ACCELERATING STRUCTURAL ANALYSIS WITH THE RB-FEA WORKFLOW
Accelerating Structural Analysis with the RB-FEA Workflow

**OVERVIEW**

Akselos Integra™ streamlines simulation through its parametrized component-based modeling approach and RB-FEA solver technology. The RB-FEA analysis workflow is especially beneficial when solving very large and complex finite element models or solving smaller models many times.

**CAPABILITIES**

- 100 - 1000x speedup compared to standard FEA.
- Component-based architecture that gives users the ability to add/remove/replace components to efficiently modify and re-analyze large models.
- Parametrized components that efficiently handle systems with many material, load, and geometry parameters.
- Fully-detailed global models of large assets.
- Hybrid solver for solving large-scale nonlinear problems via coupled FEA/RB-FEA method.
- Modern computational technologies, including parallel computing and cloud.
- Compatible with CAD-based modeling workflows using tools like Spaceclaim, SolidWorks, AutoCAD, Catia V5 and V6, Autodesk Naviswork and Autodesk Inventor.
- Compatible with Abaqus, Nastran, and ExodusII mesh formats.

**BENEFITS**

- Fast design optimization: Significant productivity gains through quicker turnaround for model preparation and analysis without compromising accuracy.
- Large problem capabilities: Enable the analysis of high fidelity 2D/3D large models without incurring huge computational costs.
- Fast engineering insights: Perform thousands of parametric “What If” studies to gain more in-depth knowledge of your designs in the time it takes conventional FEA to produce a single simulation result.
- Reduced costs: Improved productivity and efficiency, particularly when the analysis of large models is involved.
- Condition-based modeling: Incorporate true wear and tear condition into global high-fidelity RB-FEA models of critical assets.

**WHY USE THE RB-FEA WORKFLOW?**

With conventional FEA solve times and memory requirements grow rapidly with model size. This puts a hard limit on model detail/size/complexity with conventional FEA. Moreover, a FEA model is rarely analyzed only once. Often, a model is modified.
and re-analyzed to perform in-depth, multi-scenario analyses. Conventional FEA is not well-equipped to deal with this re-
analysis situation since CAD model and meshes must be re-created with each geometry change, which is time-consuming and
laborious.

RB-FEA addresses these drawbacks of FEA, as described in more detail below.

**Akselos RB-FEA Workflow Approach**

Instead of recreating a CAD model and meshing it each time a re-analysis is needed, the RB-FEA approach offers the advantage
of parametric analysis. Akselos Components are preconditioned reduced-order models that contain adjustable parameters
defining geometric and physical properties, loads, and other boundary conditions. Preconditioning data for parameterized
components is stored on the cloud and re-used each time a solve is performed. This means that the system load conditions,
geometrical or physical properties can be changed in just a few clicks within Akselos Modeler, and a new high fidelity
simulation is obtained in seconds.

**FUNDAMENTALS OF COMPONENT-BASED MODELING**

The RB-FEA modeling approach enables large models to be solved very quickly. The key idea is
to break the structure into a set of components. A reduced-order model is automatically trained for
each component. The reduced order models at the component level may then be combined into
a single, global model that can be solved orders of magnitude faster than FEA. This modeling
approach enables engineers to efficiently create large, reusable, and reconfigurable models.

Components used to model a semi-submersible platform
HOW ARE COMPONENTS CREATED?

To achieve the speedup of RB-FEA, a reduced-order model for each component is automatically preconditioned. This process uses FEA to capture the full range of component behavior across the parameter range defined for each component, and the resulting data is stored on Akselos Cloud. The preconditioning phase is followed by an RB-FEA solve phase where the reduced-order model data is re-used in order to solve large models much faster than with standard FEA, with virtually no loss in accuracy.

WHAT DO COMPONENTS CONTAIN?

Akselos components consist of two regions:

- **Ports**: the shared surface on which components connect.
- **Interiors**: the rest of the component (non-port regions).

Automatic RB-FEA algorithms create the data for component interiors and ports so that the reduced-order models accurately reproduce the physics of component interiors, and component interactions with neighboring components.

THE FULL RB-FEA ANALYSIS WORKFLOW

**1. Divide CAD model into smaller components**

Divide the CAD model into as many components as you see fit.

CAPABILITIES

- Easily models large systems with more than 1 billion degrees of freedom.
- Parametrizes geometries so that engineers don’t have to go to the drawing board every time a modification of the geometry is made.
- Modularity makes it easier to modify systems: global systems can be changed by simply modifying individual components.
- Any model division is permissible

BENEFITS

- Engineers can simulate more model configurations with less time thanks to the simplified model construction process.
- Accelerate the simulation time by orders of magnitude without compromising accuracy.
- Facilitate the division of labor. Different components are taken care of by different design teams that can work independently and in parallel.
- Efficiently reuse similar components. Many structures are built of many similar components, in which case it is only necessary to deal with each component type once.

COMPONENT EDITOR

Component Editor is an advanced tool in Akselos Modeler that allows users to create/modify components.
2. Mesh each component

Mesh each component separately.

3. Pre-compute Components

Using the Component Editor functionality, define the parameter ranges for each component. With a push of a button, pre-condition components to generate the entire datasets that encapsulate the full range of component behavior over the predefined parameter ranges.

4. Set up the simulation model

Assemble the full model from the pre-conditioned components using a drag and drop functionality. Then set geometric and material parameters and apply boundary conditions and loads.

5. Run the RB-FEA solution

Perform the RB-FEA solve, which enables analysis of large models in seconds. Several types of RB-FEA solve types are available, including static, dynamic, modal, harmonic, centrifugal/rotational, and thermoelasticity.

PRODUCTIVITY GAINS

For this fully detailed, condition-based shiploader model that has 20 million degrees of freedom, it's infeasible to run a full solve using conventional FEA. In Akselos Modeler, using the RB-FEA workflow, the analysis required only 3s using a 1 core machine.
About Akselos

Akselos is a digital technology company headquartered in Switzerland, with operations in Europe, the USA and South East Asia. The company has created the world’s most advanced engineering modeling, and fastest simulation technology, to protect the world’s critical infrastructure today and tomorrow. The technology has the power to revolutionize how we build and manage our critical infrastructure, and pushes the boundaries of what modern engineering and data analytics can achieve. Developed by some of the world’s best minds, the MIT-licensed technology builds something far beyond the capability of a conventional digital twin – a digital guardian that allows operators to not only monitor an asset’s condition in real time, but helps them to see the future.