Griddle generation of FLAC3D models for the Baihetan Dam project

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INTRODUCTION

- The Baihetan dam and hydropower plant project currently under development is located on the Jinsha River, in the southwest of China.
- It is the second largest hydropower project in China, after the Three Gorges Dam Project.
- *FLAC3D* /*3DEC* play an important role in the Baihetan dam project; they are used for rock mechanics analysis, optimization design, reinforcement design and feedback analysis for the slopes, dam, and caverns.

MESHING METHOD

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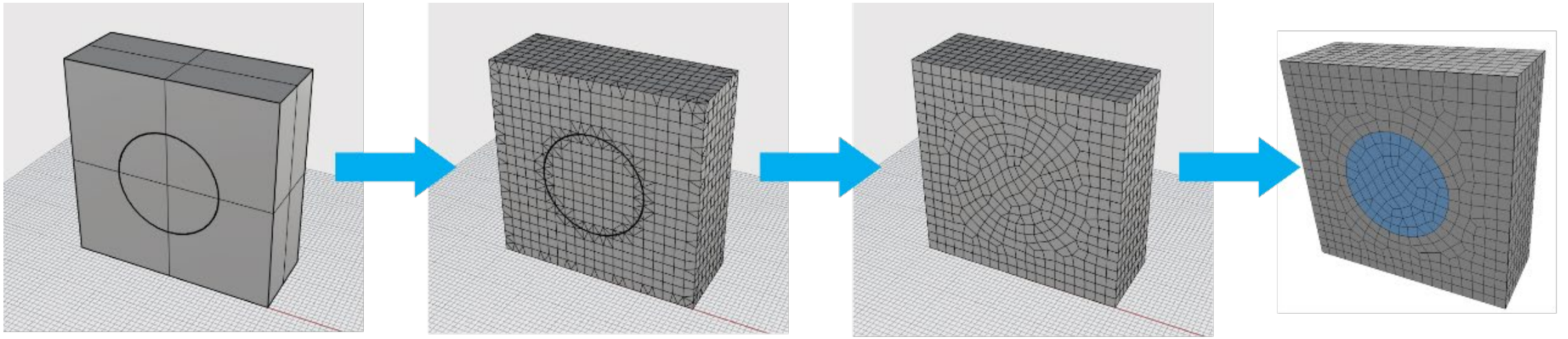
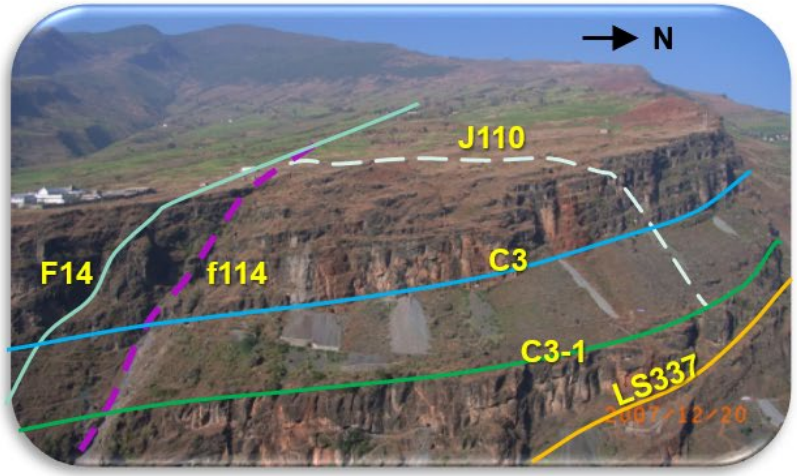
- To build a *FLAC3D* mesh with many explicit features is often a major technical challenge for large-scale projects in complex geological conditions.
- The Griddle mesh generation is a good compromise between efficiency and accuracy, and has been widely used in the Baihetan dam project.

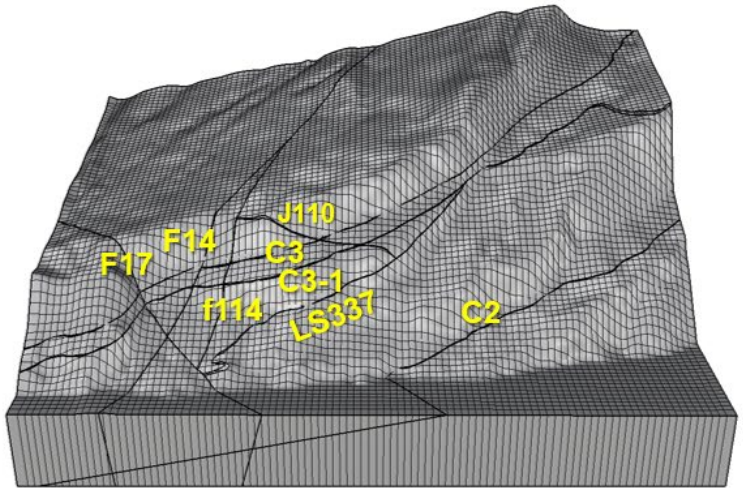


(Itasca 2017)

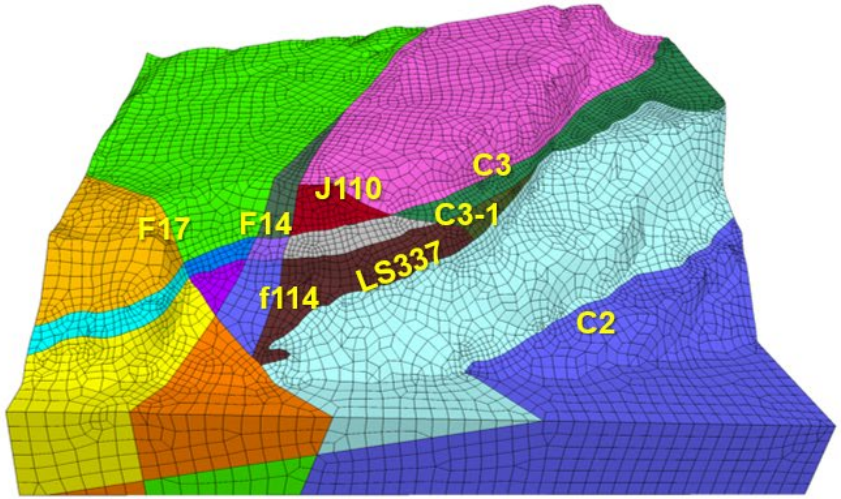
SLOPE MODEL



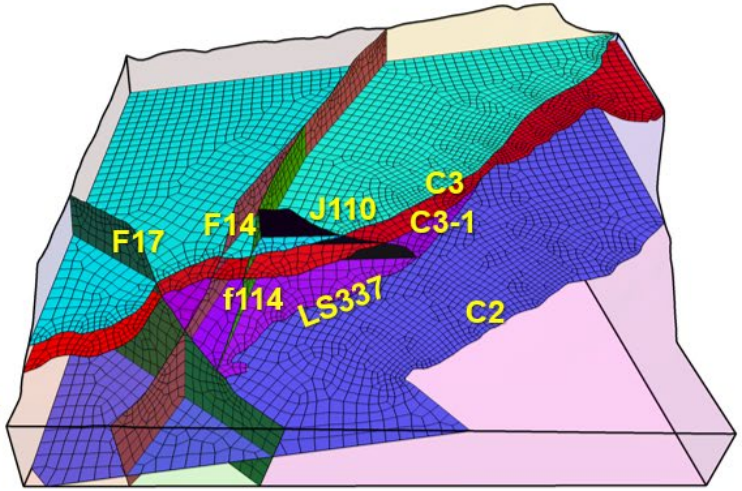
a) View of the natural slope



b) Rhino solid and surfaces



c) FLAC3D volume mesh



d) FLAC3D interface surfaces

- The displacement and stability of the 500 m natural slope are dominated by the presence of discontinuities, including bedding plane and faults.
- *Griddle* was used to generate the grid for the natural slope.
- The *FLAC3D* mesh contains 101,226 zones, 22 groups, and 8 face groups.

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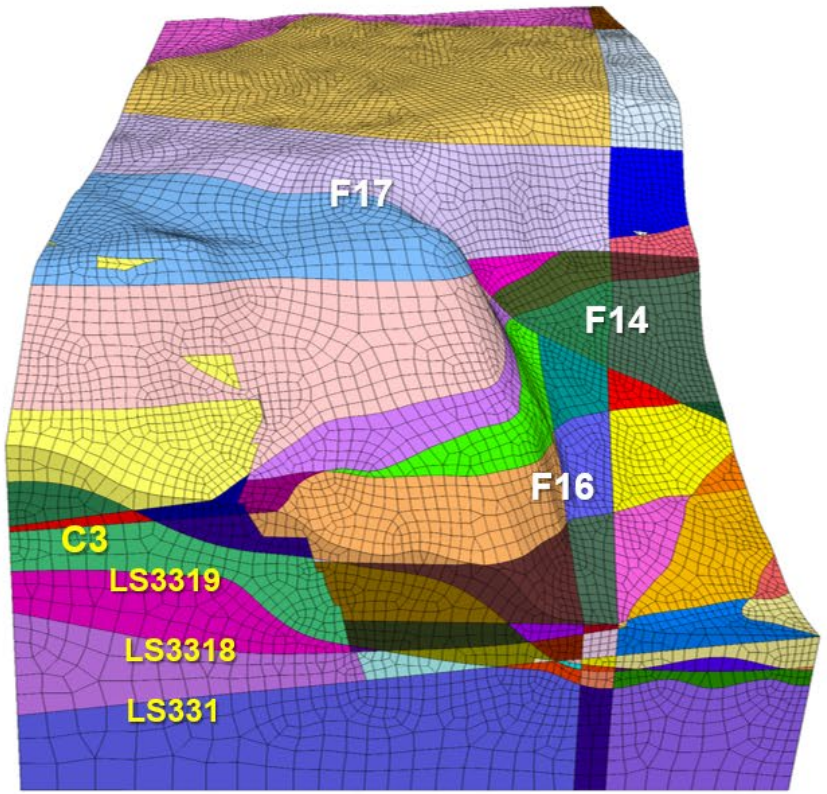
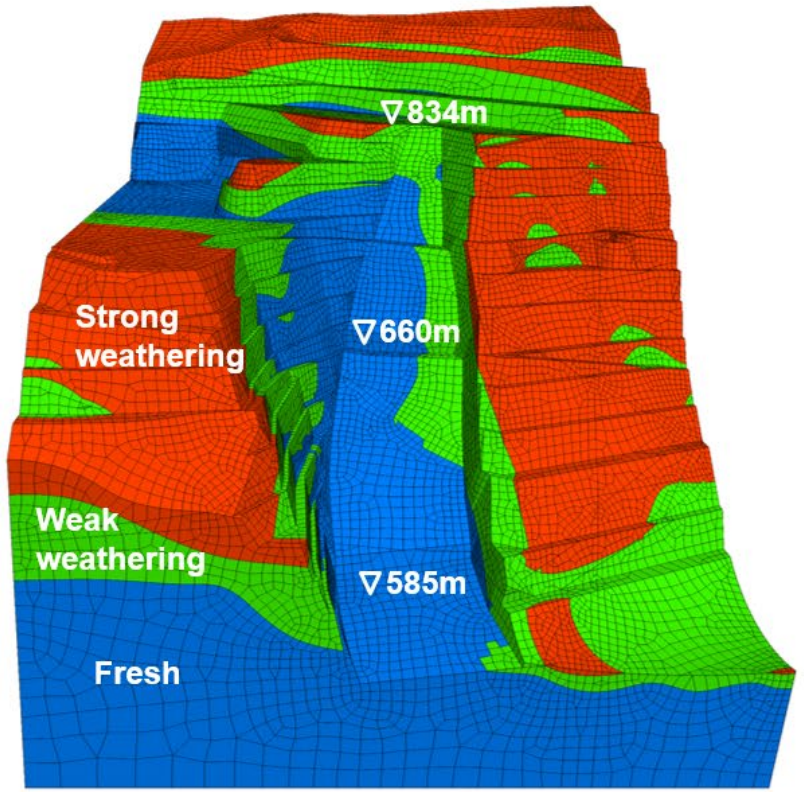
- The excavation deformation is mainly controlled by the removing volume, geology structures and material parameters.
- *Griddle* was used to generate the grid for the excavation slope.
- The *FLAC3D* mesh contains 101,226 zones, 22 groups, and 8 face groups.

a) View of the excavation slope



b) Volume mesh before excavation



c) Volume mesh after excavation

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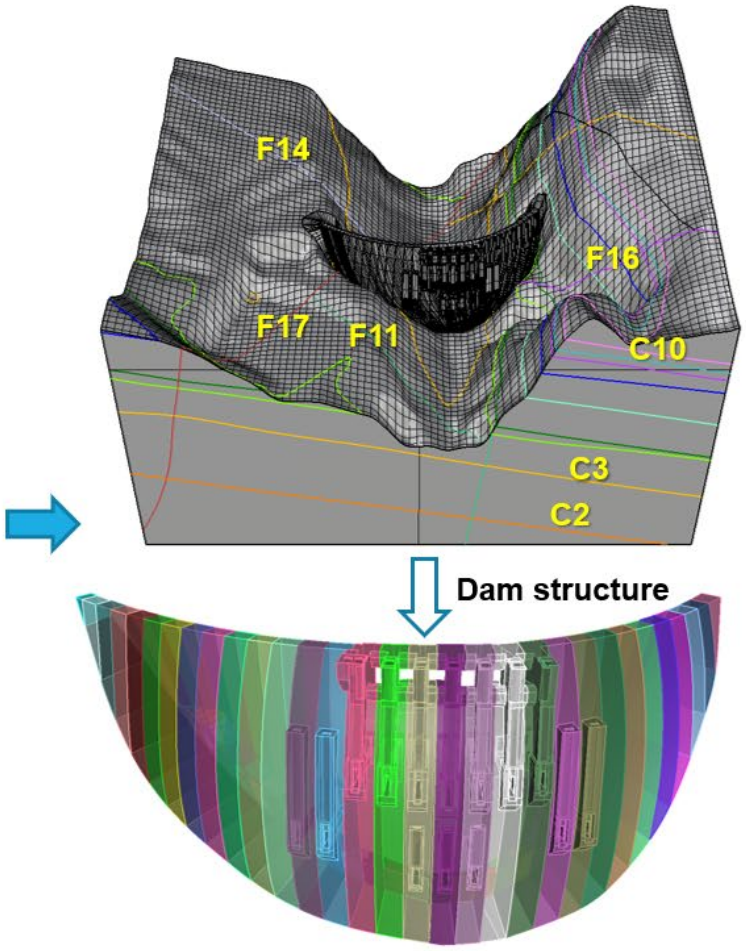
DAM MODEL

a) View of the dam (November, 2019)



b) Rhino solids and surfaces

- This Baihetan project includes a 289m-high double-arched concrete dam embedded in the river bank slopes.
- The stress distribution in the dam is controlled by both complicated geological and dam structures.

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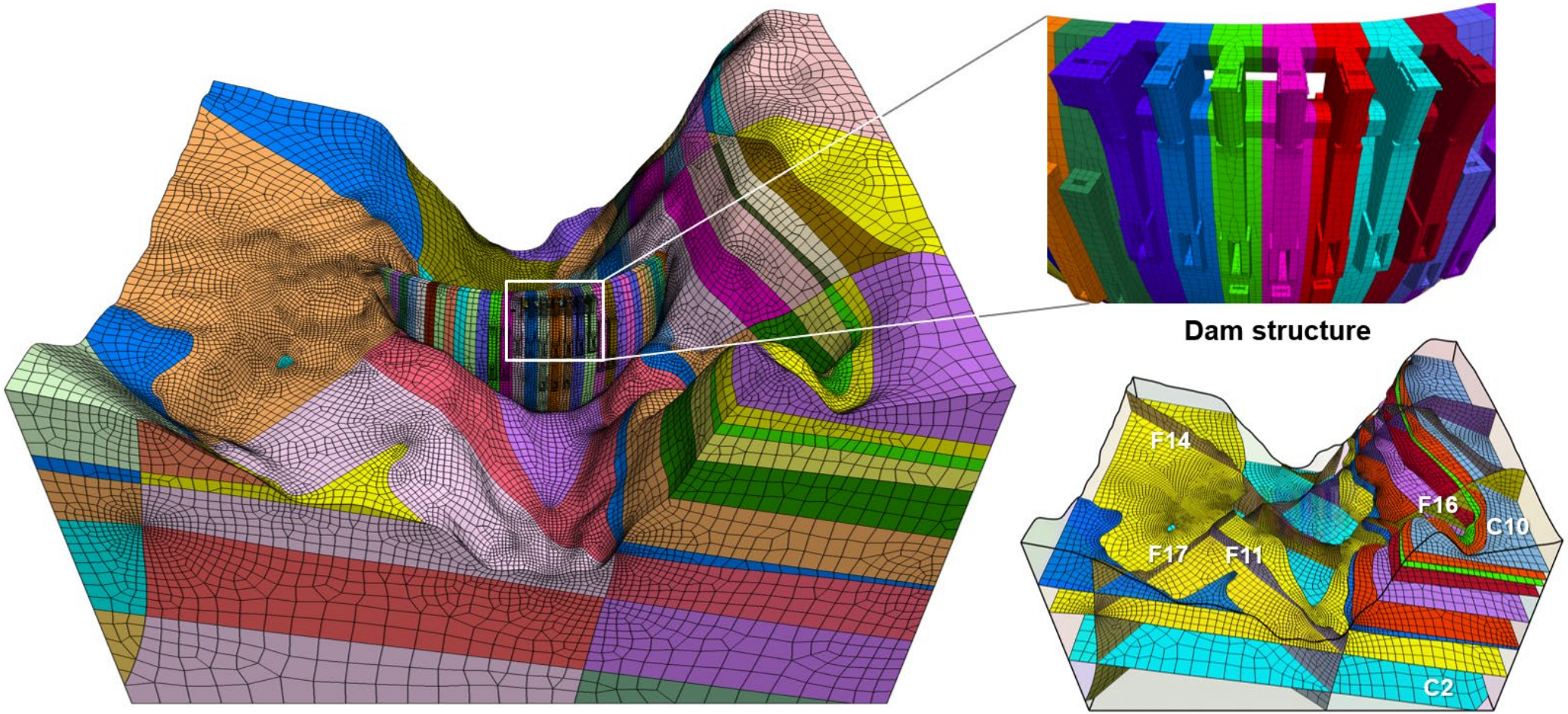
- Therefore, a detailed meshing of the dam body should be included in the model of the valley slope excavation to perform the dam stress analysis.
- The *FLAC3D* mesh generated by *Griddle* for the valley and dam contains 430,269 zones, 98 zone groups, and 17 face groups.



a) FLAC3D volume mesh

b) FLAC3D Interface surfaces

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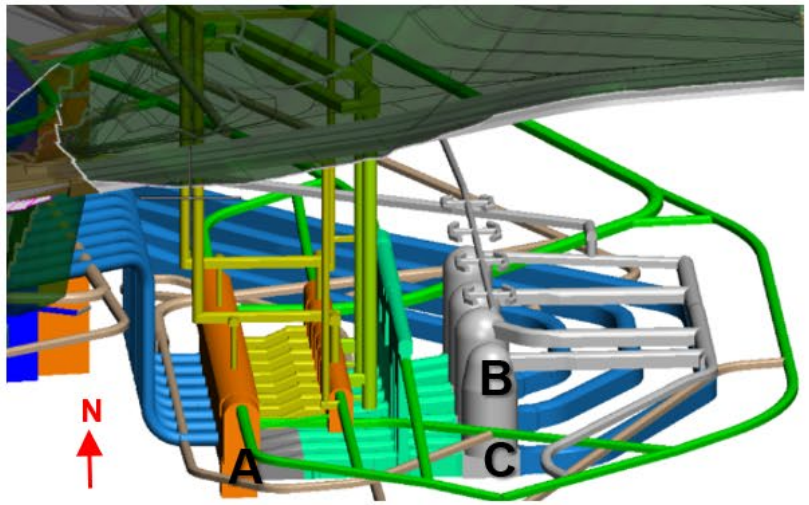
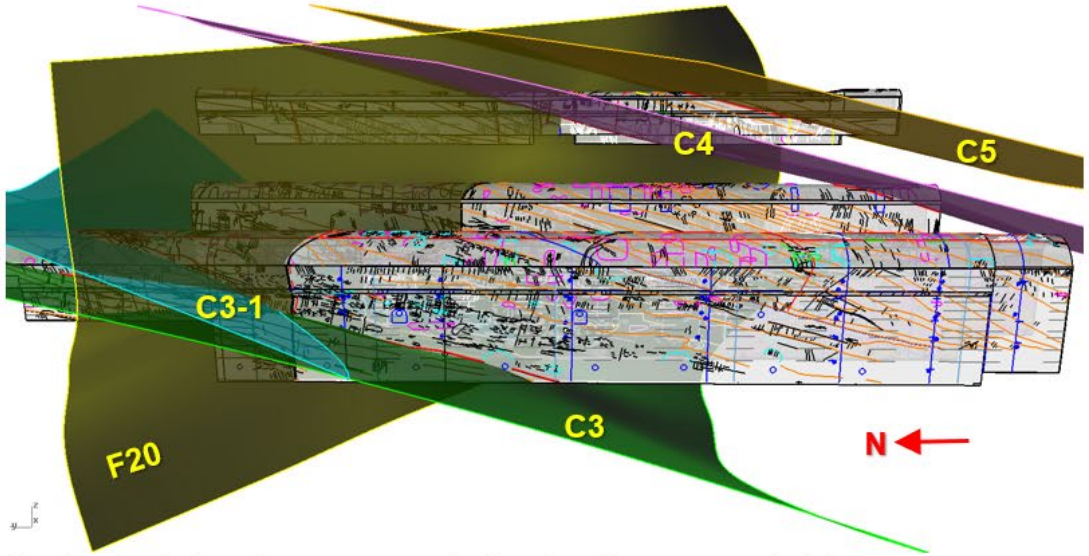
CAVERNS MODEL



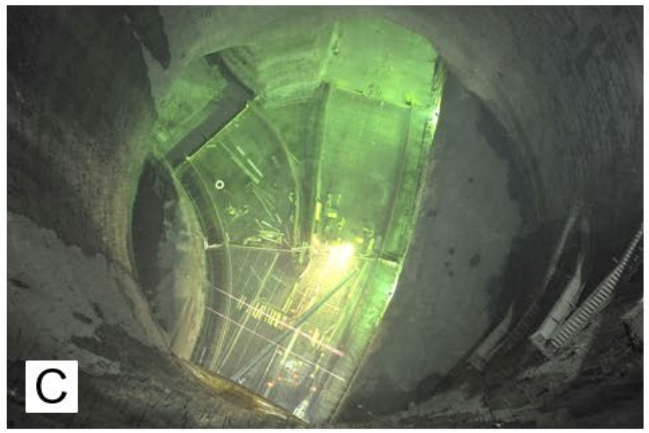
a) Rhino solid representing the caverns



b) Geological structures generated using the mapped data

c) View of the powerhouse

d) View of the chamber roof



e) View of the chamber floor

- The world's largest underground powerhouse caverns has total excavation volume of about 25 million m^3.
- The caverns are crisscrossing each other, with scales ranging from 2×3m to 34×88.7×438m, making the mesh generation work complicated.

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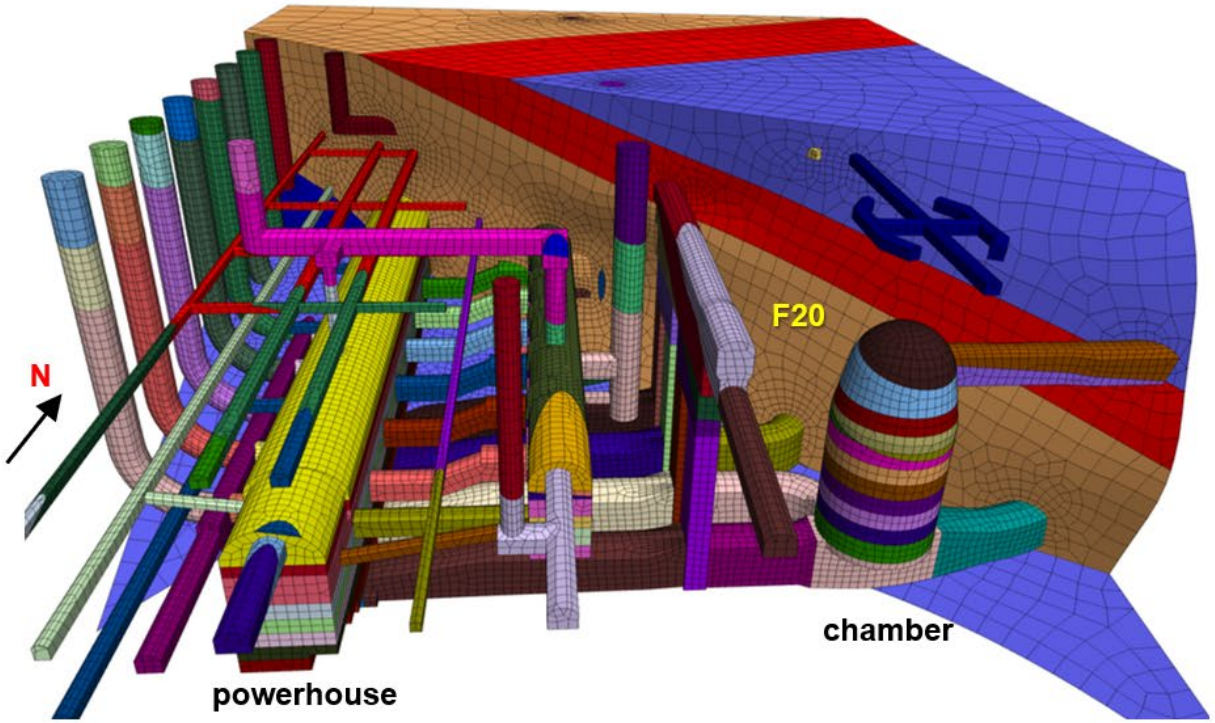
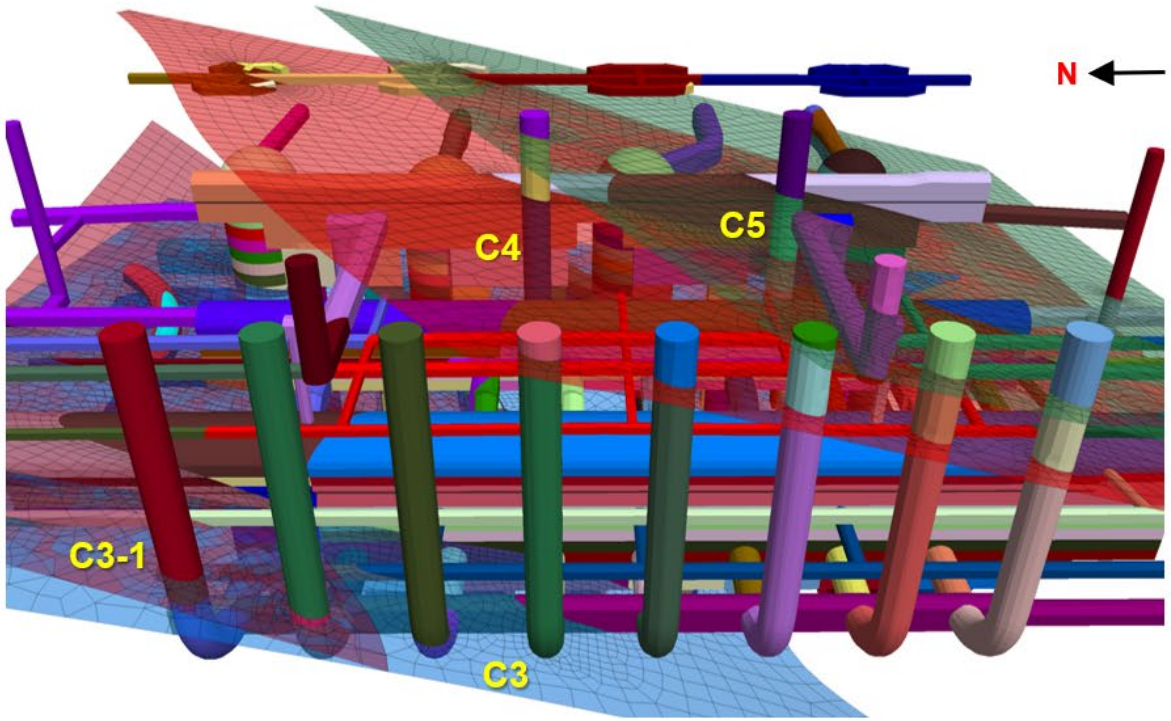
- According to actual geological data, including bedding, faults, and joints in the carven area that were mapped during excavation, the geological structure can be built and updated in the numerical model quickly, which is beneficial to carry out feedback analysis during construction period.
- The *FLAC3D* mesh generated by *Griddle* for the caverns contains 1,039,301 zones, 315 zone groups and 5 face groups.



a) FLAC3D volume mesh



b) FLAC3D Interface surfaces

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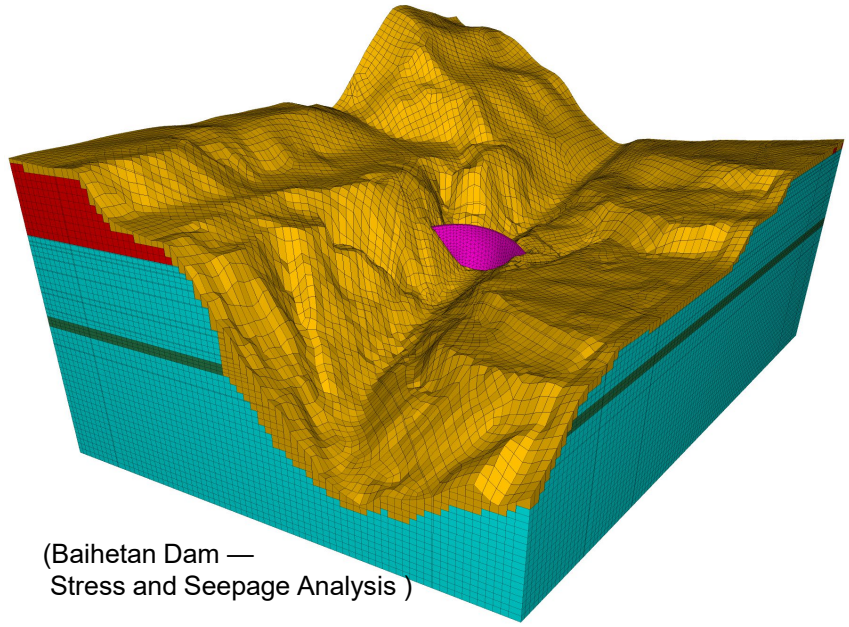
CONCLUSIONS

- ✓ *Griddle* has a simple work flow and is easy-to-use. It usually takes only a few hours to build a geometrically complex mesh based on CAD model.
- ✓ *Griddle* is powerful, it can handle the most complex geometries with multiple volumes and surfaces, including floating surfaces. It allows for rapid rebuilt models based on mapping data obtained during the excavation and construction periods.
- ✓ *Griddle* can generate high-quality hexahedral-dominant unstructured meshes. The percentage of hexahedra in the meshes by volume considered in the paper reaches 64~85%. This percentage is suitable for stress analysis but may not be high enough for coupled fluid-mechanical analysis.

models	elements	tetrahedra	pyramids	prisms	hexahedra
natural slope	101,226	2.7%	9.7%	2.5%	85.1%
excavation slope	499,806	4.5%	14.7%	3.5%	77.6%
arch dam	430,269	3.5%	12.4%	3.3%	80.8%
caverns	1,039,301	7.7%	23.1%	5.0%	64.2%



(Baihetan Dam — Stress and Seepage Analysis)

Thank you