

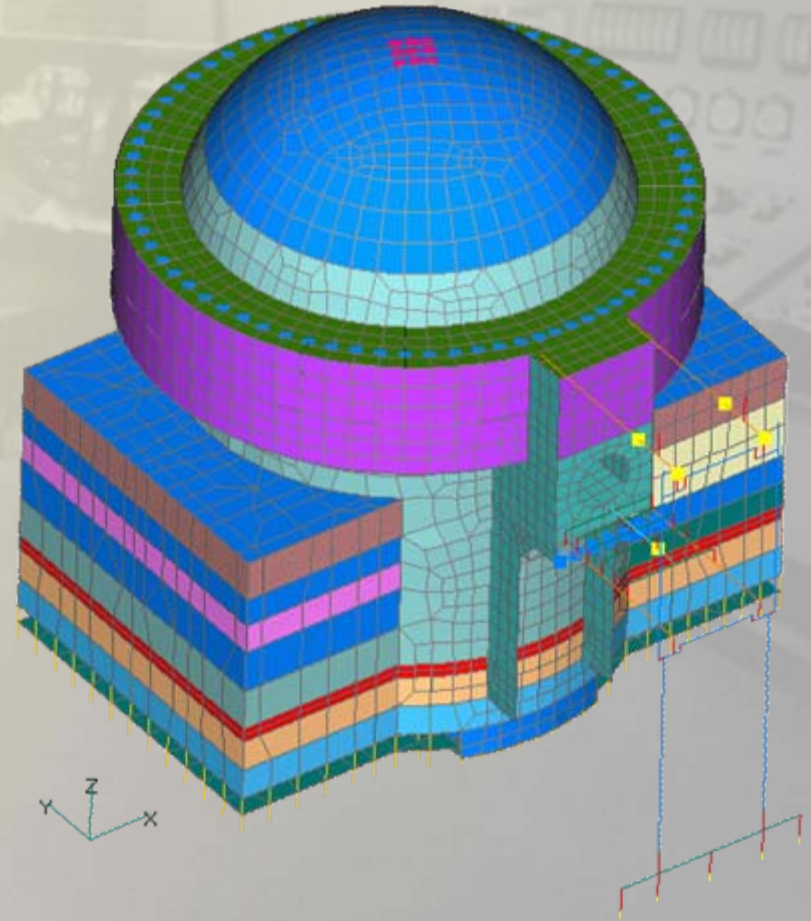
Application of  
Optimization Program IOSO NM  
and ABAQUS  
at Civil Structures of NPP

# IOSO & ABAQUS

## Task statement

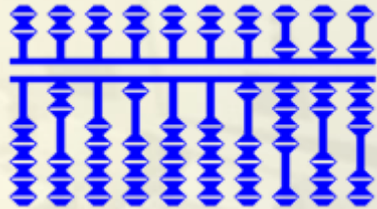
A transport container of the atomic power station that is schematically presented on this slide undergoes seismic activity. The construction of the container should be optimized for the envelope of the acceleration response spectra to be in the appropriate limits.

V1  
L1  
C1  
G2



# IOSO & ABAQUS

Software being used



**ABAQUS**

FEA software

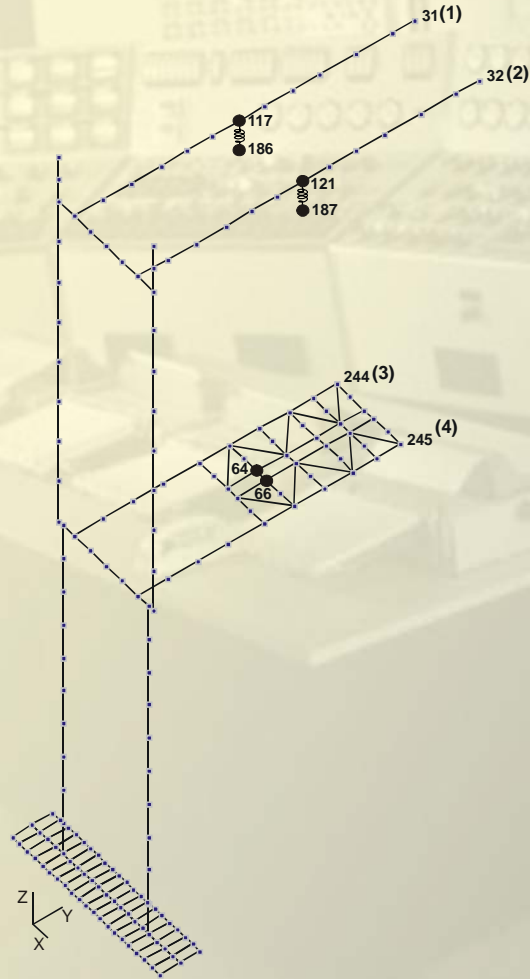


**IOSO**  
NM

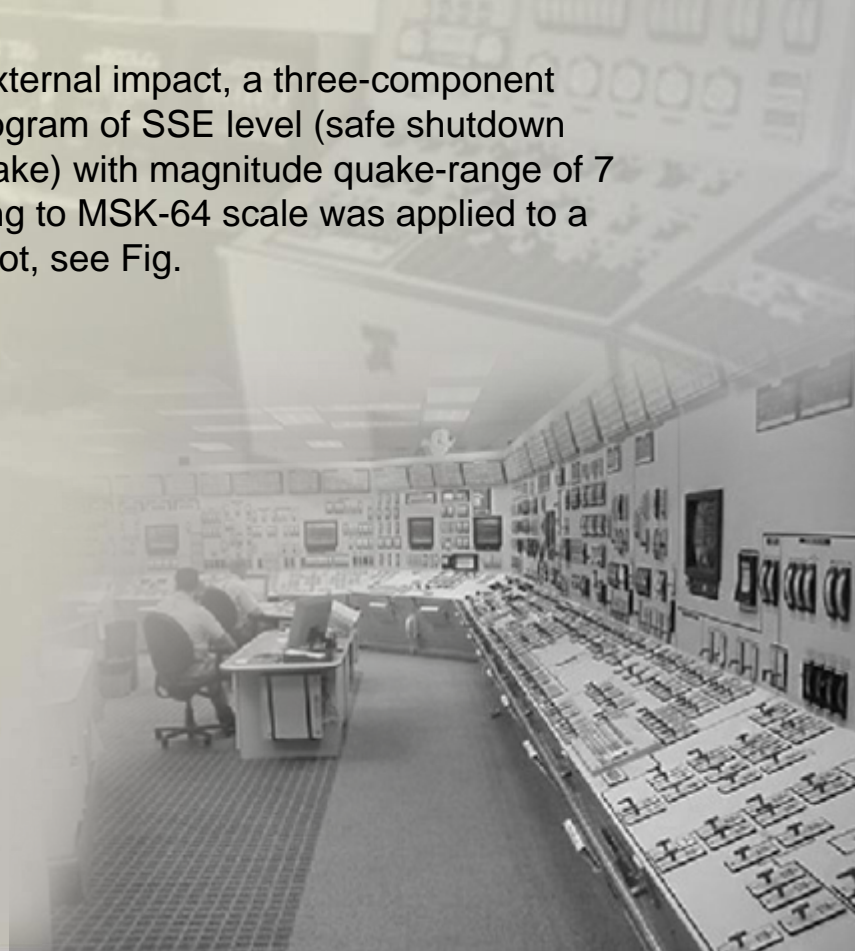
Optimization software

# IOSO & ABAQUS

## Task setup

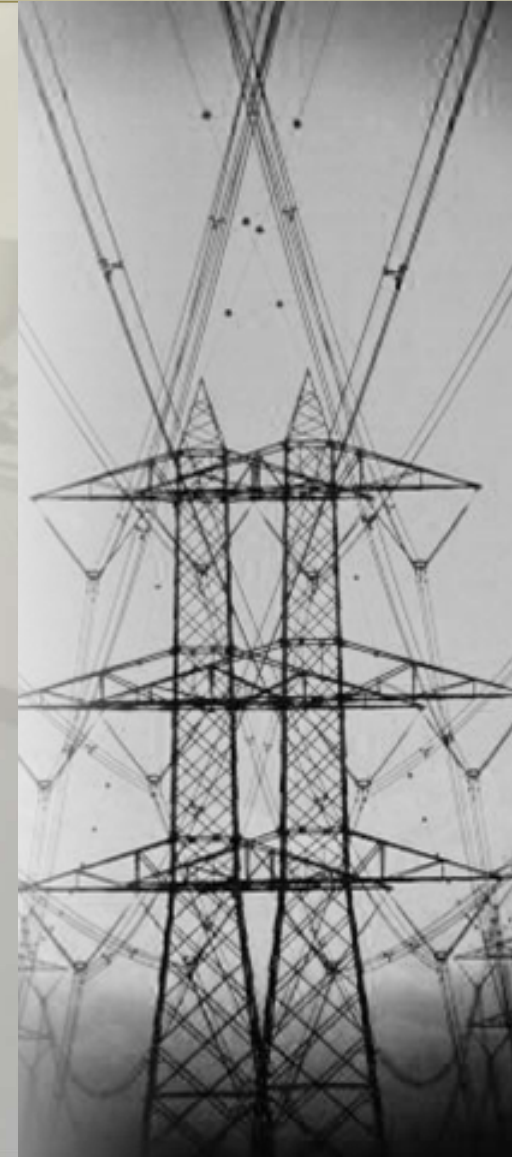
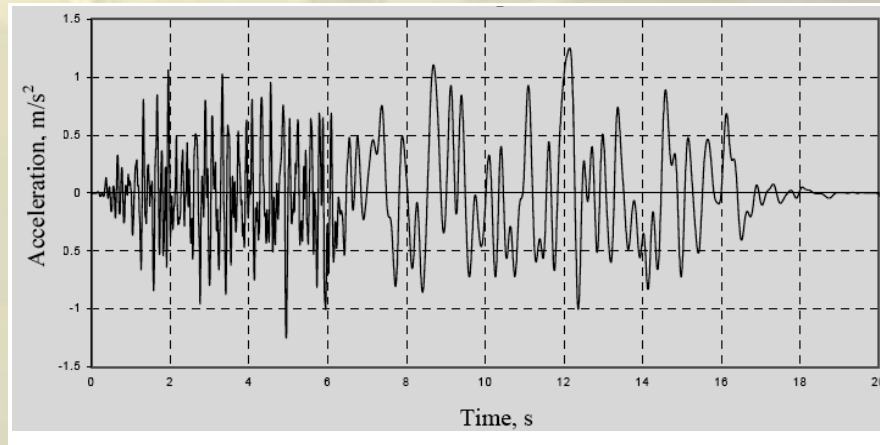
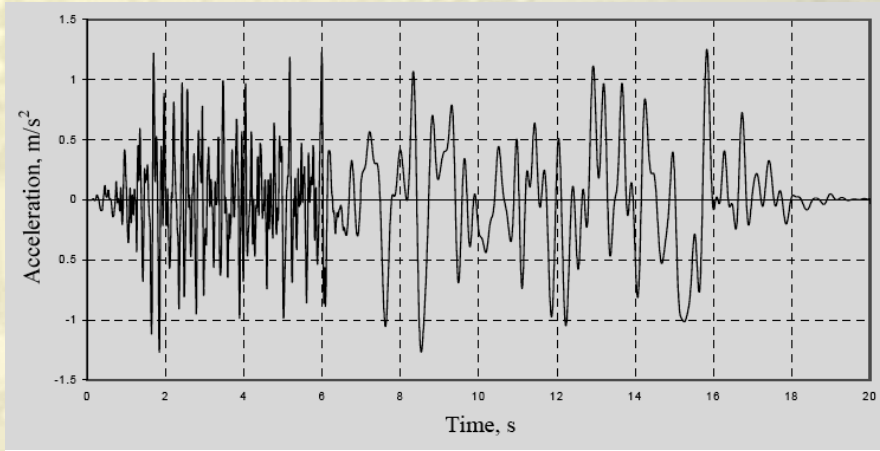


As an external impact, a three-component accelerogram of SSE level (safe shutdown earthquake) with magnitude quake-range of 7 according to MSK-64 scale was applied to a portal foot, see Fig.



# IOSO & ABAQUS

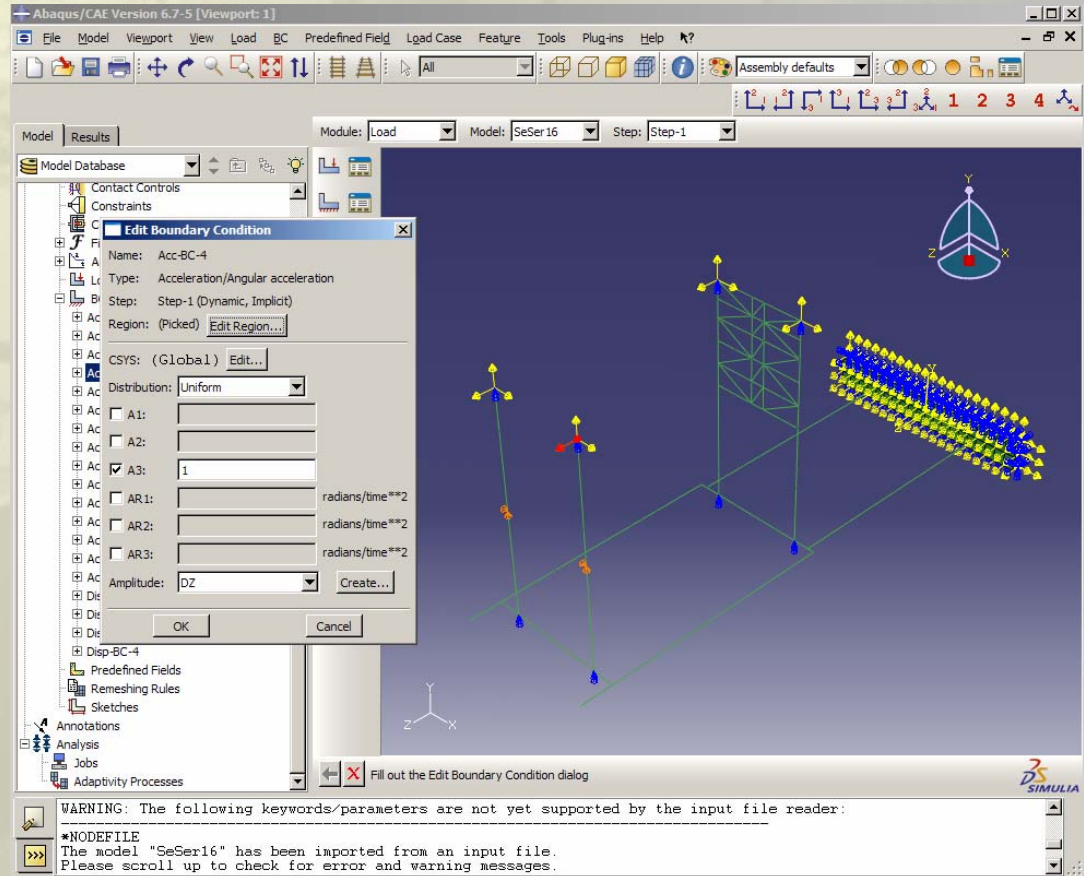
## Accelerograms





# IOSO & ABAQUS

## ABAQUS task statement



Abaqus/CAE Version 6.7-5 [Viewport: 1]

File Model Viewport View Load BC Predefined Field Lgad Case Feature Tools Plug-ins Help ?

Assembly defaults

Module: Load Model: SeSer16 Step: Step-1

Model Database

- Contact Controls
- Constraints
- CSYS
- Di
- Disp-BC-4
- Predefined Fields
- Remeshing Rules
- Sketches
- Annotations
- Analysis
- Jobs
- Adaptivity Processes

**Edit Boundary Condition**

Name: Acc-BC-4

Type: Acceleration/Angular acceleration

Step: Step-1 (Dynamic, Implicit)

Region: (Picked) [Edit Region...](#)

CSYS: (Global) [Edit...](#)

Distribution: Uniform

A1:

A2:

A3:

AR1:  radians/time\*\*2

AR2:  radians/time\*\*2

AR3:  radians/time\*\*2

Amplitude: DZ [Create...](#)

Fill out the Edit Boundary Condition dialog

WARNING: The following keywords/parameters are not yet supported by the input file reader:  
\*NODEFILE  
The model "SeSer16" has been imported from an input file.  
Please scroll up to check for error and warning messages.

SIMULIA

# IOSO & ABAQUS

## IOSO NM project

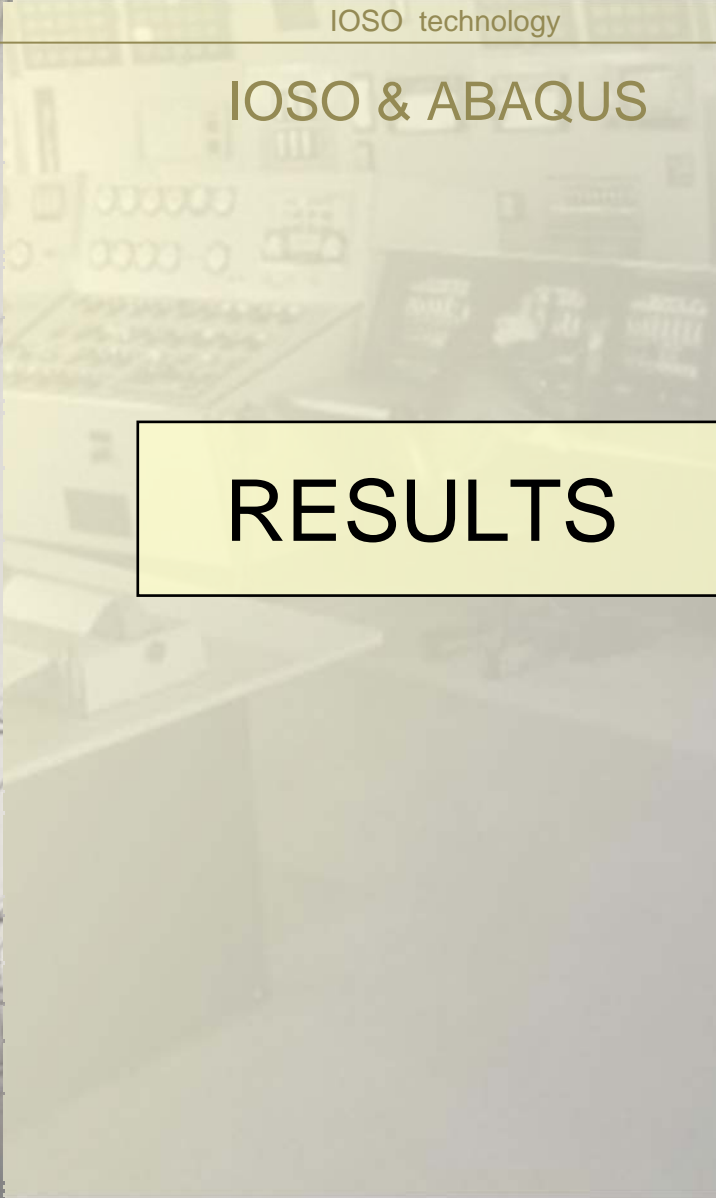
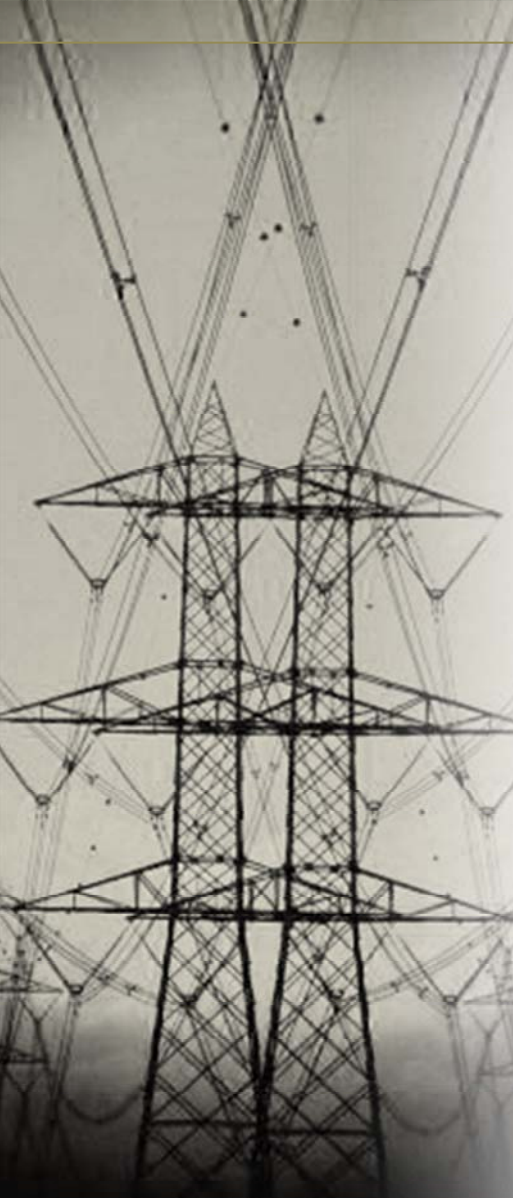
The screenshot displays the Atom software interface for the IOSO NM 1.1.0 project. The window title is "Atom [Task Task] - IOSO NM 1.1.0". The menu bar includes File, Edit, View, Format, Data, Project, Computation, and Help. The toolbar contains various icons for file operations and execution. Below the toolbar, the text "Project with automated data exchange" is visible.

The interface is divided into several sections:

- Left Panel:** A vertical sidebar with icons for Project Setting, Parametric Studies, Task Setting, Status, Results, and Log Protocol.
- File Explorer:** A tree view showing the project structure under "Computation Block". It includes folders for "Abaqus" and "Prevatric". The "Abaqus" folder contains sub-folders for "SeSer16\_In" and "SeSer16\_Out", each with files for "a\_VehBal", "b\_VehBal", "t\_VehBal", "a\_NizBal", and "b\_NizBal". Other files include "t\_NizBal", "k\_Spin1", "k\_Spin12", "k\_Spin2", "Start.bat", and "SeSer16\_Out". The "Prevatric" folder contains "SeSer16\_Out", "Fortr.exe", and "Rez".
- Flowchart:** A central workspace showing a sequence of tasks: "SeSer16\_In" (Start) → "Abaqus localhost" → "SeSer16\_Out" → "SeSer16\_Out" → "Prevatric localhost" → "Rez" (Stop). A red line highlights the connection between the two "SeSer16\_Out" boxes.
- Status Bar:** At the bottom, it shows "106/1000" and "Pareto: 6/20".

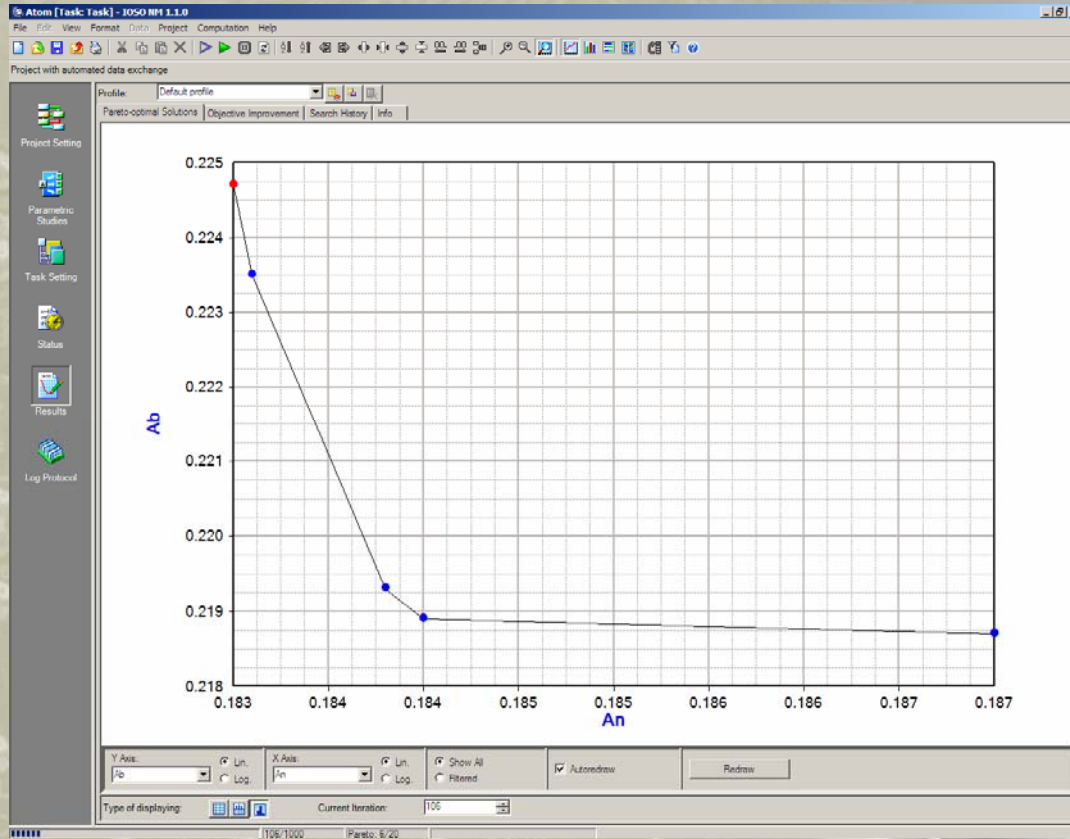
# IOSO & ABAQUS

## RESULTS



# IOSO & ABAQUS

Results Pareto  
Acceleration spectra envelopes

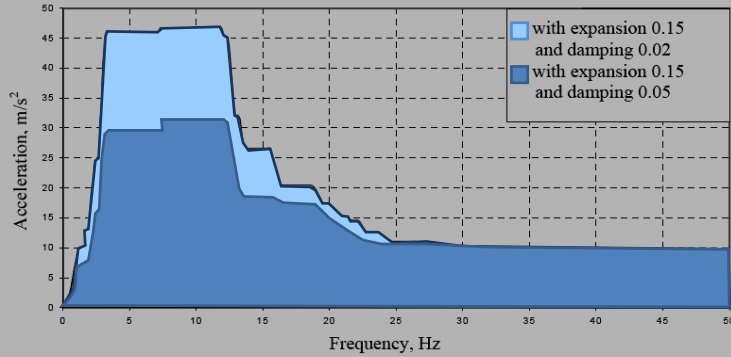


# IOSO & ABAQUS

## Results Pareto Acceleration spectra envelopes

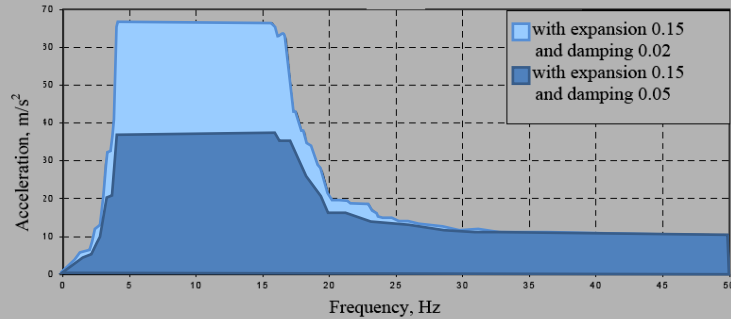
ZPA = 9.31

Y



ZPA = 9.86

Z



# IOSO & ABAQUS

## Conclusion

There are examples when without the use of the optimizer it is impossible to achieve necessary results. This is an example of such kind of work.

Application of IOSO NM leads to the reduction of the acceleration response spectra by 7-8 times and makes it possible to keep them in the appropriate limits.

