FEM Design Verification Checklist for Generic Pile Caps in OASYS.GSA 8.7

Project Title		Job No.	
Discipline	Structural	File Ref.	
Review Date		Reviewer	
Project Stage		Circulation	

Abbreviations

FE – finite element
2D – 2-dimensional
SLS – serviceability limit state
ULS – ultimate limit state
GT – Gateway Tree
LT – long-term

Legend

Pass ☑
Not Applicable ☒

ITEM	CONTENT	☑
1.0	**MODEL EXPORT AND IMPORT**	
1.1	**Model Export from CSC.ORION**	
1.11	Mesh model in CSC.ORION complete with pile arrangement and pile cap dimensions.	☐
1.12	Structure Tree → select St00 → Run → FE Raft Foundation Analysis → checking the following options (a) Ignore the Bearing Capacity of Soil and (b) Include Column Section in FE Model → Raft Foundation Mesh and Analysis → Generate Model → Close.	☐
1.13	Run → Column Punching Check → check punching shear at wall/column framing. Note perform load take down calculation for **both frame analysis methods**, i.e. BA and CBAFE.	☐
1.14	Export output file: Run → FE Raft Foundation Analysis → Model Export Tab → check SAP2000 → SAP Analysis Model Export (to generate a ".s2k file").	☐
1.2	**Model Import into OASYS.GSA**	
1.21	OASYS.GSA → GT → Specification → set Units Specification to kN-m. OASYS.GSA → GT → Specification → Analysis Specification → set Global Restraints to x, y and zz.	☐
1.22	Open ".s2k" file with Notepad → copy all contents into Excel → Data → split data using Text to Columns.	☐
1.23	Copy coordinates X, Y, Z from Excel → OASYS.GSA → GT → Nodes → Coordinates → paste as x, y, z ensuring that node numbers are sequential from 1 without any gaps.	☐
1.24	Insert Ground Springs: copy Springs from Excel → OASYS.GSA → GT → Elements → paste nodes to topology 1. Insert Shells: copy Shells from Excel → OASYS.GSA → GT → Elements → paste nodes to topology 1, 2, 3.	☐
1.25	Perform p-refinement of FE mesh: OASYS.GSA → Graphics → right-click on selection → Modify Selected Elements → click Modify type of 2D elements → Parabolic. Perform h-refinement of FE mesh: OASYS.GSA → Sculpt → 2D Element Operations → Split Tri Elements… → refine Trias to Trias or Quads.	☐
2.0	**PRE – ANALYSIS SETTINGS**	
2.1	**Pile Section Properties**	
2.11	Add section properties for piles: OASYS.GSA → GT → Properties → Springs → Spring Properties. **#A:** Note L/C denotes "Linear or Curve Reference". **#B:** Note vertical pile stiffness may be calculated based on allowable pile capacity / anticipated pile settlement. Assign properties to all ground spring piles: Graphics → right-click on selection → Modify Selected Elements → click Modify property to → PS1 etc…	☐
2.2	**Pile Cap Material and Section Properties**	
2.21	Add material properties for pile caps: OASYS.GSA → GT → Properties → Materials → User Defined. **#A:** Note Young's modulus, E = (28GPa/2) x (1/(1+Φ)) = 28GPa/6, note Φ = 2 (for permanent loading).	☐
2.22	Add section properties for pile caps: OASYS.GSA → GT → Properties → 2D Element Properties.	☐

Node	Coordinates (Global)		
	x	y	z
N1, N2, N3 etc…	X	Y	Z

Element	Type	Property	Group	Topology					
				1	2	3	4	5	6
E1, E2, E3 etc…	Ground Spring	Pile Prop. No.	1	N1	–	–	–	–	–
E101, E102, E103 etc…	Triangle 3	Pile Cap Prop. No.	1	N1	N2	N3	–	–	–

Prop.	Name	Axis	Type	x		y		z		Matrix	Damping Ratio
				L/C #A	Stiff. kN/m	L/C #A	Stiff. kN/m	L/C #A	Stiff. kN/m		%
PS1 etc…	PILE1200	Global	Transl.	Linear	0	Linear	0	Linear	… #B	–	0

Mat.	Name	Mat. Model	Mat. Type	Young's Mod. #A N/mm²	Poisson's Ratio	Shear Mod. N/mm²	Density t/m³	Temp. Coeff. 1/°C	Damp. Ratio %
M1	Conc. LT with creep	Elastic Isotropic	–	4667	0.2	E/2(1+nu)	2.4	1e-005	0

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	Assign properties to all 2D element pile caps: Graphics → right-click on selection → Modify Selected Elements → click Modify property to → PA1 etc…	

Prop.	Name	Type	Axis	Material	Thk. mm	Thickness Factor Bending	In-plane	Mass/Weight
PA1 etc…	4PC1200	Shell	Global	Conc. LT with creep	3000	100%	100%	100%

			☐
2.23	Check orientation of local x-axis of all 2D elements: Graphics → Label element x axes → ensure consistency. Check orientation of local z-axis of all 2D elements: Graphics → Diagram settings → Geometry → 2D Element Geometry → Projected axes → Ensure consistency of direction of z axis.		☐
3.0	**LOADING CHECKS**		
3.1	**Load and Combination Cases**		
3.11	Insert load / combination cases: OASYS.GSA → GT → Cases and Tasks → Load Case Titles / Combination Cases.		☐

	Name	Description
1	SLS Combo	1A1+1A2
2	ULS Combo	1.5A1+1.5A2

	Name	Case Type
1	Pile Cap Dead Load	Dead
2	SLS Column Loading	Imposed

			☐
3.12	Insert gravity loads: OASYS.GSA → GT → Loading → Gravity Loading.		☐

Record	Nodes	Load Case	Gravity Factors x (g)	y (g)	z (g)
1	all	Pile Cap Dead Load	0	0	−1

			☐
3.13	Insert nodal loading: OASYS.GSA → GT → Loading → Nodal Loading → Node Loads.		☐

Record	Nodes	Load Case	Axis	Direction	Value (kN)
1 etc…	N1, N2, N3 etc…	SLS Column Loading	Global	z	… #A

#A: Note wall/column pressure loading is to be calculated and inserted as negative for a downward load.

			☐
3.14	Insert line loading: OASYS.GSA → GT → Loading → Beam Loading → Beam Loads.		☐

Record	Beam List	Load Case	Type	Axis	Projected	Direction	Load (kN/m)
1 etc…	E21, E22, E23 etc… #B	SLS Column Loading	Uniform	Global	–	z	… #A

#A: Note wall/column pressure loading is to be calculated and inserted as negative for a downward load.
#B: Note create fictitious beams (with zero stiffness) to create line loading.

4.0	**ANALYSIS AND POST-ANALYSIS**	
4.1	**Analysis**	
4.11	OASYS.GSA → Analysis → Analyse All.	☐
4.2	**Pile Displacements and Reactions**	
4.21	Check pile deflection to **SLS Combo**: OASYS.GSA → Graphics → Contour settings → Grounded Spring and Mass Element Results → Grounded Spring and Mass Displacements → Elem. Trans., Uz ≈ anticipated pile settlement.	☐
4.22	Check pile reaction to **SLS Combo**: OASYS.GSA → Graphics → Contour settings → Grounded Spring and Mass Element Results → Grounded Spring Forces and Moments → Shear Force, Fz ≈ allowable pile capacity. Check for no overstress by ensuring Fz ≤ allowable pile capacity. Check for no pile tension / uplift by ensuring Fz ≥ 0.0.	☐
4.3	**Pile Cap Displacements and Rotations**	
4.31	Check pile cap deflection to **SLS Combo**: OASYS.GSA → Graphics → Contour settings → 2D Element Results → 2D Element Displacements → Elem. Trans., Uz ≈ anticipated pile cap settlement.	☐
4.32	Check pile cap rotation to **SLS Combo**: OASYS.GSA → Graphics → Contour settings → Nodal Results → Displacements → Rotations, Rxx, Ryy and Resolved Rotation, |R| ≤ ±1/400 = ±0.0025rads.	☐
5.0	**PILE CAP DESIGN**	
5.1	**Pile Cap ULS Design Checks**	
5.11	Check pile cap bending moments per metre **to ULS Combo**: OASYS.GSA → Graphics → Contour settings → 2D Element Results → 2D Element Projected Moments → visually integrating **hogging** and **sagging** 2D Moment, |Mx|+|Mxy| and |My|+|Myx| on a fine FE mesh (ignoring artificial stress concentrations to St. Venant's Principle) whilst selecting Average stresses and forces at nodes ≤ bending moment capacity table values.	☐
5.12	Check pile cap shear forces per metre **to ULS Combo**: OASYS.GSA → Graphics → Contour settings → 2D Element Results → 2D Element Derived Forces and Moments → visually integrating Max 2D Through-Thk Shear, Qmax on a fine FE mesh (ignoring artificial stress concentrations to St. Venant's Principle) whilst selecting Average stresses and forces at nodes ≤ shear force capacity table values.	☐