14th International Benchmark Workshop on Numerical Analysis of Dams

THEME B

STATIC AND SEISMIC ANALYSIS OF AN ARCH-GRAVITY DAM

SURVEY SPREADSHEET

The present spreadsheet aims to summarize the main assumptions used by each participant.
Each tab corresponds to one of the following models :

Static calculations	**Model 1**	Linear analysis
	Model 2	Simplified non-linear analysis
	Model 3	Non-linear analysis with propagation of uplift
Dynamic calculations	**Model 4**	Non-linear pseudo-static analysis based on the site response spectrum acceleration
	Model 5	Linear time-history analysis with simplified dynamic interactions
	Model 6	Non-linear time-history analysis with simplified dam-reservoir interactions
	Model 7	Linear time-history analysis with advanced dynamic interactions
	Model 8	Non-linear time-history analysis with advanced dynamic interactions

PARTICIPANT INFORMATION

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MODEL 1: LINEAR ANALYSIS

GENERAL INFORMATION

Calculation code		ABAQUS
Integration scheme	Implicit, explicit…	implicit
Estimated time spent on this model		two months

NUMERICAL MODEL

Mesh	Modification of the provided mesh, element type, 1st or 2nd order elements…	In order to take advantage from the geometrical facilities offered by Abaqus code when a solid model is provided, the orphane mesh from Ansys code was ignored. The solid model provided was modified in order to remove a large number of very short edges which disturbed the meshing and contact algorithm. 4-node linear tetrahedron stress/displacement elements were used
Boundary conditions	Description	Displacements normal to the five plane of equation z=-400 m,y=+/-385 m,x=-487 m, x=92m , were imposed as 0

MECHANICAL ASSUMPTIONS

Dam / foundation interface	If any, description of the type, constitutive law, mechanical properties	The dam is assumed as attached to his foundation.

OTHER INFORMATION

Description of other important information or assumption		The compression resultants are assumed as positive. Stresses are integrated on the interface surface. Therefore the normal unit vector changes from point to point. At the end of the integration process the resultant force is projected on the mean value of the normal unit vector. The interface for block B5 is divided in two parts. The up-stream part is open and the normal unit vector is largely different from that related to the downstream part. Therefore it is not included in the integration surface.

MODEL 2: SIMPLIFIED NON-LINEAR ANALYSIS

GENERAL INFORMATION

Calculation code		ABAQUS
Integration scheme	Implicit, explicit…	Implicit
Estimated time spent on this model		halp month

NUMERICAL MODEL

Mesh	Modification of the provided mesh, element type, 1st or 2nd order elements…	The same mesh used for Model_1
Boundary conditions	Description	The same boundary conditions used for Model_1

MECHANICAL ASSUMPTIONS

Dam / foundation interface	Description of the type, constitutive law, mechanical properties	A node-to-surface contact method and the penalty methods are used. In order to prevent a large number of sticking-to-slipping alternate transitions, during the self_weight application, an elastic slip tolerance equal to 0.2 mm is used.

OTHER INFORMATION

Description of other important information or assumption		The interface for block B5 is divided in two parts. The up-stream part is open and the normal unit vector is largely different from that related to the downstream part. Therefore it is not included in the integration surface. In order to allow the comparison, the same hypothesis is assumed on Model_1

MODEL 4: NON-LINEAR PSEUDO-STATIC ANALYSIS BASED ON THE SITE RESPONSE SPECTRUM

GENERAL INFORMATION

Calculation code		ABAQUS
Integration scheme	Implicit, explicit…	Implicit
Estimated time spent on this model		Half month

NUMERICAL MODEL

Mesh	Modification of the provided mesh, element type, 1st or 2nd order elements…	The same boundary conditions used for Model_1
Boundary conditions	Description	The same boundary conditions used for Model_1

MECHANICAL ASSUMPTIONS

Dam / foundation interface	Description of the type, constitutive law, mechanical properties	A node-to-surface contact method and the penalty method are used. In order to prevent a large number of sticking-to-slipping alternate transitions, an elastic slip tolerance equal to 0.2 mm is used.
Uplift / pore pressures	Variable of the model (effective stresses) or external force	The uplift pressures are applied as external forces

OTHER INFORMATION

Description of other important information or assumption		When the system in linearized for NWL 839 m.a.s.l. a fundamental period 0.39 sec is obtained. As a consequence, according to the site spectrum acceleration provided, an acceleration equal to 6.65 m/sec^2 was assumed.

MODEL 5: LINEAR TIME-HISTORY ANALYSIS WITH SIMPLIFIED DYNAMIC INTERACTIONS

GENERAL INFORMATION

Calculation code		ABAQUS
Integration scheme	Implicit, explicit…	Implicit
Estimated time spent on this model		half month

NUMERICAL MODEL

Mesh	Modification of the provided mesh, element type, 1st or 2nd order elements…	The same mesh used for Model_1
Boundary conditions	Description (fixed base / base motion)	The same boundary conditions used for Model_1

MECHANICAL ASSUMPTIONS

Dam / foundation interface	If any, description of the type, constitutive law, mechanical properties	The dam is assumed as attached to his foundation.

DYNAMIC ASSUMPTIONS

Damping	Description	The modal damping assumed is 5% of the critical value.
Added masses	Direction (normal to faces, x-directed, ...)	X-directed
Dynamic integration method	Modal Decomposition / Newmark / HHT / HFT...	The Modal superimposition method is used. The 12 modes considered cumulate 93% of the total mass in X direction.

OTHER INFORMATION

Description of other important information or assumption		