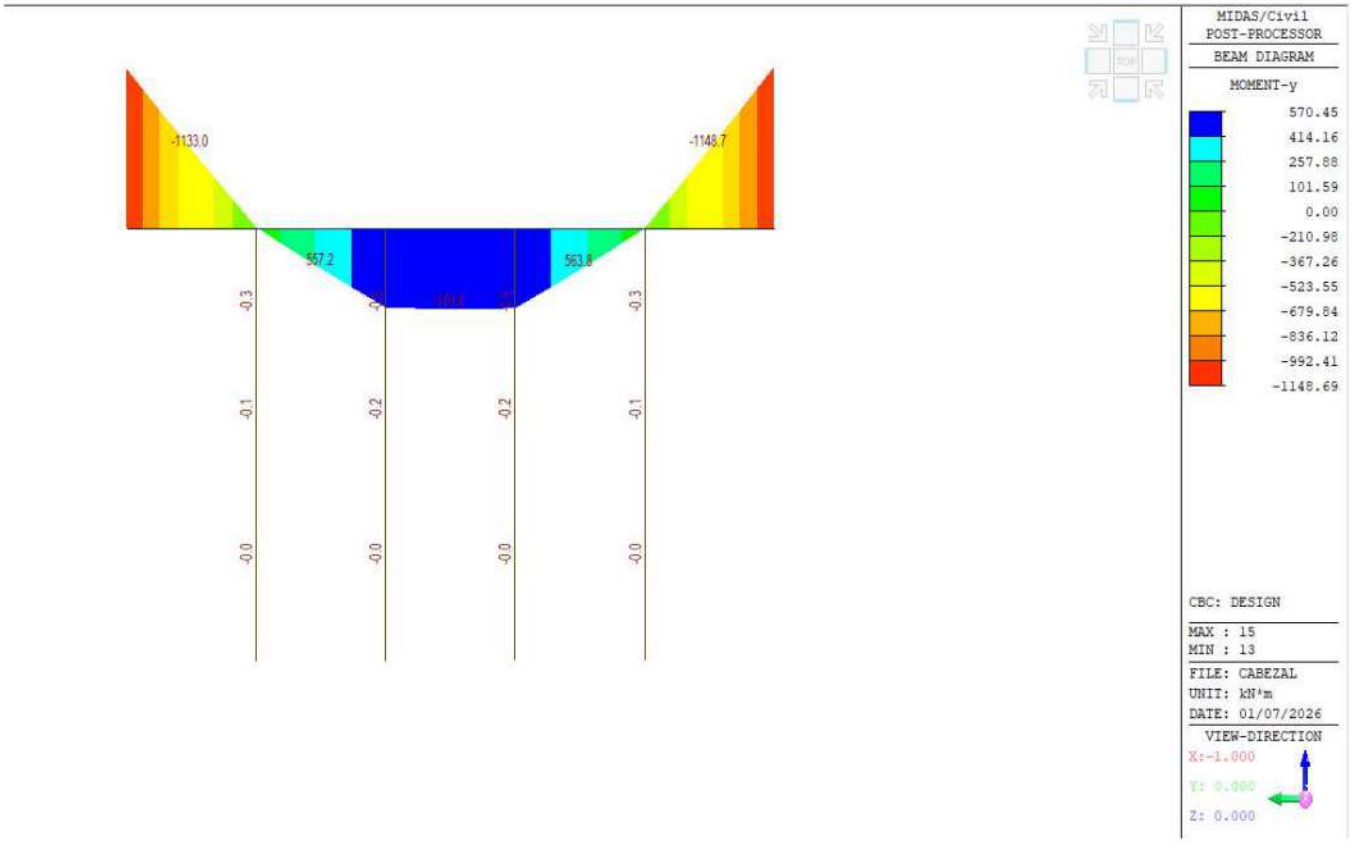
Fuente: Midas Civil

5.4 OBTENCIÓN DE SOLICITACIONES PARA EL DISEÑO.

A partir del modelo estructural en MIDAS Civil se obtuvieron las **reacciones en la base de las pilas**, los **diagramas de momentos flectores, fuerzas cortantes y esfuerzos axiales**, tanto para condiciones estáticas como sísmicas.

Las solicitaciones resultantes fueron empleadas directamente para el **diseño estructural de la viga cabezal y las pilas**, garantizando la compatibilidad entre el modelo geotécnico y el modelo estructural, y asegurando que los elementos estructurales cuenten con la capacidad requerida para resistir las acciones actuantes bajo las combinaciones más críticas.

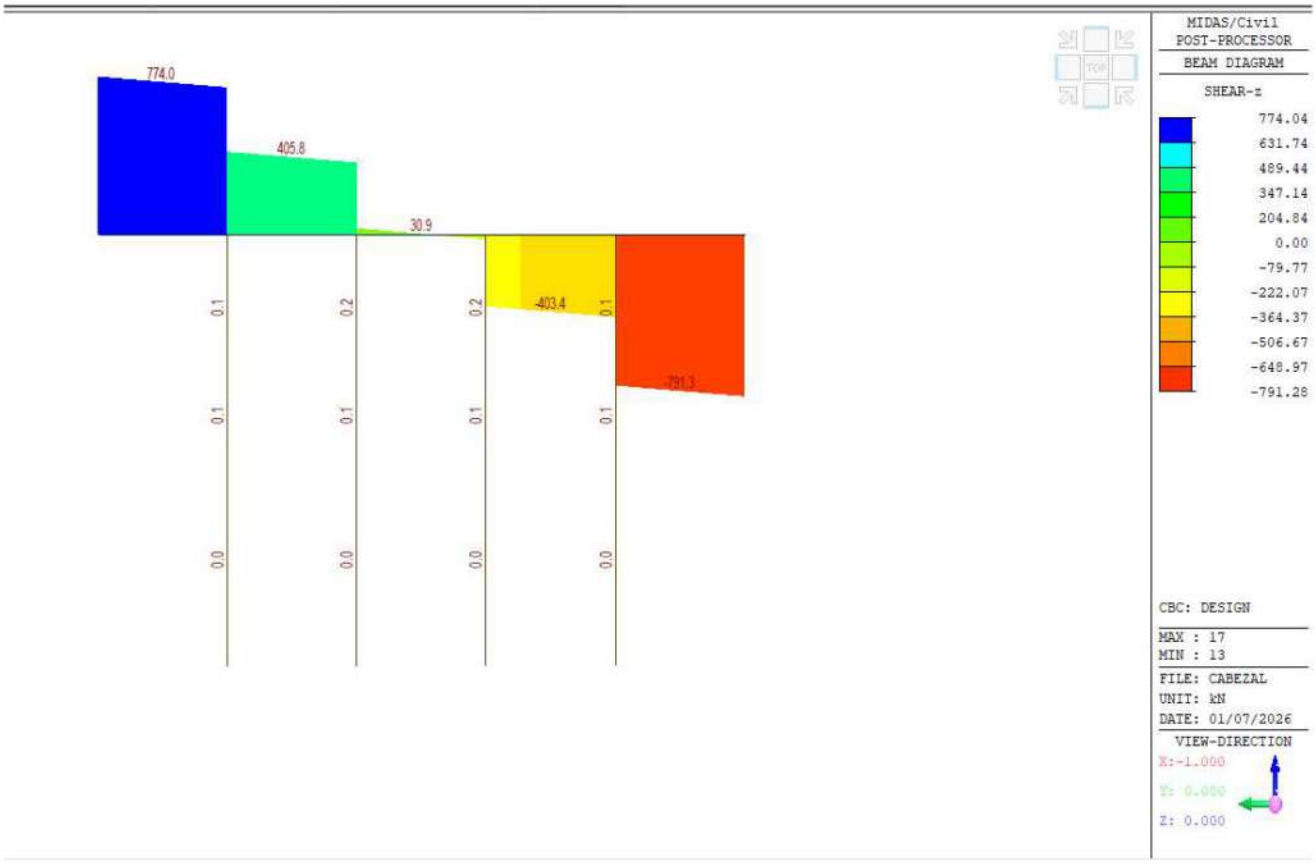
Figura 4 Diagrama de momento en la viga cabezal



Fuente: Midas Civil

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Figura 5 Diagrama de cortante en la viga cabezal



Fuente: Midas Civil

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5.5 RESUMEN DEL DISEÑO.

Tabla 2 Resumen de diseño de elementos tipo beam (viga cabezal) (unidades kN - m)

MEMB	Section	Section	fc	POS	CHK	AsTop	AsBot	N(-) Mu	N(-) Mr	LCB	Rat-N	P(+) Mu	P(+) Mr	LCB	Rat-P	Vu	pV	LCB	Rat-V	Tu	Tn	LCB	Rat-T	CHK	Top S	Top Sa	Bot S	Bot Sa
SECT	Bc	Hc	fy	POS	CHK	AsTop	AsBot	N(-) Mu	N(-) Mr	LCB	Rat-N	P(+) Mu	P(+) Mr	LCB	Rat-P	Vu	pV	LCB	Rat-V	Tu	Tn	LCB	Rat-T	CHK	Top S	Top Sa	Bot S	Bot Sa
Span	bf	hf	fys	POS	CHK	AsTop	AsBot	N(-) Mu	N(-) Mr	LCB	Rat-N	P(+) Mu	P(+) Mr	LCB	Rat-P	Vu	pV	LCB	Rat-V	Tu	Tn	LCB	Rat-T	CHK	Top S	Top Sa	Bot S	Bot Sa
13	VC	VC	27579	I	OK	0.0097	0.0031	1148.69	3115.96	E.L.S.	0.369	0	1042.78	E.L.S.	0	791.275	3465.24	3	0.228	0.86627	881.214	3	0.001	OK	0.0545	0.2851	0	0.4572
1	1.5	1	413686	M	OK-..-	0.0031	0.0085	854.45	1042.78	E.L.S.	0.819	0	2766.71	E.L.S.	0	778.021	2711	3	0.287	0.86627	728.942	3	0.001	T*	0.187	0.1156	0	0.4572
1.5	0	0	413686	J	OK	0.0097	0.0031	280.874	3115.96	E.L.S.	0.09	0	1042.78	E.L.S.	0	751.513	3755.99	3	0.2	0.86627	919.623	3	0.001	OK	0.0545	0.4572	0.187	0.4572
14	VC	VC	27579	I	OK	0.0097	0.0031	1.54233	3115.96	E.L.S.	0	147.257	1042.78	E.L.S.	0.141	403.425	3436.46	3	0.117	0.57866	855.499	3	0.001	OK	0	0.4572	0.187	0.4572
1	1.5	1	413686	M	OK	0.0031	0.0085	0	1042.78	E.L.S.	0	429.945	2766.71	E.L.S.	0.155	390.171	4168.87	3	0.094	0.57866	962.088	3	0.001	OK	0	0.4572	0.0623	0.4572
1.5	0	0	413686	J	OK	0.0097	0.0031	0	3115.96	E.L.S.	0	563.833	1042.78	E.L.S.	0.541	363.663	3231.41	3	0.113	0.57866	823.664	3	0.001	*B	0	0.4572	0.187	0.1418
15	VC	VC	27579	I	OK	0.0097	0.0031	0	3115.96	E.L.S.	0	569.626	1042.78	E.L.S.	0.546	22.0753	3682.76	3	0.006	0.0065	889.942	3	0	*B	0	0.4572	0.187	0.141
1	1.5	1	413686	M	OK	0.0031	0.0085	0	1042.78	E.L.S.	0	570.449	2766.71	E.L.S.	0.206	17.6875	4275.66	3	0.004	0.0065	972.488	3	0	OK	0	0.4572	0.0623	0.4572
1.5	0	0	413686	J	OK	0.0097	0.0031	0	3115.96	E.L.S.	0	566.301	1042.78	E.L.S.	0.543	30.9418	3680.51	3	0.008	0.0065	889.646	3	0	*B	0	0.4572	0.187	0.1436
16	VC	VC	27579	I	OK	0.0097	0.0031	0	3115.96	E.L.S.	0	557.183	1042.78	E.L.S.	0.534	366.029	3280.81	3	0.112	0.57456	831.606	3	0.001	*B	0	0.4572	0.187	0.1471
1	1.5	1	413686	M	OK	0.0031	0.0085	0	1042.78	E.L.S.	0	422.407	2766.71	E.L.S.	0.153	392.538	4197.24	3	0.094	0.57456	964.907	3	0.001	OK	0	0.4572	0.0623	0.4572
1.5	0	0	413686	J	OK	0.0097	0.0031	11.7419	3115.96	E.L.S.	0.004	137.945	1042.78	E.L.S.	0.132	405.792	3481.3	3	0.117	0.57456	862.07	3	0.001	OK	0.0545	0.4572	0.187	0.4572
17	VC	VC	27579	I	OK	0.0097	0.0031	284.611	3115.96	E.L.S.	0.091	0	1042.78	E.L.S.	0	734.279	3818.36	3	0.192	0.87687	927.15	3	0.001	OK	0.0545	0.4572	0	0.4572
1	1.5	1	413686	M	OK-..-	0.0031	0.0085	845.261	1042.78	E.L.S.	0.811	0	2766.71	E.L.S.	0	760.788	2798.43	3	0.272	0.87687	746.299	3	0.001	T*	0.187	0.1156	0	0.4572
1.5	0	0	413686	J	OK	0.0097	0.0031	1133.04	3115.96	E.L.S.	0.364	0	1042.78	E.L.S.	0	774.042	3516.08	3	0.22	0.87687	888.342	3	0.001	OK	0.0545	0.2944	0	0.4572

Fuente: Midas Civil

Nota: el resumen detallado se anexa al final de este documento.

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Tabla 3 Resumen de diseño de elementos tipo beam (Pilas)(unidades kN - m)

MEMB	Section	Section	Bc	Hc	fc	fy	CHK	LCB	POS	Ast	Pr-max	Pu	Pr	Rat-P	LCB	Vu
SECT	Section	t	a	b	Height	fys	CHK	LCB	POS	Rho	Pr-max	Mc	Mr	Rat-M	LCB	Rat-V
1	PILA	PILA	0.5	0.5	27579	413686	OK-	E.L.S.	J	0.0016	3136.35	-11.567	-590.61	0.02	E.L.S.	0.00919
2	PILA	0	0	0	2.5	413686	OK-	E.L.S.	J	0.0081	3136.35	0.02297	1.17306	0.02	E.L.S.	0
2	PILA	PILA	0.5	0.5	27579	413686	OK-	E.L.S.	J	0.0016	3136.35	-11.567	-585.3	0.02	E.L.S.	0.01894
2	PILA	0	0	0	2.5	413686	OK-	E.L.S.	J	0.0081	3136.35	0.04735	2.39592	0.02	E.L.S.	0
3	PILA	PILA	0.5	0.5	27579	413686	OK-	E.L.S.	J	0.0016	3136.35	-11.567	-585.12	0.02	E.L.S.	0.01927
2	PILA	0	0	0	2.5	413686	OK-	E.L.S.	J	0.0081	3136.35	0.04818	2.43724	0.02	E.L.S.	0
4	PILA	PILA	0.5	0.5	27579	413686	OK-	E.L.S.	J	0.0016	3136.35	-11.567	-590.31	0.02	E.L.S.	0.00974
2	PILA	0	0	0	2.5	413686	OK-	E.L.S.	J	0.0081	3136.35	0.02435	1.24254	0.02	E.L.S.	0
5	PILA	PILA	0.5	0.5	27579	413686	OK-	E.L.S.	J	0.0016	3136.35	-15.453	-582.07	0.027	E.L.S.	0.07186
2	PILA	0	0	0	0.84	413686	OK-	E.L.S.	J	0.0081	3136.35	0.08333	3.13896	0.027	E.L.S.	0
6	PILA	PILA	0.5	0.5	27579	413686	OK-	E.L.S.	J	0.0016	3136.35	-15.453	-568.95	0.027	E.L.S.	0.1428
2	PILA	0	0	0	0.84	413686	OK-	E.L.S.	J	0.0081	3136.35	0.1673	6.15985	0.027	E.L.S.	0
7	PILA	PILA	0.5	0.5	27579	413686	OK-	E.L.S.	J	0.0016	3136.35	-15.453	-568.54	0.027	E.L.S.	0.14502
2	PILA	0	0	0	0.84	413686	OK-	E.L.S.	J	0.0081	3136.35	0.16999	6.2544	0.027	E.L.S.	0
8	PILA	PILA	0.5	0.5	27579	413686	OK-	E.L.S.	J	0.0016	3136.35	-15.453	-581.36	0.027	E.L.S.	0.07551
2	PILA	0	0	0	0.84	413686	OK-	E.L.S.	J	0.0081	3136.35	0.08778	3.30229	0.027	E.L.S.	0
9	PILA	PILA	0.5	0.5	27579	413686	OK-	E.L.S.	J	0.0016	3136.35	-23.133	-565.18	0.041	E.L.S.	0.12306
2	PILA	0	0	0	1.66	413686	OK-	E.L.S.	J	0.0081	3136.35	0.28761	7.02689	0.041	E.L.S.	0
10	PILA	PILA	0.5	0.5	27579	413686	OK-	E.L.S.	J	0.0016	3136.35	-23.133	-537.92	0.043	E.L.S.	0.24389
2	PILA	0	0	0	1.66	413686	OK-	E.L.S.	J	0.0081	3136.35	0.57215	13.3044	0.043	E.L.S.	0
11	PILA	PILA	0.5	0.5	27579	413686	OK-	E.L.S.	J	0.0016	3136.35	-23.133	-537.1	0.043	E.L.S.	0.24763
2	PILA	0	0	0	1.66	413686	OK-	E.L.S.	J	0.0081	3136.35	0.58106	13.491	0.043	E.L.S.	0
12	PILA	PILA	0.5	0.5	27579	413686	OK-	E.L.S.	J	0.0016	3136.35	-23.133	-563.71	0.041	E.L.S.	0.12924
2	PILA	0	0	0	1.66	413686	OK-	E.L.S.	J	0.0081	3136.35	0.30231	7.36669	0.041	E.L.S.	0

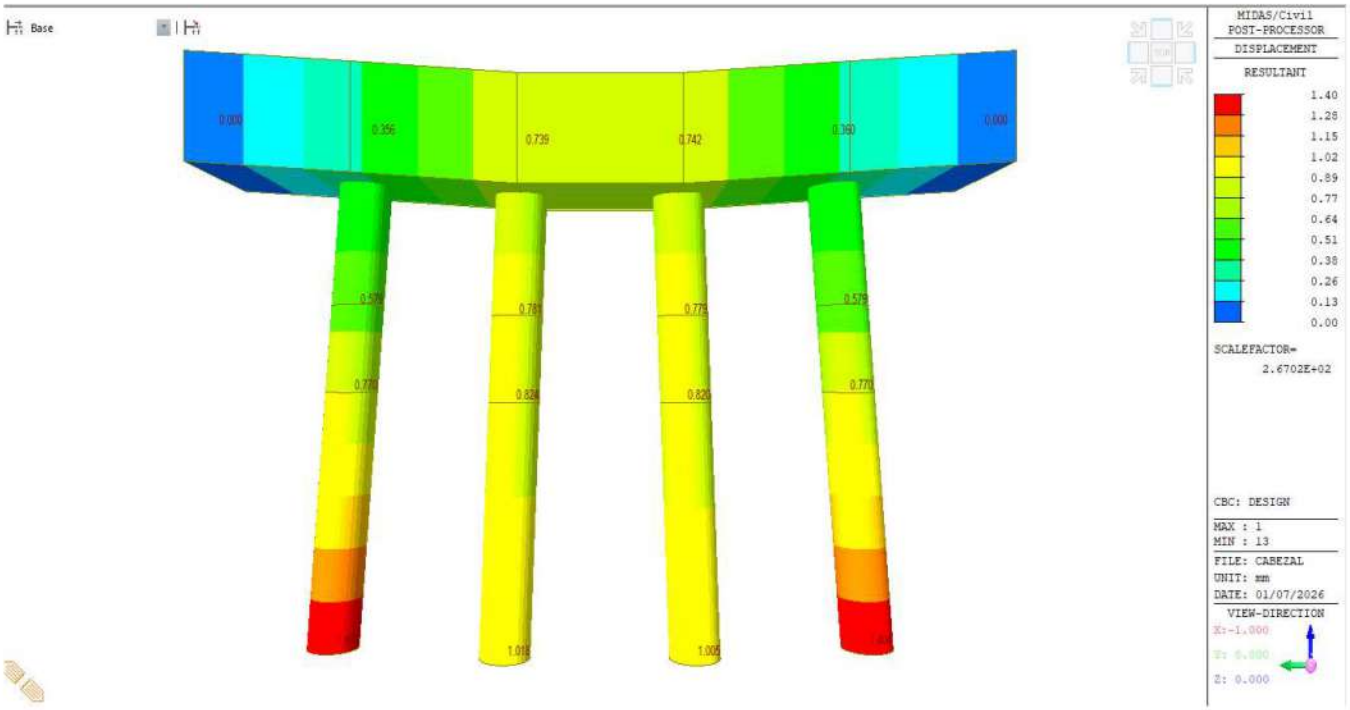
Fuente: Midas Civil

Nota: el resumen detallado se anexa al final de este documento.

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5.6 DEFORMACIONES.

Figura 6 Deformación en estado límite de servicio



Fuente: Midas Civil

Node	Load	DX (mm)	DY (mm)	DZ (mm)	RX ([rad])	RY ([rad])	RZ ([rad])
1	Design	0.000499	-1.35434	-0.371503	-0.000272	0.000005	-0.000013
2	Design	0.001029	-0.665525	-0.752648	-0.000134	0.000011	-0.000007
3	Design	0.001047	0.688799	-0.749701	0.000137	0.000011	0.000006
4	Design	0.000529	1.354274	-0.367008	0.00027	0.000006	0.000013
5	Design	0.013624	-0.675559	-0.368572	-0.000272	0.000005	-0.000013
6	Design	0.026927	-0.330347	-0.749717	-0.000134	0.00001	-0.000007
7	Design	0.027336	0.346816	-0.746771	0.000137	0.00001	0.000006
8	Design	0.014299	0.678748	-0.364077	0.00027	0.000005	0.000013
9	Design	0.017656	-0.447489	-0.366272	-0.000272	0.000004	-0.000013
10	Design	0.034856	-0.217727	-0.747417	-0.000134	0.000009	-0.000007
11	Design	0.035383	0.231909	-0.74447	0.000137	0.000009	0.000006
12	Design	0.018526	0.451771	-0.361777	0.00027	0.000005	0.000013
13	Design	0	0	0	0	0	0

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Node	Load	DX (mm)	DY (mm)	DZ (mm)	RX ([rad])	RY ([rad])	RZ ([rad])
14	Design	0.022392	0.003221	-0.35978	-0.000272	0	-0.000013
15	Design	0.04406	0.004832	-0.740925	-0.000134	0.000001	-0.000007
16	Design	0.044718	0.004832	-0.737979	0.000137	0.000001	0.000006
17	Design	0.023478	0.003221	-0.355285	0.00027	0	0.000013
18	Design	0	0	0	0	0	0

6 LIMITACIONES DEL ESTUDIO

Las recomendaciones planteadas en el presente estudio se basan en los resultados de las investigaciones de campo, la información proporcionada por el contratista y en los análisis de ingeniería anteriormente descritos. Si durante la construcción del proyecto llegaran a presentarse condiciones diferentes a las enunciadas y asumidas como típicas, o surgiese cualquier dificultad imprevista, está situación deberá ser informada oportunamente a fin de realizar los ajustes y evaluaciones pertinentes.

Juan Arismendy

JUAN SEBASTIAN ARISMENDY BERROCAL
INGENIERO CIVIL
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PROJECT TITLE :

MIDAS	Company		Client	
	Author		File Name	CABEZAL

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Beam Checking   [ AASHTO-LRFD12 ]                              Civil 2022
============================================================================================


       +============================================================+
       |  MIDAS(Modeling, Integrated Design & Analysis Software)    |
       |  MIDAS/Civil - Design & checking system for windows        |
       +============================================================+
       |  RC-Member(Beam or Column) Analysis and Design             |
       |  Based On  AASHTO-LRFD17, AASHTO-LRFD16, AASHTO-LRFD12,    |
       |            AASHTO-LRFD07, AASHTO-LRFD02, AASHTO-LFD96,     |
       |            ACI318-02, CSA-S6-00, CSA-S6-14,                |
       |            Eurocode2-2:05, SNiP 2.05.03-84*,               |
       |            SP 35.13330.2011, SNiP 2.05.03-84*(MKS),        |
       |            SP 35.13330.2011(MKS), IRC:21-2000,             |
       |            IRC:112-2011, IS456:2000, IRS                   |
       |                                          (c)SINCE 1989     |
       +============================================================+
       |  MIDAS Information Technology Co.,Ltd.         (MIDAS IT)  |
       |  MIDAS IT Design Development Team                          |
       +============================================================+
       |            HomePage : www.MidasUser.com                    |
       +============================================================+
       |  MIDAS/Civil  Version 9.1.0                                |
       +============================================================+


    *.DEFINITION OF LOAD COMBINATIONS WITH SCALING UP FACTORS.
--------------------------------------------------------------------------------------------
     LCB  C    Loadcase Name(Factor) + Loadcase Name(Factor) + Loadcase Name(Factor)
--------------------------------------------------------------------------------------------
       2  2               D( 1.000) +           EX( 1.000) +           PP( 1.000)
       3  1               D( 1.000) +           PP( 1.000)
--------------------------------------------------------------------------------------------
```

PROJECT TITLE :

MIDAS	Company		Client	
	Author		File Name	CABEZAL

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Beam Checking    [ AASHTO-LRFD12 ]                              Civil 2022
============================================================================================

      *.MIDAS/Civil - RC-BEAM Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = BEAM,   MEMB =    13

      *.DESCRIPTION OF BEAM DATA (iSEC =     1) : VC
        Section Type : Rectangle (RECT)
        Beam Length (Span)              =         1.500 m.
        Section Depth (Hc)              =         1.000 m.
        Section Width (Bc)              =         1.500 m.
        Concrete Strength (fc')         =     27579.038 KPa.
        Main Rebar Strength (fy)        =    413685.566 KPa.
        Stirrups Strength (fys)         =    413685.566 KPa.
        Modulus of Elasticity (Es)      = 199948023.746 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Seismic Zone3.

      *.FORCES AND MOMENTS AT CHECK POINT <I> :
        Positive Bending Moment   P-Mu =        0.00 kN-m.,  LCB =   3
        Negative Bending Moment   N-Mu =     1148.69 kN-m.,  LCB =   3
        Shear Force               Vu   =      791.28 kN.  ,  LCB =   3

      *.REINFORCEMENT PATTERN :
        ---------------------------------------------------------
           Location    i     di( m.)       Rebar    Asi( m^2.)
        ---------------------------------------------------------
           Top         1      0.075    25- #7, 7      0.00968
           Bottom      1      0.075     8- #7, 7      0.00310
        ---------------------------------------------------------
           Stirrups : 6.0-#3  @100

 ============================================================================
    [[[*]]]   ANALYZE NEGATIVE BENDING MOMENT CAPACITY.
 ============================================================================

      ( ). Compute parameter.
           -. phi   =   0.90
           -. Alpha =   0.85
           -. Beta  =   0.85
           -. d     =     0.9250 m.
           -. ecu   =  0.0030

      ( ). Compute maximum and minimum reinforcement.
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Beam Checking   [ AASHTO-LRFD12 ]                              Civil 2022
============================================================================================

          -. Iyy     =       0.1250 m^4.
          -. zbar    =       0.5000 m.
          -. fr      = 0.24*SQRT[fc'] =     3309.48 KPa.
          -. Sc      = Iyy / zbar     =      0.2500 m^3.
          -. Mcr     = 1.2*Sc*fr      =      992.85 kN-m.
          -. Rhomin1 = Mcr/[ phi*fy*b*d*(d-a/2) ]     =   0.0021
          -. Rhomin2 = 1.33*Mu/[ phi*fy*b*d*(d-a/2) ] =   0.0033
          -. Rhomin  = MIN[ Rhomin1, Rhomin2 ]        =   0.0021
          -. As_min =  Rhomin * Ag  =     0.0032 m^2.

     ( ). Check tensile reinforcement.
          -. As     =     0.0097 m^2.
          -. As_min < As   --->  O.K !

     ( ). Check moment capacity.
          -. c          =     0.1328 m.
          -. Cc         =       3969.60 kN.
          -. Ts         =       4003.40 kN.
          -. Mr         =       3115.96 kN-m.
          -. Mu/Mr      =   0.369  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE POSITIVE BENDING MOMENT CAPACITY.
 ============================================================================

     ( ). Compute parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. d     =     0.9250 m.
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Iyy     =       0.1250 m^4.
          -. zbar    =       0.5000 m.
          -. fr      = 0.24*SQRT[fc'] =     3309.48 KPa.
          -. Sc      = Iyy / zbar     =      0.2500 m^3.
          -. Mcr     = 1.2*Sc*fr      =      992.85 kN-m.
          -. Rhomin1 = Mcr/[ phi*fy*b*d*(d-a/2) ]     =   0.0021
          -. Rhomin2 = 1.33*Mu/[ phi*fy*b*d*(d-a/2) ] =   0.0000
          -. Rhomin  = MIN[ Rhomin1, Rhomin2 ]        =   0.0000
          -. As_min =  Rhomin * Ag  =     0.0000 m^2.

     ( ). Check tensile reinforcement.
          -. As     =     0.0031 m^2.
          -. As_min < As   --->  O.K !
```

PROJECT TITLE :

MIDAS	Company		Client	
	Author		File Name	CABEZAL

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Beam Checking   [ AASHTO-LRFD12 ]                              Civil 2022
============================================================================================


     ( ). Check moment capacity.
          -. c          =     0.0426 m.
          -. Cc         =       1274.55 kN.
          -. Ts         =       1281.09 kN.
          -. Mr         =       1042.78 kN-m.
          -. Mu/Mr      =   0.000  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY.
 ============================================================================

     ( ). Compute shear parameter.
          -. phi   =   0.90
          -. Av    =     0.0004 m^2.
          -. bv    =   1.50 m.
          -. dv    =  MAX[ dv, 0.9*d, 0.72*Hc ]  =   0.87 m.
          -. theta =  32.90 Deg.           [Clause 5.8.3.4.2]
          -. beta  =   2.62

     ( ). Compute shear strength of concrete.
          -. Vu     =      791.28 kN.
          -. Vc     = 0.0316*beta*SQRT[fc']*bv*dv =     1485.01 kN.
          -. phiVc  = phi * Vc =     1336.51 kN.
          -. Vn_lim = 0.25*fc'*bv*dv =     8982.71 kN.

     ( ). Compute stirrup spacing.
          -. Maximum spacing smax = MIN[ 0.8*dv, 24 in ] =    0.610 m.
          -. phiVc/2 < Vu < phiVc  --->  Required minimum shear reinforcement.
          -.                 smax = MIN[ smax, Av/(0.0316*SQRT(fc')*bv/fys) ] =    0.269 m.
          -. Applied spacing s    =    0.100 m.

     ( ). Compute shear strength of reinforcement.
          -. Vs      = Av*fys*dv*cot(theta) / s =     2365.25 kN.
          -. Vs_lim  = 0.25*fc'*bv*dv - Vc =     7497.70 kN.
          -. Vs      = MIN[ Vs, Vs_lim ] =     2365.25 kN.
          -. phiVs   = phi*Vs =     2128.73 kN.

          -. phiVs > (Vu-phiVc)  --->  O.K !
          -. Using Av/s  =  Vs / (fys*dv*cot(theta)) =   0.0043 m^2/m.

     ( ). Check tension force in the longitudinal reinforcement caused by shear.
          -. phib    =   0.90
          -. phiv    =   0.90
          -. Vs1     =  MIN[ Vs, Vu/phiv ] =      879.19 kN.
          -. As_req  =  [ Mu/(phib*dv) + (Vu/phiv - 0.5*Vs1)*cot(theta) ] / fy =   0.0052 m^2.

 ============================================================================
    [[[*]]]   ANALYZE TORSION CAPACITY.
 ============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Beam Checking   [ AASHTO-LRFD12 ]                              Civil 2022
============================================================================================


      ( ). Compute torsion parameter.
           -. phi   =   0.90
           -. Acp   =       1.50 m^2.
           -. Pc    =       5.00 m.
           -. Aoh   =       1.27 m^2.
           -. Ao    =  0.85*Aoh =      1.08 m^2.
           -. Ph    =       4.63 m.
           -. Tu    =          0.87 kN-m.
           -. theta =  32.90 Deg.

           -. Tcr   =  0.125*SQRT(fc')*Acp^2/Pc =       775.66 kN-m.

           -. Tu < 0.25*phi*Tcr =       174.52 kN-m.
               ---> Torsion check is not required.

 ============================================================================
    [[[*]]]   ANALYZE CRACK.
 ============================================================================

      ( ). Check crack control of top reinforcement. ( LCB =    2 )
           -. Mu      =   2055.9886 kN-m.
           -. h       =      1.0000 m.
           -. dc      =      0.0750 m.
           -. Beta_s  = 1+dc/(0.7*(h-dc)) = 1.12 m.
           -. Gamma_e = 1.00
           -. c_cr    =      0.2529 m.
           -. Icr     =      0.0436 m^4.
           -. fss     =    252485.108 KPa.
           -. s       =       0.0545 m.
           -. sa      = 700*Gamma_e/(Beta_s*fss)-2*dc =      0.2851 m.
           -. s < sa --->  O.K !

      ( ). Check crack control of bottom reinforcement. ( LCB =    2 )
           -. Mu      =      0.0000 kN-m.
           -. h       =      1.0000 m.
           -. dc      =      0.0750 m.
           -. Beta_s  = 1+dc/(0.7*(h-dc)) = 1.12 m.
           -. Gamma_e = 1.00
           -. c_cr    =      0.1410 m.
           -. Icr     =      0.0169 m^4.
           -. fss     =         0.000 KPa.
           -. s       =       0.0000 m.
           -. sa      = 700*Gamma_e/(Beta_s*fss)-2*dc =      0.4572 m.
           -. fss = 0 --->  Crack check is not required.(Mu=0)

--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Beam Checking   [ AASHTO-LRFD12 ]                              Civil 2022
============================================================================================

      *.MIDAS/Civil - RC-BEAM Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = BEAM,   MEMB =    14

      *.DESCRIPTION OF BEAM DATA (iSEC =     1) : VC
        Section Type : Rectangle (RECT)
        Beam Length (Span)             =         1.500 m.
```

```
  Section Depth (Hc)              =         1.000 m.
  Section Width (Bc)              =         1.500 m.
  Concrete Strength (fc')         =     27579.038 KPa.
  Main Rebar Strength (fy)        =    413685.566 KPa.
  Stirrups Strength (fys)         =    413685.566 KPa.
  Modulus of Elasticity (Es)      = 199948023.746 KPa.

*.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
  Special Provisions For Seismic Design : Seismic Zone3.

*.FORCES AND MOMENTS AT CHECK POINT <I> :
  Positive Bending Moment   P-Mu =      147.26 kN-m.,  LCB =   3
  Negative Bending Moment   N-Mu =        1.54 kN-m.,  LCB =   3
  Shear Force               Vu   =      403.43 kN.  ,  LCB =   3

*.REINFORCEMENT PATTERN :
  ------------------------------------------------------
     Location    i     di( m.)       Rebar    Asi( m^2.)
  ------------------------------------------------------
     Top         1      0.075    25- #7, 7      0.00968
     Bottom      1      0.075     8- #7, 7      0.00310
  ------------------------------------------------------
     Stirrups : 6.0-#3  @100

================================================================================
   [[[*]]]   ANALYZE NEGATIVE BENDING MOMENT CAPACITY.
================================================================================

     ( ). Compute parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. d     =     0.9250 m.
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Beam Checking   [ AASHTO-LRFD12 ]                              Civil 2022
============================================================================================

          -. Iyy     =       0.1250 m^4.
          -. zbar    =       0.5000 m.
          -. fr      = 0.24*SQRT[fc'] =     3309.48 KPa.
          -. Sc      = Iyy / zbar     =      0.2500 m^3.
          -. Mcr     = 1.2*Sc*fr      =      992.85 kN-m.
          -. Rhomin1 = Mcr/[ phi*fy*b*d*(d-a/2) ]     =   0.0021
          -. Rhomin2 = 1.33*Mu/[ phi*fy*b*d*(d-a/2) ] =4.2930e-06
          -. Rhomin  = MIN[ Rhomin1, Rhomin2 ]        =4.2930e-06
          -. As_min =  Rhomin * Ag  =  6.4395e-06 m^2.

     ( ). Check tensile reinforcement.
          -. As     =     0.0097 m^2.
          -. As_min < As   --->  O.K !

     ( ). Check moment capacity.
          -. c          =     0.1328 m.
          -. Cc         =       3969.60 kN.
          -. Ts         =       4003.40 kN.
          -. Mr         =       3115.96 kN-m.
          -. Mu/Mr      =  4.950e-04  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE POSITIVE BENDING MOMENT CAPACITY.
 ============================================================================

     ( ). Compute parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. d     =     0.9250 m.
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Iyy     =       0.1250 m^4.
          -. zbar    =       0.5000 m.
          -. fr      = 0.24*SQRT[fc'] =     3309.48 KPa.
          -. Sc      = Iyy / zbar     =      0.2500 m^3.
          -. Mcr     = 1.2*Sc*fr      =      992.85 kN-m.
          -. Rhomin1 = Mcr/[ phi*fy*b*d*(d-a/2) ]     =   0.0021
          -. Rhomin2 = 1.33*Mu/[ phi*fy*b*d*(d-a/2) ] =   0.0004
          -. Rhomin  = MIN[ Rhomin1, Rhomin2 ]        =   0.0004
          -. As_min =  Rhomin * Ag  =     0.0006 m^2.

     ( ). Check tensile reinforcement.
          -. As     =     0.0031 m^2.
          -. As_min < As   --->  O.K !
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Beam Checking    [ AASHTO-LRFD12 ]                              Civil 2022
============================================================================================


      ( ). Check moment capacity.
           -. c          =     0.0426 m.
           -. Cc         =       1274.55 kN.
           -. Ts         =       1281.09 kN.
           -. Mr         =       1042.78 kN-m.
           -. Mu/Mr      =   0.141  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY.
 ============================================================================

      ( ). Compute shear parameter.
           -. phi   =   0.90
           -. Av    =     0.0004 m^2.
           -. bv    =   1.50 m.
           -. dv    =  MAX[ dv, 0.9*d, 0.72*Hc ]  =   0.91 m.
           -. theta =  33.68 Deg.           [Clause 5.8.3.4.2]
           -. beta  =   2.40

      ( ). Compute shear strength of concrete.
           -. Vu     =      403.43 kN.
           -. Vc     = 0.0316*beta*SQRT[fc']*bv*dv =     1421.11 kN.
           -. phiVc  = phi * Vc =     1279.00 kN.
           -. Vn_lim = 0.25*fc'*bv*dv =     9377.61 kN.

      ( ). Compute stirrup spacing.
           -. Maximum spacing smax = MIN[ 0.8*dv, 24 in ] =    0.610 m.
           -. Vu < phiVc/2  --->  Not required shear reinforcement.
           -. Applied spacing s    =    0.100 m.

      ( ). Compute shear strength of reinforcement.
           -. Vs      = Av*fys*dv*cot(theta) / s =     2397.18 kN.
           -. Vs_lim  = 0.25*fc'*bv*dv - Vc =     7956.50 kN.
           -. Vs      = MIN[ Vs, Vs_lim ] =     2397.18 kN.
           -. phiVs   = phi*Vs =     2157.46 kN.

           -. phiVs > (Vu-phiVc)  --->  O.K !
           -. Using Av/s  =  Vs / (fys*dv*cot(theta)) =   0.0043 m^2/m.

      ( ). Check tension force in the longitudinal reinforcement caused by shear.
           -. phib    =   0.90
           -. phiv    =   0.90
           -. Vs1     =  MIN[ Vs, Vu/phiv ] =      448.25 kN.
           -. As_req  =  [ Mu/(phib*dv) + (Vu/phiv - 0.5*Vs1)*cot(theta) ] / fy =   0.0012 m^2.

 ============================================================================
    [[[*]]]   ANALYZE TORSION CAPACITY.
 ============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Beam Checking   [ AASHTO-LRFD12 ]                              Civil 2022
============================================================================================


      ( ). Compute torsion parameter.
           -. phi   =   0.90
           -. Acp   =       1.50 m^2.
           -. Pc    =       5.00 m.
           -. Aoh   =       1.27 m^2.
           -. Ao    =  0.85*Aoh =      1.08 m^2.
           -. Ph    =       4.63 m.
           -. Tu    =          0.58 kN-m.
           -. theta =  33.68 Deg.

           -. Tcr   =  0.125*SQRT(fc')*Acp^2/Pc =       775.66 kN-m.

           -. Tu < 0.25*phi*Tcr =       174.52 kN-m.
               ---> Torsion check is not required.

 ============================================================================
    [[[*]]]   ANALYZE CRACK.
 ============================================================================

      ( ). Check crack control of top reinforcement. ( LCB =    2 )
           -. Mu      =      0.0000 kN-m.
           -. h       =      1.0000 m.
           -. dc      =      0.0750 m.
           -. Beta_s  = 1+dc/(0.7*(h-dc)) = 1.12 m.
           -. Gamma_e = 1.00
           -. c_cr    =      0.2529 m.
           -. Icr     =      0.0436 m^4.
           -. fss     =         0.000 KPa.
           -. s       =       0.0000 m.
           -. sa      = 700*Gamma_e/(Beta_s*fss)-2*dc =      0.4572 m.
           -. fss = 0 --->  Crack check is not required.(Mu=0)

      ( ). Check crack control of bottom reinforcement. ( LCB =    2 )
           -. Mu      =    267.0591 kN-m.
           -. h       =      1.0000 m.
           -. dc      =      0.0750 m.
           -. Beta_s  = 1+dc/(0.7*(h-dc)) = 1.12 m.
           -. Gamma_e = 1.00
           -. c_cr    =      0.1410 m.
           -. Icr     =      0.0169 m^4.
           -. fss     =     98921.472 KPa.
           -. s       =       0.1870 m.
           -. sa      = 700*Gamma_e/(Beta_s*fss)-2*dc =      0.4572 m.
           -. s < sa --->  O.K !

--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Beam Checking   [ AASHTO-LRFD12 ]                              Civil 2022
============================================================================================

      *.MIDAS/Civil - RC-BEAM Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = BEAM,   MEMB =    15

      *.DESCRIPTION OF BEAM DATA (iSEC =     1) : VC
        Section Type : Rectangle (RECT)
        Beam Length (Span)             =         1.500 m.
```

```
  Section Depth (Hc)              =         1.000 m.
  Section Width (Bc)              =         1.500 m.
  Concrete Strength (fc')         =     27579.038 KPa.
  Main Rebar Strength (fy)        =    413685.566 KPa.
  Stirrups Strength (fys)         =    413685.566 KPa.
  Modulus of Elasticity (Es)      = 199948023.746 KPa.

*.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
  Special Provisions For Seismic Design : Seismic Zone3.

*.FORCES AND MOMENTS AT CHECK POINT <I> :
  Positive Bending Moment   P-Mu =      569.63 kN-m.,  LCB =   3
  Negative Bending Moment   N-Mu =        0.00 kN-m.,  LCB =   3
  Shear Force               Vu   =       22.08 kN.  ,  LCB =   3

*.REINFORCEMENT PATTERN :
  ------------------------------------------------------
     Location    i     di( m.)       Rebar    Asi( m^2.)
  ------------------------------------------------------
     Top         1      0.075    25- #7, 7      0.00968
     Bottom      1      0.075     8- #7, 7      0.00310
  ------------------------------------------------------
     Stirrups : 6.0-#3  @100

================================================================================
   [[[*]]]   ANALYZE NEGATIVE BENDING MOMENT CAPACITY.
================================================================================

     ( ). Compute parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. d     =     0.9250 m.
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Beam Checking   [ AASHTO-LRFD12 ]                              Civil 2022
============================================================================================

          -. Iyy     =       0.1250 m^4.
          -. zbar    =       0.5000 m.
          -. fr      = 0.24*SQRT[fc'] =     3309.48 KPa.
          -. Sc      = Iyy / zbar     =      0.2500 m^3.
          -. Mcr     = 1.2*Sc*fr      =      992.85 kN-m.
          -. Rhomin1 = Mcr/[ phi*fy*b*d*(d-a/2) ]     =   0.0021
          -. Rhomin2 = 1.33*Mu/[ phi*fy*b*d*(d-a/2) ] =   0.0000
          -. Rhomin  = MIN[ Rhomin1, Rhomin2 ]        =   0.0000
          -. As_min =  Rhomin * Ag  =     0.0000 m^2.

     ( ). Check tensile reinforcement.
          -. As     =     0.0097 m^2.
          -. As_min < As   --->  O.K !

     ( ). Check moment capacity.
          -. c          =     0.1328 m.
          -. Cc         =       3969.60 kN.
          -. Ts         =       4003.40 kN.
          -. Mr         =       3115.96 kN-m.
          -. Mu/Mr      =   0.000  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE POSITIVE BENDING MOMENT CAPACITY.
 ============================================================================

     ( ). Compute parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. d     =     0.9250 m.
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Iyy     =       0.1250 m^4.
          -. zbar    =       0.5000 m.
          -. fr      = 0.24*SQRT[fc'] =     3309.48 KPa.
          -. Sc      = Iyy / zbar     =      0.2500 m^3.
          -. Mcr     = 1.2*Sc*fr      =      992.85 kN-m.
          -. Rhomin1 = Mcr/[ phi*fy*b*d*(d-a/2) ]     =   0.0021
          -. Rhomin2 = 1.33*Mu/[ phi*fy*b*d*(d-a/2) ] =   0.0016
          -. Rhomin  = MIN[ Rhomin1, Rhomin2 ]        =   0.0016
          -. As_min =  Rhomin * Ag  =     0.0024 m^2.

     ( ). Check tensile reinforcement.
          -. As     =     0.0031 m^2.
          -. As_min < As   --->  O.K !
```

PROJECT TITLE :

MIDAS	Company		Client	
	Author		File Name	CABEZAL

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Beam Checking   [ AASHTO-LRFD12 ]                              Civil 2022
============================================================================================


      ( ). Check moment capacity.
           -. c          =     0.0426 m.
           -. Cc         =       1274.55 kN.
           -. Ts         =       1281.09 kN.
           -. Mr         =       1042.78 kN-m.
           -. Mu/Mr      =   0.546  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY.
 ============================================================================

      ( ). Compute shear parameter.
           -. phi   =   0.90
           -. Av    =     0.0004 m^2.
           -. bv    =   1.50 m.
           -. dv    =  MAX[ dv, 0.9*d, 0.72*Hc ]  =   0.91 m.
           -. theta =  32.64 Deg.           [Clause 5.8.3.4.2]
           -. beta  =   2.70

      ( ). Compute shear strength of concrete.
           -. Vu     =       22.08 kN.
           -. Vc     = 0.0316*beta*SQRT[fc']*bv*dv =     1598.26 kN.
           -. phiVc  = phi * Vc =     1438.44 kN.
           -. Vn_lim = 0.25*fc'*bv*dv =     9377.61 kN.

      ( ). Compute stirrup spacing.
           -. Maximum spacing smax = MIN[ 0.8*dv, 24 in ] =    0.610 m.
           -. Vu < phiVc/2  --->  Not required shear reinforcement.
           -. Applied spacing s    =    0.100 m.

      ( ). Compute shear strength of reinforcement.
           -. Vs      = Av*fys*dv*cot(theta) / s =     2493.69 kN.
           -. Vs_lim  = 0.25*fc'*bv*dv - Vc =     7779.35 kN.
           -. Vs      = MIN[ Vs, Vs_lim ] =     2493.69 kN.
           -. phiVs   = phi*Vs =     2244.32 kN.

           -. phiVs > (Vu-phiVc)  --->  O.K !
           -. Using Av/s  =  Vs / (fys*dv*cot(theta)) =   0.0043 m^2/m.

      ( ). Check tension force in the longitudinal reinforcement caused by shear.
           -. phib    =   0.90
           -. phiv    =   0.90
           -. Vs1     =  MIN[ Vs, Vu/phiv ] =       24.53 kN.
           -. As_req  =  [ Mu/(phib*dv) + (Vu/phiv - 0.5*Vs1)*cot(theta) ] / fy =   0.0017 m^2.

 ============================================================================
    [[[*]]]   ANALYZE TORSION CAPACITY.
 ============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Beam Checking   [ AASHTO-LRFD12 ]                              Civil 2022
============================================================================================


      ( ). Compute torsion parameter.
           -. phi   =   0.90
           -. Acp   =       1.50 m^2.
           -. Pc    =       5.00 m.
           -. Aoh   =       1.27 m^2.
           -. Ao    =  0.85*Aoh =      1.08 m^2.
           -. Ph    =       4.63 m.
           -. Tu    =     6.50e-03 kN-m.
           -. theta =  32.64 Deg.

           -. Tcr   =  0.125*SQRT(fc')*Acp^2/Pc =       775.66 kN-m.

           -. Tu < 0.25*phi*Tcr =       174.52 kN-m.
               ---> Torsion check is not required.

 ============================================================================
    [[[*]]]   ANALYZE CRACK.
 ============================================================================

      ( ). Check crack control of top reinforcement. ( LCB =    2 )
           -. Mu      =      0.0000 kN-m.
           -. h       =      1.0000 m.
           -. dc      =      0.0750 m.
           -. Beta_s  = 1+dc/(0.7*(h-dc)) = 1.12 m.
           -. Gamma_e = 1.00
           -. c_cr    =      0.2529 m.
           -. Icr     =      0.0436 m^4.
           -. fss     =         0.000 KPa.
           -. s       =       0.0000 m.
           -. sa      = 700*Gamma_e/(Beta_s*fss)-2*dc =      0.4572 m.
           -. fss = 0 --->  Crack check is not required.(Mu=0)

      ( ). Check crack control of bottom reinforcement. ( LCB =    2 )
           -. Mu      =   1019.3764 kN-m.
           -. h       =      1.0000 m.
           -. dc      =      0.0750 m.
           -. Beta_s  = 1+dc/(0.7*(h-dc)) = 1.12 m.
           -. Gamma_e = 1.00
           -. c_cr    =      0.1410 m.
           -. Icr     =      0.0169 m^4.
           -. fss     =    377587.694 KPa.
           -. s       =       0.1870 m.
           -. sa      = 700*Gamma_e/(Beta_s*fss)-2*dc =      0.1410 m.
           -. s > sa --->  Not Acceptable !!!

--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Beam Checking   [ AASHTO-LRFD12 ]                              Civil 2022
============================================================================================

      *.MIDAS/Civil - RC-BEAM Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = BEAM,   MEMB =    16

      *.DESCRIPTION OF BEAM DATA (iSEC =     1) : VC
        Section Type : Rectangle (RECT)
        Beam Length (Span)             =         1.500 m.
```

```
  Section Depth (Hc)              =         1.000 m.
  Section Width (Bc)              =         1.500 m.
  Concrete Strength (fc')         =     27579.038 KPa.
  Main Rebar Strength (fy)        =    413685.566 KPa.
  Stirrups Strength (fys)         =    413685.566 KPa.
  Modulus of Elasticity (Es)      = 199948023.746 KPa.

*.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
  Special Provisions For Seismic Design : Seismic Zone3.

*.FORCES AND MOMENTS AT CHECK POINT <I> :
  Positive Bending Moment   P-Mu =      557.18 kN-m.,  LCB =   3
  Negative Bending Moment   N-Mu =        0.00 kN-m.,  LCB =   3
  Shear Force               Vu   =      366.03 kN.  ,  LCB =   3

*.REINFORCEMENT PATTERN :
  ------------------------------------------------------
     Location    i     di( m.)       Rebar    Asi( m^2.)
  ------------------------------------------------------
     Top         1      0.075    25- #7, 7      0.00968
     Bottom      1      0.075     8- #7, 7      0.00310
  ------------------------------------------------------
     Stirrups : 6.0-#3  @100

================================================================================
   [[[*]]]   ANALYZE NEGATIVE BENDING MOMENT CAPACITY.
================================================================================

     ( ). Compute parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. d     =     0.9250 m.
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Beam Checking   [ AASHTO-LRFD12 ]                              Civil 2022
============================================================================================

          -. Iyy     =       0.1250 m^4.
          -. zbar    =       0.5000 m.
          -. fr      = 0.24*SQRT[fc'] =     3309.48 KPa.
          -. Sc      = Iyy / zbar     =      0.2500 m^3.
          -. Mcr     = 1.2*Sc*fr      =      992.85 kN-m.
          -. Rhomin1 = Mcr/[ phi*fy*b*d*(d-a/2) ]     =   0.0021
          -. Rhomin2 = 1.33*Mu/[ phi*fy*b*d*(d-a/2) ] =   0.0000
          -. Rhomin  = MIN[ Rhomin1, Rhomin2 ]        =   0.0000
          -. As_min =  Rhomin * Ag  =     0.0000 m^2.

     ( ). Check tensile reinforcement.
          -. As     =     0.0097 m^2.
          -. As_min < As   --->  O.K !

     ( ). Check moment capacity.
          -. c          =     0.1328 m.
          -. Cc         =       3969.60 kN.
          -. Ts         =       4003.40 kN.
          -. Mr         =       3115.96 kN-m.
          -. Mu/Mr      =   0.000  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE POSITIVE BENDING MOMENT CAPACITY.
 ============================================================================

     ( ). Compute parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. d     =     0.9250 m.
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Iyy     =       0.1250 m^4.
          -. zbar    =       0.5000 m.
          -. fr      = 0.24*SQRT[fc'] =     3309.48 KPa.
          -. Sc      = Iyy / zbar     =      0.2500 m^3.
          -. Mcr     = 1.2*Sc*fr      =      992.85 kN-m.
          -. Rhomin1 = Mcr/[ phi*fy*b*d*(d-a/2) ]     =   0.0021
          -. Rhomin2 = 1.33*Mu/[ phi*fy*b*d*(d-a/2) ] =   0.0016
          -. Rhomin  = MIN[ Rhomin1, Rhomin2 ]        =   0.0016
          -. As_min =  Rhomin * Ag  =     0.0024 m^2.

     ( ). Check tensile reinforcement.
          -. As     =     0.0031 m^2.
          -. As_min < As   --->  O.K !
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Beam Checking    [ AASHTO-LRFD12 ]                              Civil 2022
============================================================================================


      ( ). Check moment capacity.
           -. c          =     0.0426 m.
           -. Cc         =       1274.55 kN.
           -. Ts         =       1281.09 kN.
           -. Mr         =       1042.78 kN-m.
           -. Mu/Mr      =   0.534  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY.
 ============================================================================

      ( ). Compute shear parameter.
           -. phi   =   0.90
           -. Av    =     0.0004 m^2.
           -. bv    =   1.50 m.
           -. dv    =  MAX[ dv, 0.9*d, 0.72*Hc ]  =   0.91 m.
           -. theta =  34.43 Deg.           [Clause 5.8.3.4.2]
           -. beta  =   2.22

      ( ). Compute shear strength of concrete.
           -. Vu     =      366.03 kN.
           -. Vc     = 0.0316*beta*SQRT[fc']*bv*dv =     1315.12 kN.
           -. phiVc  = phi * Vc =     1183.60 kN.
           -. Vn_lim = 0.25*fc'*bv*dv =     9377.61 kN.

      ( ). Compute stirrup spacing.
           -. Maximum spacing smax = MIN[ 0.8*dv, 24 in ] =    0.610 m.
           -. Vu < phiVc/2  --->  Not required shear reinforcement.
           -. Applied spacing s    =    0.100 m.

      ( ). Compute shear strength of reinforcement.
           -. Vs      = Av*fys*dv*cot(theta) / s =     2330.23 kN.
           -. Vs_lim  = 0.25*fc'*bv*dv - Vc =     8062.50 kN.
           -. Vs      = MIN[ Vs, Vs_lim ] =     2330.23 kN.
           -. phiVs   = phi*Vs =     2097.21 kN.

           -. phiVs > (Vu-phiVc)  --->  O.K !
           -. Using Av/s  =  Vs / (fys*dv*cot(theta)) =   0.0043 m^2/m.

      ( ). Check tension force in the longitudinal reinforcement caused by shear.
           -. phib    =   0.90
           -. phiv    =   0.90
           -. Vs1     =  MIN[ Vs, Vu/phiv ] =      406.70 kN.
           -. As_req  =  [ Mu/(phib*dv) + (Vu/phiv - 0.5*Vs1)*cot(theta) ] / fy =   0.0024 m^2.

 ============================================================================
    [[[*]]]   ANALYZE TORSION CAPACITY.
 ============================================================================
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Beam Checking   [ AASHTO-LRFD12 ]                              Civil 2022
============================================================================================


      ( ). Compute torsion parameter.
           -. phi   =   0.90
           -. Acp   =       1.50 m^2.
           -. Pc    =       5.00 m.
           -. Aoh   =       1.27 m^2.
           -. Ao    =  0.85*Aoh =      1.08 m^2.
           -. Ph    =       4.63 m.
           -. Tu    =         -0.57 kN-m.
           -. theta =  34.43 Deg.

           -. Tcr   =  0.125*SQRT(fc')*Acp^2/Pc =       775.66 kN-m.

           -. Tu < 0.25*phi*Tcr =       174.52 kN-m.
               ---> Torsion check is not required.

 ============================================================================
    [[[*]]]   ANALYZE CRACK.
 ============================================================================

      ( ). Check crack control of top reinforcement. ( LCB =    2 )
           -. Mu      =      0.0000 kN-m.
           -. h       =      1.0000 m.
           -. dc      =      0.0750 m.
           -. Beta_s  = 1+dc/(0.7*(h-dc)) = 1.12 m.
           -. Gamma_e = 1.00
           -. c_cr    =      0.2529 m.
           -. Icr     =      0.0436 m^4.
           -. fss     =         0.000 KPa.
           -. s       =       0.0000 m.
           -. sa      = 700*Gamma_e/(Beta_s*fss)-2*dc =      0.4572 m.
           -. fss = 0 --->  Crack check is not required.(Mu=0)

      ( ). Check crack control of bottom reinforcement. ( LCB =    2 )
           -. Mu      =    998.2322 kN-m.
           -. h       =      1.0000 m.
           -. dc      =      0.0750 m.
           -. Beta_s  = 1+dc/(0.7*(h-dc)) = 1.12 m.
           -. Gamma_e = 1.00
           -. c_cr    =      0.1410 m.
           -. Icr     =      0.0169 m^4.
           -. fss     =    369755.678 KPa.
           -. s       =       0.1870 m.
           -. sa      = 700*Gamma_e/(Beta_s*fss)-2*dc =      0.1471 m.
           -. s > sa --->  Not Acceptable !!!

--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Beam Checking   [ AASHTO-LRFD12 ]                              Civil 2022
============================================================================================

      *.MIDAS/Civil - RC-BEAM Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = BEAM,   MEMB =    17

      *.DESCRIPTION OF BEAM DATA (iSEC =     1) : VC
        Section Type : Rectangle (RECT)
        Beam Length (Span)             =         1.500 m.
```

```
  Section Depth (Hc)              =         1.000 m.
  Section Width (Bc)              =         1.500 m.
  Concrete Strength (fc')         =     27579.038 KPa.
  Main Rebar Strength (fy)        =    413685.566 KPa.
  Stirrups Strength (fys)         =    413685.566 KPa.
  Modulus of Elasticity (Es)      = 199948023.746 KPa.

*.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
  Special Provisions For Seismic Design : Seismic Zone3.

*.FORCES AND MOMENTS AT CHECK POINT <I> :
  Positive Bending Moment   P-Mu =        0.00 kN-m.,  LCB =   3
  Negative Bending Moment   N-Mu =      284.61 kN-m.,  LCB =   3
  Shear Force               Vu   =      734.28 kN.  ,  LCB =   3

*.REINFORCEMENT PATTERN :
  ---------------------------------------------------------
     Location    i     di( m.)       Rebar    Asi( m^2.)
  ---------------------------------------------------------
     Top         1      0.075    25- #7, 7      0.00968
     Bottom      1      0.075     8- #7, 7      0.00310
  ---------------------------------------------------------
     Stirrups : 6.0-#3  @100

================================================================================
   [[[*]]]   ANALYZE NEGATIVE BENDING MOMENT CAPACITY.
================================================================================

     ( ). Compute parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. d     =     0.9250 m.
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Beam Checking   [ AASHTO-LRFD12 ]                              Civil 2022
============================================================================================

          -. Iyy     =       0.1250 m^4.
          -. zbar    =       0.5000 m.
          -. fr      = 0.24*SQRT[fc'] =     3309.48 KPa.
          -. Sc      = Iyy / zbar     =      0.2500 m^3.
          -. Mcr     = 1.2*Sc*fr      =      992.85 kN-m.
          -. Rhomin1 = Mcr/[ phi*fy*b*d*(d-a/2) ]     =   0.0021
          -. Rhomin2 = 1.33*Mu/[ phi*fy*b*d*(d-a/2) ] =   0.0008
          -. Rhomin  = MIN[ Rhomin1, Rhomin2 ]        =   0.0008
          -. As_min =  Rhomin * Ag  =     0.0012 m^2.

     ( ). Check tensile reinforcement.
          -. As     =     0.0097 m^2.
          -. As_min < As   --->  O.K !

     ( ). Check moment capacity.
          -. c          =     0.1328 m.
          -. Cc         =       3969.60 kN.
          -. Ts         =       4003.40 kN.
          -. Mr         =       3115.96 kN-m.
          -. Mu/Mr      =   0.091  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE POSITIVE BENDING MOMENT CAPACITY.
 ============================================================================

     ( ). Compute parameter.
          -. phi   =   0.90
          -. Alpha =   0.85
          -. Beta  =   0.85
          -. d     =     0.9250 m.
          -. ecu   =  0.0030

     ( ). Compute maximum and minimum reinforcement.
          -. Iyy     =       0.1250 m^4.
          -. zbar    =       0.5000 m.
          -. fr      = 0.24*SQRT[fc'] =     3309.48 KPa.
          -. Sc      = Iyy / zbar     =      0.2500 m^3.
          -. Mcr     = 1.2*Sc*fr      =      992.85 kN-m.
          -. Rhomin1 = Mcr/[ phi*fy*b*d*(d-a/2) ]     =   0.0021
          -. Rhomin2 = 1.33*Mu/[ phi*fy*b*d*(d-a/2) ] =   0.0000
          -. Rhomin  = MIN[ Rhomin1, Rhomin2 ]        =   0.0000
          -. As_min =  Rhomin * Ag  =     0.0000 m^2.

     ( ). Check tensile reinforcement.
          -. As     =     0.0031 m^2.
          -. As_min < As   --->  O.K !
```

PROJECT TITLE :

MIDAS	Company		Client	
	Author		File Name	CABEZAL

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Beam Checking    [ AASHTO-LRFD12 ]                              Civil 2022
============================================================================================


      ( ). Check moment capacity.
           -. c          =     0.0426 m.
           -. Cc         =       1274.55 kN.
           -. Ts         =       1281.09 kN.
           -. Mr         =       1042.78 kN-m.
           -. Mu/Mr      =   0.000  --->  O.K !

 ============================================================================
    [[[*]]]   ANALYZE SHEAR CAPACITY.
 ============================================================================

      ( ). Compute shear parameter.
           -. phi   =   0.90
           -. Av    =     0.0004 m^2.
           -. bv    =   1.50 m.
           -. dv    =  MAX[ dv, 0.9*d, 0.72*Hc ]  =   0.87 m.
           -. theta =  31.58 Deg.           [Clause 5.8.3.4.2]
           -. beta  =   3.09

      ( ). Compute shear strength of concrete.
           -. Vu     =      734.28 kN.
           -. Vc     = 0.0316*beta*SQRT[fc']*bv*dv =     1754.07 kN.
           -. phiVc  = phi * Vc =     1578.66 kN.
           -. Vn_lim = 0.25*fc'*bv*dv =     8982.71 kN.

      ( ). Compute stirrup spacing.
           -. Maximum spacing smax = MIN[ 0.8*dv, 24 in ] =    0.610 m.
           -. Vu < phiVc/2  --->  Not required shear reinforcement.
           -. Applied spacing s    =    0.100 m.

      ( ). Compute shear strength of reinforcement.
           -. Vs      = Av*fys*dv*cot(theta) / s =     2488.55 kN.
           -. Vs_lim  = 0.25*fc'*bv*dv - Vc =     7228.65 kN.
           -. Vs      = MIN[ Vs, Vs_lim ] =     2488.55 kN.
           -. phiVs   = phi*Vs =     2239.69 kN.

           -. phiVs > (Vu-phiVc)  --->  O.K !
           -. Using Av/s  =  Vs / (fys*dv*cot(theta)) =   0.0043 m^2/m.

      ( ). Check tension force in the longitudinal reinforcement caused by shear.
           -. phib    =   0.90
           -. phiv    =   0.90
           -. Vs1     =  MIN[ Vs, Vu/phiv ] =      815.87 kN.
           -. As_req  =  [ Mu/(phib*dv) + (Vu/phiv - 0.5*Vs1)*cot(theta) ] / fy =   0.0025 m^2.

 ============================================================================
    [[[*]]]   ANALYZE TORSION CAPACITY.
 ============================================================================
```

PROJECT TITLE :

MIDAS	Company		Client	
	Author		File Name	CABEZAL

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Beam Checking   [ AASHTO-LRFD12 ]                              Civil 2022
==========================================================================================


      ( ). Compute torsion parameter.
           -. phi   =   0.90
           -. Acp   =       1.50 m^2.
           -. Pc    =       5.00 m.
           -. Aoh   =       1.27 m^2.
           -. Ao    =  0.85*Aoh =      1.08 m^2.
           -. Ph    =       4.63 m.
           -. Tu    =         -0.88 kN-m.
           -. theta =  31.58 Deg.

           -. Tcr   =  0.125*SQRT(fc')*Acp^2/Pc =       775.66 kN-m.

           -. Tu < 0.25*phi*Tcr =       174.52 kN-m.
               ---> Torsion check is not required.

 ==========================================================================
    [[[*]]]   ANALYZE CRACK.
 ==========================================================================

      ( ). Check crack control of top reinforcement. ( LCB =    2 )
           -. Mu      =    511.2768 kN-m.
           -. h       =      1.0000 m.
           -. dc      =      0.0750 m.
           -. Beta_s  = 1+dc/(0.7*(h-dc)) = 1.12 m.
           -. Gamma_e = 1.00
           -. c_cr    =      0.2529 m.
           -. Icr     =      0.0436 m^4.
           -. fss     =     62787.206 KPa.
           -. s       =       0.0545 m.
           -. sa      = 700*Gamma_e/(Beta_s*fss)-2*dc =      0.4572 m.
           -. s < sa --->  O.K !

      ( ). Check crack control of bottom reinforcement. ( LCB =    2 )
           -. Mu      =      0.0000 kN-m.
           -. h       =      1.0000 m.
           -. dc      =      0.0750 m.
           -. Beta_s  = 1+dc/(0.7*(h-dc)) = 1.12 m.
           -. Gamma_e = 1.00
           -. c_cr    =      0.1410 m.
           -. Icr     =      0.0169 m^4.
           -. fss     =         0.000 KPa.
           -. s       =       0.0000 m.
           -. sa      = 700*Gamma_e/(Beta_s*fss)-2*dc =      0.4572 m.
           -. fss = 0 --->  Crack check is not required.(Mu=0)
```

PROJECT TITLE :

MIDAS	Company		Client	
	Author		File Name	CABEZAL

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2022
============================================================================================


      +============================================================+
      |  MIDAS(Modeling, Integrated Design & Analysis Software)    |
      |  MIDAS/Civil - Design & checking system for windows        |
      +============================================================+
      |  RC-Member(Beam or Column) Analysis and Design             |
      |  Based On  AASHTO-LRFD17, AASHTO-LRFD16, AASHTO-LRFD12,    |
      |            AASHTO-LRFD07, AASHTO-LRFD02, AASHTO-LFD96,     |
      |            ACI318-02, CSA-S6-00, CSA-S6-14,                |
      |            Eurocode2-2:05, SNiP 2.05.03-84*,               |
      |            SP 35.13330.2011, SNiP 2.05.03-84*(MKS),        |
      |            SP 35.13330.2011(MKS), IRC:21-2000,             |
      |            IRC:112-2011, IS456:2000, IRS                   |
      |                                          (c)SINCE 1989     |
      +============================================================+
      |  MIDAS Information Technology Co.,Ltd.         (MIDAS IT)  |
      |  MIDAS IT Design Development Team                          |
      +============================================================+
      |            HomePage : www.MidasUser.com                    |
      +============================================================+
      |  MIDAS/Civil  Version 9.1.0                                |
      +============================================================+


    *.DEFINITION OF LOAD COMBINATIONS WITH SCALING UP FACTORS.
--------------------------------------------------------------------------------------------
     LCB  C    Loadcase Name(Factor) + Loadcase Name(Factor) + Loadcase Name(Factor)
--------------------------------------------------------------------------------------------
       3  1               D( 1.000) +            PP( 1.000)
--------------------------------------------------------------------------------------------
```

PROJECT TITLE :

MIDAS	Company		Client	
	Author		File Name	CABEZAL

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2022
============================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =     1,  LCB =    3,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =     2) : PILA
        Column Height (L)                =         2.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)             =         0.500 m.
        Concrete Strength (fc)            =     27579.038 KPa.
        Main Rebar Strength (fy)          =    413685.566 KPa.
        Ties/Spirals Strength (fys)       =    413685.566 KPa.
        Modulus of Elasticity (Es)        = 199948023.746 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Seismic Zone3.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer          Pos1    As( m^2.)          Pos2    As( m^2.)          Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
             1          8- #5 (    0.0016)            -                          -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#3  @0

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID =    3
           ------------------------------------------------------------------------------
            Load Case          Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                -11.57         0.00        -0.02         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL             -11.57         0.00        -0.02         0.00         0.00
            Others             -0.00         0.00         0.00         0.00         0.00
           ------------------------------------------------------------------------------
            DL+LL+Others      -11.57         0.00        -0.02         0.00         0.00
           ------------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

PROJECT TITLE :

MIDAS	Company		Client	
	Author		File Name	CABEZAL

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2022
==========================================================================================


      ( ). Compute design parameter.
           -. phi   =   0.90
           -. Alpha =   0.85
           -. Beta  =   0.85
           -. ecu   =  0.0030

      ( ). Compute maximum and minimum reinforcement.
           -. Rhomax1 =   0.0800 (User Input)
           -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0800
           -. Rhomin1 = 0.135*fc'/fy =   0.0090
           -. Rhomin2 =   0.0100
           -. Rhomin  = MAX[ Rhomin1, Rhomin2 ] =   0.0100

      ( ). Check tensile reinforcement.
           -. Rho     =     0.0081
           -. Rho < Rho_min  --->  Not Acceptable !!!

      ( ). Check moment capacity.
           -. Pr_max     =      3136.350 kN.
           -. Pr         =      -590.611 kN.
           -. Mry        =         1.173 kN-m.
           -. Mrz        =         0.000 kN-m.
           -. Mr         =         1.173 kN-m.
           -. Pu/Pr      =   0.020  --->  O.K !
           -. Muy/Mry    =   0.020  --->  O.K !
           -. Muz/Mrz    =   0.000  --->  O.K !
           -. Mu/Mr      =   0.020  --->  O.K !
           -. Ratio      =   0.020  --->  O.K !

==========================================================================================
   [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
==========================================================================================

      ( ). Compute shear parameter. ( LCB = 3, POS = J )
           -. phi    =   0.90
           -. Av     =     0.0001 m^2.
           -. Pu     =        -11.57 kN.
           -. Vuz    =      9.19e-03 kN.
           -. Muy    =         -0.02 kN-m.
           -. bvz    =   0.50 m.
           -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.50 m.
           -. thetaz =  29.17 Deg.          [Clause 5.8.3.4.2]
           -. betaz  =   4.63
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2022
============================================================================================


        -. Vuy    =          0.00 kN.
        -. Muz    =          0.00 kN-m.
        -. bvy    =   0.50 m.
        -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.36 m.
        -. thetay =  29.17 Deg.          [Clause 5.8.3.4.2]
        -. betay  =   4.63

     ( ). Compute shear strength of concrete.
        -. Vuz       =    9.19e-03 kN.
        -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      506.10 kN.
        -. phiVcz    = phi * Vcz =      455.49 kN.

        -. Vuy       =        0.00 kN.
        -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      363.19 kN.
        -. phiVcy    = phi * Vcy =      326.87 kN.

     ( ). Compute maximum spacing of ties.
        -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.401 m.
        -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
        -. Applied spacing s_z   =    0.100 m.

        -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.288 m.
        -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
        -. Applied spacing s_y   =    0.100 m.

        -. Applied spacing s     = MIN[ s_y, s_z ] =    0.100 m.

     ( ). Compute shear strength of reinforcement.
        -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      527.63 kN.
        -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     1223.12 kN.
        -. Vsz      = MIN[ Vsz, Vsz_lim ] =      527.63 kN.
        -. phiVsz   = phi*Vsz =      474.87 kN.
        -. phiVsz > (Vuz-phiVcz)  --->  O.K !
        -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0014 m^2/m.

        -. Vsy      = Av*fys*dvy*cot(thetay) / s =      378.67 kN.
        -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =      877.87 kN.
        -. Vsy      = MIN[ Vsy, Vsy_lim ] =      378.67 kN.
        -. phiVsy   = phi*Vsy =      340.80 kN.
        -. phiVsy > (Vuy-phiVcy)  --->  O.K !
        -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0014 m^2/m.
```

PROJECT TITLE :

MIDAS	Company		Client	
	Author		File Name	CABEZAL

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2022
============================================================================================


          -. Vu       =       0.009 kN.
          -. Vr       =     667.675 kN.
          -. Ratio    = Vu / Vr =1.376e-05  --->  O.K !

     ( ). Compute minimum longitudinal reinforcement by shear.
          -. phia     =   0.90
          -. phib     =   0.90
          -. phiv     =   0.90
          -. Vs1y     =  MIN[ Vsy, Vuy/phiv ] =        0.01 kN.
          -. Vs1z     =  MIN[ Vsz, Vuz/phiv ] =        0.01 kN.
          -. Asy_req =  [ Muz/(phib*dvy)  - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay) ] / fy
=1.5727e-05 m^2.
          -. Asz_req =  [ Muy/(phib*dvz)  - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz) ] / fy
=1.5678e-05 m^2.
          -. As_req  =  MAX[ Asy_req, Asz_req ] =1.5727e-05 m^2.
          -. As      =   0.0016 m^2.
          -. As_req < As  --->  O.K !
```

PROJECT TITLE :

MIDAS	Company		Client	
	Author		File Name	CABEZAL

```
--------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                    Civil 2022
================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =     2,  LCB =    3,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =     2) : PILA
        Column Height (L)               =         2.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         0.500 m.
        Concrete Strength (fc)           =     27579.038 KPa.
        Main Rebar Strength (fy)         =    413685.566 KPa.
        Ties/Spirals Strength (fys)      =    413685.566 KPa.
        Modulus of Elasticity (Es)       = 199948023.746 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Seismic Zone3.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------
          Layer          Pos1    As( m^2.)          Pos2    As( m^2.)          Pos3    As( m^2.)
        ------------------------------------------------------------------------------
             1          8- #5 (    0.0016)            -                          -
        ------------------------------------------------------------------------------

      *.Ties :  2.0-#3  @0

 ================================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ================================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID =    3
           ------------------------------------------------------------------------
           Load Case          Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------
           DL                -11.57         0.00        -0.05         0.00         0.00
           LL                 -0.00         0.00         0.00         0.00         0.00
           DL+LL             -11.57         0.00        -0.05         0.00         0.00
           Others             -0.00         0.00         0.00         0.00         0.00
           ------------------------------------------------------------------------
           DL+LL+Others      -11.57         0.00        -0.05         0.00         0.00
           ------------------------------------------------------------------------

 ================================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ================================================================================
```

PROJECT TITLE :

MIDAS	Company		Client	
	Author		File Name	CABEZAL

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2022
==========================================================================================


      ( ). Compute design parameter.
           -. phi   =   0.90
           -. Alpha =   0.85
           -. Beta  =   0.85
           -. ecu   =  0.0030

      ( ). Compute maximum and minimum reinforcement.
           -. Rhomax1 =   0.0800 (User Input)
           -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0800
           -. Rhomin1 = 0.135*fc'/fy =   0.0090
           -. Rhomin2 =   0.0100
           -. Rhomin  = MAX[ Rhomin1, Rhomin2 ] =   0.0100

      ( ). Check tensile reinforcement.
           -. Rho     =     0.0081
           -. Rho < Rho_min  --->  Not Acceptable !!!

      ( ). Check moment capacity.
           -. Pr_max     =      3136.350 kN.
           -. Pr         =      -585.299 kN.
           -. Mry        =         2.396 kN-m.
           -. Mrz        =         0.000 kN-m.
           -. Mr         =         2.396 kN-m.
           -. Pu/Pr      =   0.020  --->  O.K !
           -. Muy/Mry    =   0.020  --->  O.K !
           -. Muz/Mrz    =   0.000  --->  O.K !
           -. Mu/Mr      =   0.020  --->  O.K !
           -. Ratio      =   0.020  --->  O.K !

==========================================================================================
   [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
==========================================================================================

      ( ). Compute shear parameter. ( LCB = 3, POS = J )
           -. phi    =   0.90
           -. Av     =     0.0001 m^2.
           -. Pu     =        -11.57 kN.
           -. Vuz    =          0.02 kN.
           -. Muy    =         -0.05 kN-m.
           -. bvz    =   0.50 m.
           -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.50 m.
           -. thetaz =  29.17 Deg.          [Clause 5.8.3.4.2]
           -. betaz  =   4.63
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2022
============================================================================================


        -. Vuy    =          0.00 kN.
        -. Muz    =          0.00 kN-m.
        -. bvy    =   0.50 m.
        -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.36 m.
        -. thetay =  29.17 Deg.          [Clause 5.8.3.4.2]
        -. betay  =   4.63

     ( ). Compute shear strength of concrete.
        -. Vuz       =        0.02 kN.
        -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      505.93 kN.
        -. phiVcz    = phi * Vcz =      455.33 kN.

        -. Vuy       =        0.00 kN.
        -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      363.02 kN.
        -. phiVcy    = phi * Vcy =      326.72 kN.

     ( ). Compute maximum spacing of ties.
        -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.401 m.
        -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
        -. Applied spacing s_z   =    0.100 m.

        -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.288 m.
        -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
        -. Applied spacing s_y   =    0.100 m.

        -. Applied spacing s     = MIN[ s_y, s_z ] =    0.100 m.

     ( ). Compute shear strength of reinforcement.
        -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      527.60 kN.
        -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     1223.30 kN.
        -. Vsz      = MIN[ Vsz, Vsz_lim ] =      527.60 kN.
        -. phiVsz   = phi*Vsz =      474.84 kN.
        -. phiVsz > (Vuz-phiVcz)  --->  O.K !
        -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0014 m^2/m.

        -. Vsy      = Av*fys*dvy*cot(thetay) / s =      378.64 kN.
        -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =      878.04 kN.
        -. Vsy      = MIN[ Vsy, Vsy_lim ] =      378.64 kN.
        -. phiVsy   = phi*Vsy =      340.77 kN.
        -. phiVsy > (Vuy-phiVcy)  --->  O.K !
        -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0014 m^2/m.
```

PROJECT TITLE :

MIDAS	Company		Client	
	Author		File Name	CABEZAL

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2022
============================================================================================


          -. Vu       =       0.019 kN.
          -. Vr       =     667.491 kN.
          -. Ratio    = Vu / Vr =2.837e-05  --->  O.K !

     ( ). Compute minimum longitudinal reinforcement by shear.
          -. phia     =   0.90
          -. phib     =   0.90
          -. phiv     =   0.90
          -. Vs1y     =  MIN[ Vsy, Vuy/phiv ] =        0.02 kN.
          -. Vs1z     =  MIN[ Vsz, Vuz/phiv ] =        0.02 kN.
          -. Asy_req =  [ Muz/(phib*dvy)  - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay) ] / fy
=1.5932e-05 m^2.
          -. Asz_req =  [ Muy/(phib*dvz)  - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz) ] / fy
=1.5832e-05 m^2.
          -. As_req  =  MAX[ Asy_req, Asz_req ] =1.5932e-05 m^2.
          -. As      =   0.0016 m^2.
          -. As_req < As  --->  O.K !
```

PROJECT TITLE :

MIDAS	Company		Client	
	Author		File Name	CABEZAL

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2022
============================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =     3,  LCB =    3,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =     2) : PILA
        Column Height (L)                =         2.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)             =         0.500 m.
        Concrete Strength (fc)            =     27579.038 KPa.
        Main Rebar Strength (fy)          =    413685.566 KPa.
        Ties/Spirals Strength (fys)       =    413685.566 KPa.
        Modulus of Elasticity (Es)        = 199948023.746 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Seismic Zone3.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer          Pos1    As( m^2.)          Pos2    As( m^2.)          Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
             1          8- #5 (    0.0016)            -                                 -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#3  @0

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID =    3
           ------------------------------------------------------------------------------
            Load Case          Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                -11.57         0.00        -0.05         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL             -11.57         0.00        -0.05         0.00         0.00
            Others             -0.00         0.00         0.00         0.00         0.00
           ------------------------------------------------------------------------------
            DL+LL+Others      -11.57         0.00        -0.05         0.00         0.00
           ------------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

PROJECT TITLE :

MIDAS	Company		Client	
	Author		File Name	CABEZAL

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2022
==========================================================================================


      ( ). Compute design parameter.
           -. phi   =   0.90
           -. Alpha =   0.85
           -. Beta  =   0.85
           -. ecu   =  0.0030

      ( ). Compute maximum and minimum reinforcement.
           -. Rhomax1 =   0.0800 (User Input)
           -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0800
           -. Rhomin1 = 0.135*fc'/fy =   0.0090
           -. Rhomin2 =   0.0100
           -. Rhomin  = MAX[ Rhomin1, Rhomin2 ] =   0.0100

      ( ). Check tensile reinforcement.
           -. Rho     =     0.0081
           -. Rho < Rho_min  --->  Not Acceptable !!!

      ( ). Check moment capacity.
           -. Pr_max     =      3136.350 kN.
           -. Pr         =      -585.119 kN.
           -. Mry        =         2.437 kN-m.
           -. Mrz        =         0.000 kN-m.
           -. Mr         =         2.437 kN-m.
           -. Pu/Pr      =   0.020  --->  O.K !
           -. Muy/Mry    =   0.020  --->  O.K !
           -. Muz/Mrz    =   0.000  --->  O.K !
           -. Mu/Mr      =   0.020  --->  O.K !
           -. Ratio      =   0.020  --->  O.K !

==========================================================================================
   [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
==========================================================================================

      ( ). Compute shear parameter. ( LCB = 3, POS = J )
           -. phi    =   0.90
           -. Av     =     0.0001 m^2.
           -. Pu     =        -11.57 kN.
           -. Vuz    =          0.02 kN.
           -. Muy    =         -0.05 kN-m.
           -. bvz    =   0.50 m.
           -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.50 m.
           -. thetaz =  29.17 Deg.          [Clause 5.8.3.4.2]
           -. betaz  =   4.63
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2022
============================================================================================


        -. Vuy    =          0.00 kN.
        -. Muz    =          0.00 kN-m.
        -. bvy    =   0.50 m.
        -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.36 m.
        -. thetay =  29.17 Deg.          [Clause 5.8.3.4.2]
        -. betay  =   4.63

     ( ). Compute shear strength of concrete.
        -. Vuz       =        0.02 kN.
        -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      505.92 kN.
        -. phiVcz    = phi * Vcz =      455.33 kN.

        -. Vuy       =        0.00 kN.
        -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      363.01 kN.
        -. phiVcy    = phi * Vcy =      326.71 kN.

     ( ). Compute maximum spacing of ties.
        -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.401 m.
        -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
        -. Applied spacing s_z   =    0.100 m.

        -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.288 m.
        -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
        -. Applied spacing s_y   =    0.100 m.

        -. Applied spacing s     = MIN[ s_y, s_z ] =    0.100 m.

     ( ). Compute shear strength of reinforcement.
        -. Vsz       = Av*fys*dvz*cot(thetaz) / s =      527.59 kN.
        -. Vsz_lim   = 0.25*fc'*bvz*dvz - Vcz =     1223.30 kN.
        -. Vsz       = MIN[ Vsz, Vsz_lim ] =      527.59 kN.
        -. phiVsz    = phi*Vsz =      474.83 kN.
        -. phiVsz > (Vuz-phiVcz)  --->  O.K !
        -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0014 m^2/m.

        -. Vsy       = Av*fys*dvy*cot(thetay) / s =      378.64 kN.
        -. Vsy_lim   = 0.25*fc'*bvy*dvy - Vcy =      878.04 kN.
        -. Vsy       = MIN[ Vsy, Vsy_lim ] =      378.64 kN.
        -. phiVsy    = phi*Vsy =      340.77 kN.
        -. phiVsy > (Vuy-phiVcy)  --->  O.K !
        -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0014 m^2/m.
```

```
-------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2022
===========================================================================================


          -. Vu       =       0.019 kN.
          -. Vr       =     667.485 kN.
          -. Ratio    = Vu / Vr =2.887e-05  --->  O.K !

     ( ). Compute minimum longitudinal reinforcement by shear.
          -. phia     =   0.90
          -. phib     =   0.90
          -. phiv     =   0.90
          -. Vs1y     =  MIN[ Vsy, Vuy/phiv ] =        0.02 kN.
          -. Vs1z     =  MIN[ Vsz, Vuz/phiv ] =        0.02 kN.
          -. Asy_req =  [ Muz/(phib*dvy)  - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay) ] / fy
=1.5939e-05 m^2.
          -. Asz_req =  [ Muy/(phib*dvz)  - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz) ] / fy
=1.5838e-05 m^2.
          -. As_req  =  MAX[ Asy_req, Asz_req ] =1.5939e-05 m^2.
          -. As      =   0.0016 m^2.
          -. As_req < As  --->  O.K !
```

PROJECT TITLE :

MIDAS	Company		Client	
	Author		File Name	CABEZAL

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2022
============================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =     4,  LCB =    3,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =     2) : PILA
        Column Height (L)                =         2.500 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)             =         0.500 m.
        Concrete Strength (fc)            =     27579.038 KPa.
        Main Rebar Strength (fy)          =    413685.566 KPa.
        Ties/Spirals Strength (fys)       =    413685.566 KPa.
        Modulus of Elasticity (Es)        = 199948023.746 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Seismic Zone3.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer          Pos1    As( m^2.)          Pos2    As( m^2.)          Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
             1          8- #5 (    0.0016)            -                          -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#3  @0

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID =    3
           ------------------------------------------------------------------------------
            Load Case          Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                -11.57         0.00        -0.02         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL             -11.57         0.00        -0.02         0.00         0.00
            Others             -0.00         0.00         0.00         0.00         0.00
           ------------------------------------------------------------------------------
            DL+LL+Others      -11.57         0.00        -0.02         0.00         0.00
           ------------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

PROJECT TITLE :

MIDAS	Company		Client	
	Author		File Name	CABEZAL

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------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2022
==========================================================================================


      ( ). Compute design parameter.
           -. phi   =   0.90
           -. Alpha =   0.85
           -. Beta  =   0.85
           -. ecu   =  0.0030

      ( ). Compute maximum and minimum reinforcement.
           -. Rhomax1 =   0.0800 (User Input)
           -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0800
           -. Rhomin1 = 0.135*fc'/fy =   0.0090
           -. Rhomin2 =   0.0100
           -. Rhomin  = MAX[ Rhomin1, Rhomin2 ] =   0.0100

      ( ). Check tensile reinforcement.
           -. Rho     =     0.0081
           -. Rho < Rho_min  --->  Not Acceptable !!!

      ( ). Check moment capacity.
           -. Pr_max     =      3136.350 kN.
           -. Pr         =      -590.309 kN.
           -. Mry        =         1.243 kN-m.
           -. Mrz        =         0.000 kN-m.
           -. Mr         =         1.243 kN-m.
           -. Pu/Pr      =   0.020  --->  O.K !
           -. Muy/Mry    =   0.020  --->  O.K !
           -. Muz/Mrz    =   0.000  --->  O.K !
           -. Mu/Mr      =   0.020  --->  O.K !
           -. Ratio      =   0.020  --->  O.K !

==========================================================================================
   [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
==========================================================================================

      ( ). Compute shear parameter. ( LCB = 3, POS = J )
           -. phi    =   0.90
           -. Av     =     0.0001 m^2.
           -. Pu     =        -11.57 kN.
           -. Vuz    =      9.74e-03 kN.
           -. Muy    =         -0.02 kN-m.
           -. bvz    =   0.50 m.
           -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.50 m.
           -. thetaz =  29.17 Deg.          [Clause 5.8.3.4.2]
           -. betaz  =   4.63
```

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-------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2022
===========================================================================================


        -. Vuy    =          0.00 kN.
        -. Muz    =          0.00 kN-m.
        -. bvy    =   0.50 m.
        -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.36 m.
        -. thetay =  29.17 Deg.          [Clause 5.8.3.4.2]
        -. betay  =   4.63

     ( ). Compute shear strength of concrete.
        -. Vuz       =    9.74e-03 kN.
        -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      506.09 kN.
        -. phiVcz    = phi * Vcz =      455.49 kN.

        -. Vuy       =        0.00 kN.
        -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      363.18 kN.
        -. phiVcy    = phi * Vcy =      326.86 kN.

     ( ). Compute maximum spacing of ties.
        -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.401 m.
        -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
        -. Applied spacing s_z   =    0.100 m.

        -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.288 m.
        -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
        -. Applied spacing s_y   =    0.100 m.

        -. Applied spacing s     = MIN[ s_y, s_z ] =    0.100 m.

     ( ). Compute shear strength of reinforcement.
        -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      527.63 kN.
        -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     1223.13 kN.
        -. Vsz      = MIN[ Vsz, Vsz_lim ] =      527.63 kN.
        -. phiVsz   = phi*Vsz =      474.87 kN.
        -. phiVsz > (Vuz-phiVcz)  --->  O.K !
        -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0014 m^2/m.

        -. Vsy      = Av*fys*dvy*cot(thetay) / s =      378.67 kN.
        -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =      877.88 kN.
        -. Vsy      = MIN[ Vsy, Vsy_lim ] =      378.67 kN.
        -. phiVsy   = phi*Vsy =      340.80 kN.
        -. phiVsy > (Vuy-phiVcy)  --->  O.K !
        -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0014 m^2/m.
```

PROJECT TITLE :

MIDAS	Company		Client	
	Author		File Name	CABEZAL

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2022
============================================================================================


          -. Vu       =       0.010 kN.
          -. Vr       =     667.665 kN.
          -. Ratio    = Vu / Vr =1.459e-05  --->  O.K !

     ( ). Compute minimum longitudinal reinforcement by shear.
          -. phia     =   0.90
          -. phib     =   0.90
          -. phiv     =   0.90
          -. Vs1y     =  MIN[ Vsy, Vuy/phiv ] =        0.01 kN.
          -. Vs1z     =  MIN[ Vsz, Vuz/phiv ] =        0.01 kN.
          -. Asy_req =  [ Muz/(phib*dvy)  - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay) ] / fy
=1.5738e-05 m^2.
          -. Asz_req =  [ Muy/(phib*dvz)  - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz) ] / fy
=1.5687e-05 m^2.
          -. As_req  =  MAX[ Asy_req, Asz_req ] =1.5738e-05 m^2.
          -. As      =   0.0016 m^2.
          -. As_req < As  --->  O.K !
```

PROJECT TITLE :

MIDAS	Company		Client	
	Author		File Name	CABEZAL

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2022
============================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =     5,  LCB =    3,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =     2) : PILA
        Column Height (L)                =         0.840 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)             =         0.500 m.
        Concrete Strength (fc)            =     27579.038 KPa.
        Main Rebar Strength (fy)          =    413685.566 KPa.
        Ties/Spirals Strength (fys)       =    413685.566 KPa.
        Modulus of Elasticity (Es)        = 199948023.746 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Seismic Zone3.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer          Pos1    As( m^2.)          Pos2    As( m^2.)          Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
             1          8- #5 (    0.0016)            -                          -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#3  @0

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID =    3
           ------------------------------------------------------------------------------
            Load Case          Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                -15.45        -0.02        -0.08         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL             -15.45        -0.02        -0.08         0.00         0.00
            Others             -0.00         0.00         0.00         0.00         0.00
           ------------------------------------------------------------------------------
            DL+LL+Others      -15.45        -0.02        -0.08         0.00         0.00
           ------------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
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PROJECT TITLE :

MIDAS	Company		Client	
	Author		File Name	CABEZAL

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2022
============================================================================================


      ( ). Compute design parameter.
           -. phi   =   0.90
           -. Alpha =   0.85
           -. Beta  =   0.85
           -. ecu   =  0.0030

      ( ). Compute maximum and minimum reinforcement.
           -. Rhomax1 =   0.0800 (User Input)
           -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0800
           -. Rhomin1 = 0.135*fc'/fy =   0.0090
           -. Rhomin2 =   0.0100
           -. Rhomin  = MAX[ Rhomin1, Rhomin2 ] =   0.0100

      ( ). Check tensile reinforcement.
           -. Rho     =     0.0081
           -. Rho < Rho_min  --->  Not Acceptable !!!

      ( ). Check moment capacity.
           -. Pr_max     =      3136.350 kN.
           -. Pr         =      -582.071 kN.
           -. Mry        =         3.139 kN-m.
           -. Mrz        =         0.000 kN-m.
           -. Mr         =         3.139 kN-m.
           -. Pu/Pr      =   0.027  --->  O.K !
           -. Muy/Mry    =   0.027  --->  O.K !
           -. Muz/Mrz    =   0.000  --->  O.K !
           -. Mu/Mr      =   0.027  --->  O.K !
           -. Ratio      =   0.027  --->  O.K !

============================================================================================
   [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
============================================================================================

      ( ). Compute shear parameter. ( LCB = 3, POS = J )
           -. phi    =   0.90
           -. Av     =     0.0001 m^2.
           -. Pu     =        -15.45 kN.
           -. Vuz    =          0.07 kN.
           -. Muy    =         -0.08 kN-m.
           -. bvz    =   0.50 m.
           -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.50 m.
           -. thetaz =  29.23 Deg.          [Clause 5.8.3.4.2]
           -. betaz  =   4.57
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2022
============================================================================================


        -. Vuy    =          0.00 kN.
        -. Muz    =          0.00 kN-m.
        -. bvy    =   0.50 m.
        -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.36 m.
        -. thetay =  29.23 Deg.          [Clause 5.8.3.4.2]
        -. betay  =   4.57

     ( ). Compute shear strength of concrete.
        -. Vuz       =        0.07 kN.
        -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      499.70 kN.
        -. phiVcz    = phi * Vcz =      449.73 kN.

        -. Vuy       =        0.00 kN.
        -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      358.49 kN.
        -. phiVcy    = phi * Vcy =      322.64 kN.

     ( ). Compute maximum spacing of ties.
        -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.401 m.
        -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
        -. Applied spacing s_z   =    0.100 m.

        -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.288 m.
        -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
        -. Applied spacing s_y   =    0.100 m.

        -. Applied spacing s     = MIN[ s_y, s_z ] =    0.100 m.

     ( ). Compute shear strength of reinforcement.
        -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      526.29 kN.
        -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     1229.53 kN.
        -. Vsz      = MIN[ Vsz, Vsz_lim ] =      526.29 kN.
        -. phiVsz   = phi*Vsz =      473.66 kN.
        -. phiVsz > (Vuz-phiVcz)  --->  O.K !
        -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0014 m^2/m.

        -. Vsy      = Av*fys*dvy*cot(thetay) / s =      377.69 kN.
        -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =      882.57 kN.
        -. Vsy      = MIN[ Vsy, Vsy_lim ] =      377.69 kN.
        -. phiVsy   = phi*Vsy =      339.92 kN.
        -. phiVsy > (Vuy-phiVcy)  --->  O.K !
        -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0014 m^2/m.
```

PROJECT TITLE :

MIDAS	Company		Client	
	Author		File Name	CABEZAL

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2022
============================================================================================


          -. Vu       =       0.072 kN.
          -. Vr       =     662.562 kN.
          -. Ratio    = Vu / Vr =1.085e-04  --->  O.K !

     ( ). Compute minimum longitudinal reinforcement by shear.
          -. phia     =   0.90
          -. phib     =   0.90
          -. phiv     =   0.90
          -. Vs1y     =  MIN[ Vsy, Vuy/phiv ] =        0.08 kN.
          -. Vs1z     =  MIN[ Vsz, Vuz/phiv ] =        0.08 kN.
          -. Asy_req =  [ Muz/(phib*dvy)  - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay) ] / fy
=2.1546e-05 m^2.
          -. Asz_req =  [ Muy/(phib*dvz)  - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz) ] / fy
=2.1371e-05 m^2.
          -. As_req  =  MAX[ Asy_req, Asz_req ] =2.1546e-05 m^2.
          -. As      =   0.0016 m^2.
          -. As_req < As  --->  O.K !
```

PROJECT TITLE :

MIDAS	Company		Client	
	Author		File Name	CABEZAL

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2022
============================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =     6,  LCB =    3,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =     2) : PILA
        Column Height (L)               =         0.840 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         0.500 m.
        Concrete Strength (fc)           =     27579.038 KPa.
        Main Rebar Strength (fy)         =    413685.566 KPa.
        Ties/Spirals Strength (fys)      =    413685.566 KPa.
        Modulus of Elasticity (Es)       = 199948023.746 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Seismic Zone3.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer          Pos1    As( m^2.)          Pos2    As( m^2.)          Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
             1          8- #5 (    0.0016)            -                          -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#3  @0

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID =    3
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL               -15.45        -0.05        -0.17         0.00         0.00
            LL                -0.00         0.00         0.00         0.00         0.00
            DL+LL            -15.45        -0.05        -0.17         0.00         0.00
            Others            -0.00         0.00         0.00         0.00         0.00
           ------------------------------------------------------------------------------
            DL+LL+Others     -15.45        -0.05        -0.17         0.00         0.00
           ------------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

PROJECT TITLE :

MIDAS	Company		Client	
	Author		File Name	CABEZAL

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2022
==========================================================================================


      ( ). Compute design parameter.
           -. phi   =   0.90
           -. Alpha =   0.85
           -. Beta  =   0.85
           -. ecu   =  0.0030

      ( ). Compute maximum and minimum reinforcement.
           -. Rhomax1 =   0.0800 (User Input)
           -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0800
           -. Rhomin1 = 0.135*fc'/fy =   0.0090
           -. Rhomin2 =   0.0100
           -. Rhomin  = MAX[ Rhomin1, Rhomin2 ] =   0.0100

      ( ). Check tensile reinforcement.
           -. Rho     =     0.0081
           -. Rho < Rho_min  --->  Not Acceptable !!!

      ( ). Check moment capacity.
           -. Pr_max     =      3136.350 kN.
           -. Pr         =      -568.949 kN.
           -. Mry        =         6.160 kN-m.
           -. Mrz        =         0.000 kN-m.
           -. Mr         =         6.160 kN-m.
           -. Pu/Pr      =   0.027  --->  O.K !
           -. Muy/Mry    =   0.027  --->  O.K !
           -. Muz/Mrz    =   0.000  --->  O.K !
           -. Mu/Mr      =   0.027  --->  O.K !
           -. Ratio      =   0.027  --->  O.K !

==========================================================================================
   [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
==========================================================================================

      ( ). Compute shear parameter. ( LCB = 3, POS = J )
           -. phi    =   0.90
           -. Av     =     0.0001 m^2.
           -. Pu     =        -15.45 kN.
           -. Vuz    =          0.14 kN.
           -. Muy    =         -0.17 kN-m.
           -. bvz    =   0.50 m.
           -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.50 m.
           -. thetaz =  29.24 Deg.          [Clause 5.8.3.4.2]
           -. betaz  =   4.57
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2022
============================================================================================


        -. Vuy    =          0.00 kN.
        -. Muz    =          0.00 kN-m.
        -. bvy    =   0.50 m.
        -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.36 m.
        -. thetay =  29.24 Deg.          [Clause 5.8.3.4.2]
        -. betay  =   4.56

     ( ). Compute shear strength of concrete.
        -. Vuz       =        0.14 kN.
        -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      498.99 kN.
        -. phiVcz    = phi * Vcz =      449.09 kN.

        -. Vuy       =        0.00 kN.
        -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      357.84 kN.
        -. phiVcy    = phi * Vcy =      322.06 kN.

     ( ). Compute maximum spacing of ties.
        -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.401 m.
        -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
        -. Applied spacing s_z   =    0.100 m.

        -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.288 m.
        -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
        -. Applied spacing s_y   =    0.100 m.

        -. Applied spacing s     = MIN[ s_y, s_z ] =    0.100 m.

     ( ). Compute shear strength of reinforcement.
        -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      526.14 kN.
        -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     1230.23 kN.
        -. Vsz      = MIN[ Vsz, Vsz_lim ] =      526.14 kN.
        -. phiVsz   = phi*Vsz =      473.53 kN.
        -. phiVsz > (Vuz-phiVcz)  --->  O.K !
        -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0014 m^2/m.

        -. Vsy      = Av*fys*dvy*cot(thetay) / s =      377.55 kN.
        -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =      883.21 kN.
        -. Vsy      = MIN[ Vsy, Vsy_lim ] =      377.55 kN.
        -. phiVsy   = phi*Vsy =      339.80 kN.
        -. phiVsy > (Vuy-phiVcy)  --->  O.K !
        -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0014 m^2/m.
```

PROJECT TITLE :

MIDAS	Company		Client	
	Author		File Name	CABEZAL

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-------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2022
===========================================================================================


          -. Vu       =       0.143 kN.
          -. Vr       =     661.855 kN.
          -. Ratio    = Vu / Vr =2.158e-04  --->  O.K !

     ( ). Compute minimum longitudinal reinforcement by shear.
          -. phia     =   0.90
          -. phib     =   0.90
          -. phiv     =   0.90
          -. Vs1y     =  MIN[ Vsy, Vuy/phiv ] =        0.16 kN.
          -. Vs1z     =  MIN[ Vsz, Vuz/phiv ] =        0.16 kN.
          -. Asy_req =  [ Muz/(phib*dvy)  - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay) ] / fy
=2.2343e-05 m^2.
          -. Asz_req =  [ Muy/(phib*dvz)  - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz) ] / fy
=2.1991e-05 m^2.
          -. As_req  =  MAX[ Asy_req, Asz_req ] =2.2343e-05 m^2.
          -. As      =   0.0016 m^2.
          -. As_req < As  --->  O.K !
```

PROJECT TITLE :

MIDAS	Company		Client	
	Author		File Name	CABEZAL

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2022
============================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =     7,  LCB =    3,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =     2) : PILA
        Column Height (L)                =         0.840 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)             =         0.500 m.
        Concrete Strength (fc)            =     27579.038 KPa.
        Main Rebar Strength (fy)          =    413685.566 KPa.
        Ties/Spirals Strength (fys)       =    413685.566 KPa.
        Modulus of Elasticity (Es)        = 199948023.746 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Seismic Zone3.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer          Pos1    As( m^2.)          Pos2    As( m^2.)          Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
             1          8- #5 (    0.0016)            -                          -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#3  @0

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID =    3
           ------------------------------------------------------------------------------
            Load Case          Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                -15.45        -0.05        -0.17         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL             -15.45        -0.05        -0.17         0.00         0.00
            Others             -0.00         0.00         0.00         0.00         0.00
           ------------------------------------------------------------------------------
            DL+LL+Others      -15.45        -0.05        -0.17         0.00         0.00
           ------------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

PROJECT TITLE :

MIDAS	Company		Client	
	Author		File Name	CABEZAL

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2022
==========================================================================================


      ( ). Compute design parameter.
           -. phi   =   0.90
           -. Alpha =   0.85
           -. Beta  =   0.85
           -. ecu   =  0.0030

      ( ). Compute maximum and minimum reinforcement.
           -. Rhomax1 =   0.0800 (User Input)
           -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0800
           -. Rhomin1 = 0.135*fc'/fy =   0.0090
           -. Rhomin2 =   0.0100
           -. Rhomin  = MAX[ Rhomin1, Rhomin2 ] =   0.0100

      ( ). Check tensile reinforcement.
           -. Rho     =     0.0081
           -. Rho < Rho_min  --->  Not Acceptable !!!

      ( ). Check moment capacity.
           -. Pr_max     =      3136.350 kN.
           -. Pr         =      -568.539 kN.
           -. Mry        =         6.254 kN-m.
           -. Mrz        =         0.000 kN-m.
           -. Mr         =         6.254 kN-m.
           -. Pu/Pr      =   0.027  --->  O.K !
           -. Muy/Mry    =   0.027  --->  O.K !
           -. Muz/Mrz    =   0.000  --->  O.K !
           -. Mu/Mr      =   0.027  --->  O.K !
           -. Ratio      =   0.027  --->  O.K !

==========================================================================================
   [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
==========================================================================================

      ( ). Compute shear parameter. ( LCB = 3, POS = J )
           -. phi    =   0.90
           -. Av     =     0.0001 m^2.
           -. Pu     =        -15.45 kN.
           -. Vuz    =          0.15 kN.
           -. Muy    =         -0.17 kN-m.
           -. bvz    =   0.50 m.
           -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.50 m.
           -. thetaz =  29.24 Deg.          [Clause 5.8.3.4.2]
           -. betaz  =   4.57
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2022
============================================================================================


        -. Vuy    =          0.00 kN.
        -. Muz    =          0.00 kN-m.
        -. bvy    =   0.50 m.
        -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.36 m.
        -. thetay =  29.24 Deg.          [Clause 5.8.3.4.2]
        -. betay  =   4.56

     ( ). Compute shear strength of concrete.
        -. Vuz       =        0.15 kN.
        -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      498.97 kN.
        -. phiVcz    = phi * Vcz =      449.07 kN.

        -. Vuy       =        0.00 kN.
        -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      357.82 kN.
        -. phiVcy    = phi * Vcy =      322.04 kN.

     ( ). Compute maximum spacing of ties.
        -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.401 m.
        -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
        -. Applied spacing s_z   =    0.100 m.

        -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.288 m.
        -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
        -. Applied spacing s_y   =    0.100 m.

        -. Applied spacing s     = MIN[ s_y, s_z ] =    0.100 m.

     ( ). Compute shear strength of reinforcement.
        -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      526.14 kN.
        -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     1230.26 kN.
        -. Vsz      = MIN[ Vsz, Vsz_lim ] =      526.14 kN.
        -. phiVsz   = phi*Vsz =      473.52 kN.
        -. phiVsz > (Vuz-phiVcz)  --->  O.K !
        -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0014 m^2/m.

        -. Vsy      = Av*fys*dvy*cot(thetay) / s =      377.55 kN.
        -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =      883.23 kN.
        -. Vsy      = MIN[ Vsy, Vsy_lim ] =      377.55 kN.
        -. phiVsy   = phi*Vsy =      339.79 kN.
        -. phiVsy > (Vuy-phiVcy)  --->  O.K !
        -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0014 m^2/m.
```

PROJECT TITLE :

MIDAS	Company		Client	
	Author		File Name	CABEZAL

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-------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2022
===========================================================================================


          -. Vu       =       0.145 kN.
          -. Vr       =     661.832 kN.
          -. Ratio    = Vu / Vr =2.191e-04  --->  O.K !

     ( ). Compute minimum longitudinal reinforcement by shear.
          -. phia     =   0.90
          -. phib     =   0.90
          -. phiv     =   0.90
          -. Vs1y     =  MIN[ Vsy, Vuy/phiv ] =        0.16 kN.
          -. Vs1z     =  MIN[ Vsz, Vuz/phiv ] =        0.16 kN.
          -. Asy_req =  [ Muz/(phib*dvy)  - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay) ] / fy
=2.2368e-05 m^2.
          -. Asz_req =  [ Muy/(phib*dvz)  - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz) ] / fy
=2.2010e-05 m^2.
          -. As_req  =  MAX[ Asy_req, Asz_req ] =2.2368e-05 m^2.
          -. As      =   0.0016 m^2.
          -. As_req < As  --->  O.K !
```

PROJECT TITLE :

MIDAS	Company		Client	
	Author		File Name	CABEZAL

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2022
============================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =     8,  LCB =    3,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =     2) : PILA
        Column Height (L)                =         0.840 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)             =         0.500 m.
        Concrete Strength (fc)            =     27579.038 KPa.
        Main Rebar Strength (fy)          =    413685.566 KPa.
        Ties/Spirals Strength (fys)       =    413685.566 KPa.
        Modulus of Elasticity (Es)        = 199948023.746 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Seismic Zone3.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer          Pos1    As( m^2.)          Pos2    As( m^2.)          Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
             1          8- #5 (    0.0016)            -                          -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#3  @0

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID =    3
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL               -15.45        -0.02        -0.09         0.00         0.00
            LL                -0.00         0.00         0.00         0.00         0.00
            DL+LL            -15.45        -0.02        -0.09         0.00         0.00
            Others            -0.00         0.00         0.00         0.00         0.00
           ------------------------------------------------------------------------------
            DL+LL+Others     -15.45        -0.02        -0.09         0.00         0.00
           ------------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

PROJECT TITLE :

MIDAS	Company		Client	
	Author		File Name	CABEZAL

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2022
==========================================================================================


      ( ). Compute design parameter.
           -. phi   =   0.90
           -. Alpha =   0.85
           -. Beta  =   0.85
           -. ecu   =  0.0030

      ( ). Compute maximum and minimum reinforcement.
           -. Rhomax1 =   0.0800 (User Input)
           -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0800
           -. Rhomin1 = 0.135*fc'/fy =   0.0090
           -. Rhomin2 =   0.0100
           -. Rhomin  = MAX[ Rhomin1, Rhomin2 ] =   0.0100

      ( ). Check tensile reinforcement.
           -. Rho     =     0.0081
           -. Rho < Rho_min  --->  Not Acceptable !!!

      ( ). Check moment capacity.
           -. Pr_max     =      3136.350 kN.
           -. Pr         =      -581.362 kN.
           -. Mry        =         3.302 kN-m.
           -. Mrz        =         0.000 kN-m.
           -. Mr         =         3.302 kN-m.
           -. Pu/Pr      =   0.027  --->  O.K !
           -. Muy/Mry    =   0.027  --->  O.K !
           -. Muz/Mrz    =   0.000  --->  O.K !
           -. Mu/Mr      =   0.027  --->  O.K !
           -. Ratio      =   0.027  --->  O.K !

==========================================================================================
   [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
==========================================================================================

      ( ). Compute shear parameter. ( LCB = 3, POS = J )
           -. phi    =   0.90
           -. Av     =     0.0001 m^2.
           -. Pu     =        -15.45 kN.
           -. Vuz    =          0.08 kN.
           -. Muy    =         -0.09 kN-m.
           -. bvz    =   0.50 m.
           -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.50 m.
           -. thetaz =  29.23 Deg.          [Clause 5.8.3.4.2]
           -. betaz  =   4.57
```

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2022
============================================================================================


        -. Vuy    =          0.00 kN.
        -. Muz    =          0.00 kN-m.
        -. bvy    =   0.50 m.
        -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.36 m.
        -. thetay =  29.23 Deg.          [Clause 5.8.3.4.2]
        -. betay  =   4.57

     ( ). Compute shear strength of concrete.
        -. Vuz       =         0.08 kN.
        -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      499.66 kN.
        -. phiVcz    = phi * Vcz =      449.69 kN.

        -. Vuy       =         0.00 kN.
        -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      358.46 kN.
        -. phiVcy    = phi * Vcy =      322.61 kN.

     ( ). Compute maximum spacing of ties.
        -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.401 m.
        -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
        -. Applied spacing s_z   =    0.100 m.

        -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.288 m.
        -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
        -. Applied spacing s_y   =    0.100 m.

        -. Applied spacing s     = MIN[ s_y, s_z ] =    0.100 m.

     ( ). Compute shear strength of reinforcement.
        -. Vsz       = Av*fys*dvz*cot(thetaz) / s =      526.28 kN.
        -. Vsz_lim   = 0.25*fc'*bvz*dvz - Vcz =     1229.56 kN.
        -. Vsz       = MIN[ Vsz, Vsz_lim ] =      526.28 kN.
        -. phiVsz    = phi*Vsz =      473.66 kN.
        -. phiVsz > (Vuz-phiVcz)  --->  O.K !
        -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0014 m^2/m.

        -. Vsy       = Av*fys*dvy*cot(thetay) / s =      377.68 kN.
        -. Vsy_lim   = 0.25*fc'*bvy*dvy - Vcy =      882.60 kN.
        -. Vsy       = MIN[ Vsy, Vsy_lim ] =      377.68 kN.
        -. phiVsy    = phi*Vsy =      339.91 kN.
        -. phiVsy > (Vuy-phiVcy)  --->  O.K !
        -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0014 m^2/m.
```

PROJECT TITLE :

MIDAS	Company		Client	
	Author		File Name	CABEZAL

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2022
============================================================================================


          -. Vu       =       0.076 kN.
          -. Vr       =     662.524 kN.
          -. Ratio    = Vu / Vr =1.140e-04  --->  O.K !

     ( ). Compute minimum longitudinal reinforcement by shear.
          -. phia     =   0.90
          -. phib     =   0.90
          -. phiv     =   0.90
          -. Vs1y     =  MIN[ Vsy, Vuy/phiv ] =        0.08 kN.
          -. Vs1z     =  MIN[ Vsz, Vuz/phiv ] =        0.08 kN.
          -. Asy_req =  [ Muz/(phib*dvy)  - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay) ] / fy
=2.1588e-05 m^2.
          -. Asz_req =  [ Muy/(phib*dvz)  - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz) ] / fy
=2.1404e-05 m^2.
          -. As_req  =  MAX[ Asy_req, Asz_req ] =2.1588e-05 m^2.
          -. As      =   0.0016 m^2.
          -. As_req < As  --->  O.K !
```

PROJECT TITLE :

MIDAS	Company		Client	
	Author		File Name	CABEZAL

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2022
============================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =     9,  LCB =    3,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =     2) : PILA
        Column Height (L)                =         1.660 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)             =         0.500 m.
        Concrete Strength (fc)            =     27579.038 KPa.
        Main Rebar Strength (fy)          =    413685.566 KPa.
        Ties/Spirals Strength (fys)       =    413685.566 KPa.
        Modulus of Elasticity (Es)        = 199948023.746 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Seismic Zone3.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer          Pos1    As( m^2.)          Pos2    As( m^2.)          Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
             1          8- #5 (    0.0016)            -                          -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#3  @0

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID =    3
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL               -23.13        -0.08        -0.29         0.00         0.00
            LL                -0.00         0.00         0.00         0.00         0.00
            DL+LL            -23.13        -0.08        -0.29         0.00         0.00
            Others            -0.00         0.00         0.00         0.00         0.00
           ------------------------------------------------------------------------------
            DL+LL+Others     -23.13        -0.08        -0.29         0.00         0.00
           ------------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

PROJECT TITLE :

MIDAS	Company		Client	
	Author		File Name	CABEZAL

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2022
==========================================================================================


      ( ). Compute design parameter.
           -. phi   =   0.90
           -. Alpha =   0.85
           -. Beta  =   0.85
           -. ecu   =  0.0030

      ( ). Compute maximum and minimum reinforcement.
           -. Rhomax1 =   0.0800 (User Input)
           -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0800
           -. Rhomin1 = 0.135*fc'/fy =   0.0090
           -. Rhomin2 =   0.0100
           -. Rhomin  = MAX[ Rhomin1, Rhomin2 ] =   0.0100

      ( ). Check tensile reinforcement.
           -. Rho     =     0.0081
           -. Rho < Rho_min  --->  Not Acceptable !!!

      ( ). Check moment capacity.
           -. Pr_max     =      3136.350 kN.
           -. Pr         =      -565.183 kN.
           -. Mry        =         7.027 kN-m.
           -. Mrz        =         0.000 kN-m.
           -. Mr         =         7.027 kN-m.
           -. Pu/Pr      =   0.041  --->  O.K !
           -. Muy/Mry    =   0.041  --->  O.K !
           -. Muz/Mrz    =   0.000  --->  O.K !
           -. Mu/Mr      =   0.041  --->  O.K !
           -. Ratio      =   0.041  --->  O.K !

==========================================================================================
   [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
==========================================================================================

      ( ). Compute shear parameter. ( LCB = 3, POS = J )
           -. phi    =   0.90
           -. Av     =     0.0001 m^2.
           -. Pu     =        -23.13 kN.
           -. Vuz    =          0.12 kN.
           -. Muy    =         -0.29 kN-m.
           -. bvz    =   0.50 m.
           -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.50 m.
           -. thetaz =  29.36 Deg.          [Clause 5.8.3.4.2]
           -. betaz  =   4.46
```

```
-------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2022
===========================================================================================


        -. Vuy    =          0.00 kN.
        -. Muz    =          0.00 kN-m.
        -. bvy    =   0.50 m.
        -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.36 m.
        -. thetay =  29.36 Deg.          [Clause 5.8.3.4.2]
        -. betay  =   4.45

     ( ). Compute shear strength of concrete.
        -. Vuz       =         0.12 kN.
        -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      487.22 kN.
        -. phiVcz    = phi * Vcz =      438.50 kN.

        -. Vuy       =         0.00 kN.
        -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      349.22 kN.
        -. phiVcy    = phi * Vcy =      314.30 kN.

     ( ). Compute maximum spacing of ties.
        -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.401 m.
        -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
        -. Applied spacing s_z   =    0.100 m.

        -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.288 m.
        -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
        -. Applied spacing s_y   =    0.100 m.

        -. Applied spacing s     = MIN[ s_y, s_z ] =    0.100 m.

     ( ). Compute shear strength of reinforcement.
        -. Vsz       = Av*fys*dvz*cot(thetaz) / s =      523.60 kN.
        -. Vsz_lim   = 0.25*fc'*bvz*dvz - Vcz =     1242.00 kN.
        -. Vsz       = MIN[ Vsz, Vsz_lim ] =      523.60 kN.
        -. phiVsz    = phi*Vsz =      471.24 kN.
        -. phiVsz > (Vuz-phiVcz)  --->  O.K !
        -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0014 m^2/m.

        -. Vsy       = Av*fys*dvy*cot(thetay) / s =      375.68 kN.
        -. Vsy_lim   = 0.25*fc'*bvy*dvy - Vcy =      891.83 kN.
        -. Vsy       = MIN[ Vsy, Vsy_lim ] =      375.68 kN.
        -. phiVsy    = phi*Vsy =      338.12 kN.
        -. phiVsy > (Vuy-phiVcy)  --->  O.K !
        -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0014 m^2/m.
```

PROJECT TITLE :

MIDAS	Company		Client	
	Author		File Name	CABEZAL

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2022
============================================================================================


          -. Vu       =       0.123 kN.
          -. Vr       =     652.416 kN.
          -. Ratio    = Vu / Vr =1.886e-04  --->  O.K !

     ( ). Compute minimum longitudinal reinforcement by shear.
          -. phia     =   0.90
          -. phib     =   0.90
          -. phiv     =   0.90
          -. Vs1y     =  MIN[ Vsy, Vuy/phiv ] =        0.14 kN.
          -. Vs1z     =  MIN[ Vsz, Vuz/phiv ] =        0.14 kN.
          -. Asy_req =  [ Muz/(phib*dvy)  - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay) ] / fy
=3.3506e-05 m^2.
          -. Asz_req =  [ Muy/(phib*dvz)  - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz) ] / fy
=3.2900e-05 m^2.
          -. As_req  =  MAX[ Asy_req, Asz_req ] =3.3506e-05 m^2.
          -. As      =   0.0016 m^2.
          -. As_req < As  --->  O.K !
```

PROJECT TITLE :

MIDAS	Company		Client	
	Author		File Name	CABEZAL

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2022
============================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =    10,  LCB =    3,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =     2) : PILA
        Column Height (L)               =         1.660 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)            =         0.500 m.
        Concrete Strength (fc)           =     27579.038 KPa.
        Main Rebar Strength (fy)         =    413685.566 KPa.
        Ties/Spirals Strength (fys)      =    413685.566 KPa.
        Modulus of Elasticity (Es)       = 199948023.746 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Seismic Zone3.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer          Pos1    As( m^2.)          Pos2    As( m^2.)          Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
             1          8- #5 (    0.0016)            -                          -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#3  @0

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID =    3
           ---------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ---------------------------------------------------------------------------
            DL               -23.13        -0.17        -0.57         0.00         0.00
            LL                -0.00         0.00         0.00         0.00         0.00
            DL+LL            -23.13        -0.17        -0.57         0.00         0.00
            Others            -0.00         0.00         0.00         0.00         0.00
           ---------------------------------------------------------------------------
            DL+LL+Others     -23.13        -0.17        -0.57         0.00         0.00
           ---------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

PROJECT TITLE :

MIDAS	Company		Client	
	Author		File Name	CABEZAL

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2022
==========================================================================================


      ( ). Compute design parameter.
           -. phi   =   0.90
           -. Alpha =   0.85
           -. Beta  =   0.85
           -. ecu   =  0.0030

      ( ). Compute maximum and minimum reinforcement.
           -. Rhomax1 =   0.0800 (User Input)
           -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0800
           -. Rhomin1 = 0.135*fc'/fy =   0.0090
           -. Rhomin2 =   0.0100
           -. Rhomin  = MAX[ Rhomin1, Rhomin2 ] =   0.0100

      ( ). Check tensile reinforcement.
           -. Rho     =     0.0081
           -. Rho < Rho_min  --->  Not Acceptable !!!

      ( ). Check moment capacity.
           -. Pr_max     =      3136.350 kN.
           -. Pr         =      -537.916 kN.
           -. Mry        =        13.304 kN-m.
           -. Mrz        =         0.000 kN-m.
           -. Mr         =        13.304 kN-m.
           -. Pu/Pr      =   0.043  --->  O.K !
           -. Muy/Mry    =   0.043  --->  O.K !
           -. Muz/Mrz    =   0.000  --->  O.K !
           -. Mu/Mr      =   0.043  --->  O.K !
           -. Ratio      =   0.043  --->  O.K !

==========================================================================================
   [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
==========================================================================================

      ( ). Compute shear parameter. ( LCB = 3, POS = J )
           -. phi    =   0.90
           -. Av     =     0.0001 m^2.
           -. Pu     =        -23.13 kN.
           -. Vuz    =          0.24 kN.
           -. Muy    =         -0.57 kN-m.
           -. bvz    =   0.50 m.
           -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.50 m.
           -. thetaz =  29.38 Deg.          [Clause 5.8.3.4.2]
           -. betaz  =   4.44
```

```
-------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2022
===========================================================================================


        -. Vuy    =          0.00 kN.
        -. Muz    =          0.00 kN-m.
        -. bvy    =   0.50 m.
        -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.36 m.
        -. thetay =  29.39 Deg.          [Clause 5.8.3.4.2]
        -. betay  =   4.43

     ( ). Compute shear strength of concrete.
        -. Vuz       =        0.24 kN.
        -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      485.29 kN.
        -. phiVcz    = phi * Vcz =      436.76 kN.

        -. Vuy       =        0.00 kN.
        -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      347.39 kN.
        -. phiVcy    = phi * Vcy =      312.65 kN.

     ( ). Compute maximum spacing of ties.
        -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.401 m.
        -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
        -. Applied spacing s_z   =    0.100 m.

        -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.288 m.
        -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
        -. Applied spacing s_y   =    0.100 m.

        -. Applied spacing s     = MIN[ s_y, s_z ] =    0.100 m.

     ( ). Compute shear strength of reinforcement.
        -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      523.17 kN.
        -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     1243.94 kN.
        -. Vsz      = MIN[ Vsz, Vsz_lim ] =      523.17 kN.
        -. phiVsz   = phi*Vsz =      470.85 kN.
        -. phiVsz > (Vuz-phiVcz)  --->  O.K !
        -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0014 m^2/m.

        -. Vsy      = Av*fys*dvy*cot(thetay) / s =      375.28 kN.
        -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =      893.67 kN.
        -. Vsy      = MIN[ Vsy, Vsy_lim ] =      375.28 kN.
        -. phiVsy   = phi*Vsy =      337.75 kN.
        -. phiVsy > (Vuy-phiVcy)  --->  O.K !
        -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0014 m^2/m.
```

PROJECT TITLE :

MIDAS	Company		Client	
	Author		File Name	CABEZAL

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2022
============================================================================================


          -. Vu       =       0.244 kN.
          -. Vr       =     650.397 kN.
          -. Ratio    = Vu / Vr =3.750e-04  --->  O.K !

     ( ). Compute minimum longitudinal reinforcement by shear.
          -. phia     =   0.90
          -. phib     =   0.90
          -. phiv     =   0.90
          -. Vs1y     =  MIN[ Vsy, Vuy/phiv ] =        0.27 kN.
          -. Vs1z     =  MIN[ Vsz, Vuz/phiv ] =        0.27 kN.
          -. Asy_req =  [ Muz/(phib*dvy)  - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay) ] / fy
=3.5917e-05 m^2.
          -. Asz_req =  [ Muy/(phib*dvz)  - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz) ] / fy
=3.4712e-05 m^2.
          -. As_req  =  MAX[ Asy_req, Asz_req ] =3.5917e-05 m^2.
          -. As      =   0.0016 m^2.
          -. As_req < As  --->  O.K !
```

PROJECT TITLE :

MIDAS	Company		Client	
	Author		File Name	CABEZAL

```
--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2022
============================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =    11,  LCB =    3,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =     2) : PILA
        Column Height (L)                =         1.660 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)             =         0.500 m.
        Concrete Strength (fc)            =     27579.038 KPa.
        Main Rebar Strength (fy)          =    413685.566 KPa.
        Ties/Spirals Strength (fys)       =    413685.566 KPa.
        Modulus of Elasticity (Es)        = 199948023.746 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Seismic Zone3.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer          Pos1    As( m^2.)          Pos2    As( m^2.)          Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
             1          8- #5 (    0.0016)            -                          -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#3  @0

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID =    3
           ------------------------------------------------------------------------------
            Load Case         Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL               -23.13        -0.17        -0.58         0.00         0.00
            LL                -0.00         0.00         0.00         0.00         0.00
            DL+LL            -23.13        -0.17        -0.58         0.00         0.00
            Others            -0.00         0.00         0.00         0.00         0.00
           ------------------------------------------------------------------------------
            DL+LL+Others     -23.13        -0.17        -0.58         0.00         0.00
           ------------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

PROJECT TITLE :

MIDAS	Company		Client	
	Author		File Name	CABEZAL

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2022
==========================================================================================


      ( ). Compute design parameter.
           -. phi   =   0.90
           -. Alpha =   0.85
           -. Beta  =   0.85
           -. ecu   =  0.0030

      ( ). Compute maximum and minimum reinforcement.
           -. Rhomax1 =   0.0800 (User Input)
           -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0800
           -. Rhomin1 = 0.135*fc'/fy =   0.0090
           -. Rhomin2 =   0.0100
           -. Rhomin  = MAX[ Rhomin1, Rhomin2 ] =   0.0100

      ( ). Check tensile reinforcement.
           -. Rho     =     0.0081
           -. Rho < Rho_min  --->  Not Acceptable !!!

      ( ). Check moment capacity.
           -. Pr_max     =      3136.350 kN.
           -. Pr         =      -537.105 kN.
           -. Mry        =        13.491 kN-m.
           -. Mrz        =         0.000 kN-m.
           -. Mr         =        13.491 kN-m.
           -. Pu/Pr      =   0.043  --->  O.K !
           -. Muy/Mry    =   0.043  --->  O.K !
           -. Muz/Mrz    =   0.000  --->  O.K !
           -. Mu/Mr      =   0.043  --->  O.K !
           -. Ratio      =   0.043  --->  O.K !

==========================================================================================
   [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
==========================================================================================

      ( ). Compute shear parameter. ( LCB = 3, POS = J )
           -. phi    =   0.90
           -. Av     =     0.0001 m^2.
           -. Pu     =        -23.13 kN.
           -. Vuz    =          0.25 kN.
           -. Muy    =         -0.58 kN-m.
           -. bvz    =   0.50 m.
           -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.50 m.
           -. thetaz =  29.38 Deg.          [Clause 5.8.3.4.2]
           -. betaz  =   4.44
```

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2022
============================================================================================


        -. Vuy    =          0.00 kN.
        -. Muz    =          0.00 kN-m.
        -. bvy    =   0.50 m.
        -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.36 m.
        -. thetay =  29.39 Deg.          [Clause 5.8.3.4.2]
        -. betay  =   4.43

     ( ). Compute shear strength of concrete.
        -. Vuz       =        0.25 kN.
        -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      485.23 kN.
        -. phiVcz    = phi * Vcz =      436.70 kN.

        -. Vuy       =        0.00 kN.
        -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      347.33 kN.
        -. phiVcy    = phi * Vcy =      312.60 kN.

     ( ). Compute maximum spacing of ties.
        -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.401 m.
        -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
        -. Applied spacing s_z   =    0.100 m.

        -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.288 m.
        -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
        -. Applied spacing s_y   =    0.100 m.

        -. Applied spacing s     = MIN[ s_y, s_z ] =    0.100 m.

     ( ). Compute shear strength of reinforcement.
        -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      523.16 kN.
        -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     1244.00 kN.
        -. Vsz      = MIN[ Vsz, Vsz_lim ] =      523.16 kN.
        -. phiVsz   = phi*Vsz =      470.84 kN.
        -. phiVsz > (Vuz-phiVcz)  --->  O.K !
        -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0014 m^2/m.

        -. Vsy      = Av*fys*dvy*cot(thetay) / s =      375.26 kN.
        -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =      893.73 kN.
        -. Vsy      = MIN[ Vsy, Vsy_lim ] =      375.26 kN.
        -. phiVsy   = phi*Vsy =      337.74 kN.
        -. phiVsy > (Vuy-phiVcy)  --->  O.K !
        -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0014 m^2/m.
```

PROJECT TITLE :

MIDAS	Company		Client	
	Author		File Name	CABEZAL

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-----------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2022
=========================================================================================


          -. Vu       =       0.248 kN.
          -. Vr       =     650.334 kN.
          -. Ratio    = Vu / Vr =3.808e-04  --->  O.K !

     ( ). Compute minimum longitudinal reinforcement by shear.
          -. phia     =   0.90
          -. phib     =   0.90
          -. phiv     =   0.90
          -. Vs1y     =  MIN[ Vsy, Vuy/phiv ] =        0.28 kN.
          -. Vs1z     =  MIN[ Vsz, Vuz/phiv ] =        0.28 kN.
          -. Asy_req =  [ Muz/(phib*dvy)  - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay) ] / fy
=3.5992e-05 m^2.
          -. Asz_req =  [ Muy/(phib*dvz)  - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz) ] / fy
=3.4768e-05 m^2.
          -. As_req  =  MAX[ Asy_req, Asz_req ] =3.5992e-05 m^2.
          -. As      =   0.0016 m^2.
          -. As_req < As  --->  O.K !
```

PROJECT TITLE :

MIDAS	Company		Client	
	Author		File Name	CABEZAL

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--------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2022
============================================================================================

      *.MIDAS/Civil - RC-COLUMN  Analysis/Design Program.

      *.PROJECT       :
      *.DESIGN CODE   : AASHTO-LRFD12,    *.UNIT SYSTEM : kN, m
      *.MEMBER        : Member Type = COLUMN ,  MEMB =    12,  LCB =    3,  POS =    J

      *.DESCRIPTION OF COLUMN  DATA (iSEC =     2) : PILA
        Column Height (L)                =         1.660 m.

        Section Type : SOLID ROUND (SR)
        Section Diameter  (D)             =         0.500 m.
        Concrete Strength (fc)            =     27579.038 KPa.
        Main Rebar Strength (fy)          =    413685.566 KPa.
        Ties/Spirals Strength (fys)       =    413685.566 KPa.
        Modulus of Elasticity (Es)        = 199948023.746 KPa.

      *.DESCRIPTION OF APPLIED FACTORS FOR DESIGN/CHECKING.
        Special Provisions For Seismic Design : Seismic Zone3.

      *.REINFORCEMENT PATTERN :
        ------------------------------------------------------------------------------------
          Layer          Pos1    As( m^2.)          Pos2    As( m^2.)          Pos3    As( m^2.)
        ------------------------------------------------------------------------------------
             1          8- #5 (    0.0016)            -                                 -
        ------------------------------------------------------------------------------------

      *.Ties :  2.0-#3  @0

 ============================================================================
    [[[*]]]   CALCULATE SLENDERNESS RATIOS, MAGNIFIED FORCES/MOMENTS.
 ============================================================================

      ( ). Factored forces/moments caused by unit load case.  Unit : kN., m.
           *.Load combination ID =    3
           ------------------------------------------------------------------------------
            Load Case          Pu_max          Myi          Myj          Mzi          Mzj
           ------------------------------------------------------------------------------
            DL                -23.13        -0.09        -0.30         0.00         0.00
            LL                 -0.00         0.00         0.00         0.00         0.00
            DL+LL             -23.13        -0.09        -0.30         0.00         0.00
            Others             -0.00         0.00         0.00         0.00         0.00
           ------------------------------------------------------------------------------
            DL+LL+Others      -23.13        -0.09        -0.30         0.00         0.00
           ------------------------------------------------------------------------------

 ============================================================================
    [[[*]]]   ANALYZE CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
 ============================================================================
```

PROJECT TITLE :

MIDAS	Company		Client	
	Author		File Name	CABEZAL

```
------------------------------------------------------------------------------------------
 MIDAS/Civil - RC-Column Checking [ AASHTO-LRFD12 ]                              Civil 2022
==========================================================================================


      ( ). Compute design parameter.
           -. phi   =   0.90
           -. Alpha =   0.85
           -. Beta  =   0.85
           -. ecu   =  0.0030

      ( ). Compute maximum and minimum reinforcement.
           -. Rhomax1 =   0.0800 (User Input)
           -. Rhomax  = MIN[ Rhomax1, 0.08 ] =   0.0800
           -. Rhomin1 = 0.135*fc'/fy =   0.0090
           -. Rhomin2 =   0.0100
           -. Rhomin  = MAX[ Rhomin1, Rhomin2 ] =   0.0100

      ( ). Check tensile reinforcement.
           -. Rho     =     0.0081
           -. Rho < Rho_min  --->  Not Acceptable !!!

      ( ). Check moment capacity.
           -. Pr_max     =      3136.350 kN.
           -. Pr         =      -563.707 kN.
           -. Mry        =         7.367 kN-m.
           -. Mrz        =         0.000 kN-m.
           -. Mr         =         7.367 kN-m.
           -. Pu/Pr      =   0.041  --->  O.K !
           -. Muy/Mry    =   0.041  --->  O.K !
           -. Muz/Mrz    =   0.000  --->  O.K !
           -. Mu/Mr      =   0.041  --->  O.K !
           -. Ratio      =   0.041  --->  O.K !

==========================================================================================
   [[[*]]]   ANALYZE SHEAR CAPACITY OF BIAXIALLY LOADED RC-COLUMN.
==========================================================================================

      ( ). Compute shear parameter. ( LCB = 3, POS = J )
           -. phi    =   0.90
           -. Av     =     0.0001 m^2.
           -. Pu     =        -23.13 kN.
           -. Vuz    =          0.13 kN.
           -. Muy    =         -0.30 kN-m.
           -. bvz    =   0.50 m.
           -. dvz    =  MAX[ dvz_calc, 0.9*dz, 0.72*Hc ] =   0.50 m.
           -. thetaz =  29.36 Deg.          [Clause 5.8.3.4.2]
           -. betaz  =   4.46
```

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        -. Vuy    =          0.00 kN.
        -. Muz    =          0.00 kN-m.
        -. bvy    =   0.50 m.
        -. dvy    =  MAX[ dvy_calc, 0.9*dy, 0.72*Bc ] =   0.36 m.
        -. thetay =  29.37 Deg.          [Clause 5.8.3.4.2]
        -. betay  =   4.45

     ( ). Compute shear strength of concrete.
        -. Vuz       =        0.13 kN.
        -. Vcz       = 0.0316*betaz*SQRT[fc']*bvz*dvz =      487.12 kN.
        -. phiVcz    = phi * Vcz =      438.41 kN.

        -. Vuy       =        0.00 kN.
        -. Vcy       = 0.0316*betay*SQRT[fc']*bvy*dvy =      349.13 kN.
        -. phiVcy    = phi * Vcy =      314.21 kN.

     ( ). Compute maximum spacing of ties.
        -. Maximum spacing smax_z  = MIN[ 0.8*dvz, 24 in ] =    0.401 m.
        -. Vuz < phiVcz/2  --->  Not required shear reinforcement.
        -. Applied spacing s_z   =    0.100 m.

        -. Maximum spacing smax_y  = MIN[ 0.8*dvy, 24 in ] =    0.288 m.
        -. Vuy < phiVcy/2  --->  Not required shear reinforcement.
        -. Applied spacing s_y   =    0.100 m.

        -. Applied spacing s     = MIN[ s_y, s_z ] =    0.100 m.

     ( ). Compute shear strength of reinforcement.
        -. Vsz      = Av*fys*dvz*cot(thetaz) / s =      523.58 kN.
        -. Vsz_lim  = 0.25*fc'*bvz*dvz - Vcz =     1242.10 kN.
        -. Vsz      = MIN[ Vsz, Vsz_lim ] =      523.58 kN.
        -. phiVsz   = phi*Vsz =      471.22 kN.
        -. phiVsz > (Vuz-phiVcz)  --->  O.K !
        -. Using Avz/s  =  Vsz / (fys*dvz*cot(thetaz)) =   0.0014 m^2/m.

        -. Vsy      = Av*fys*dvy*cot(thetay) / s =      375.66 kN.
        -. Vsy_lim  = 0.25*fc'*bvy*dvy - Vcy =      891.93 kN.
        -. Vsy      = MIN[ Vsy, Vsy_lim ] =      375.66 kN.
        -. phiVsy   = phi*Vsy =      338.10 kN.
        -. phiVsy > (Vuy-phiVcy)  --->  O.K !
        -. Using Avy/s  =  Vsy / (fys*dvy*cot(thetay)) =   0.0014 m^2/m.
```

PROJECT TITLE :

MIDAS	Company		Client	
	Author		File Name	CABEZAL

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          -. Vu       =       0.129 kN.
          -. Vr       =     652.311 kN.
          -. Ratio    = Vu / Vr =1.981e-04  --->  O.K !

     ( ). Compute minimum longitudinal reinforcement by shear.
          -. phia     =   0.90
          -. phib     =   0.90
          -. phiv     =   0.90
          -. Vs1y     =  MIN[ Vsy, Vuy/phiv ] =        0.14 kN.
          -. Vs1z     =  MIN[ Vsz, Vuz/phiv ] =        0.14 kN.
          -. Asy_req =  [ Muz/(phib*dvy)  - 0.5*Pu/phia + (Vuy/phiv - 0.5*Vs1y)*cot(thetay) ] / fy
=3.3630e-05 m^2.
          -. Asz_req =  [ Muy/(phib*dvz)  - 0.5*Pu/phia + (Vuz/phiv - 0.5*Vs1z)*cot(thetaz) ] / fy
=3.2994e-05 m^2.
          -. As_req  =  MAX[ Asy_req, Asz_req ] =3.3630e-05 m^2.
          -. As      =   0.0016 m^2.
          -. As_req < As  --->  O.K !
```