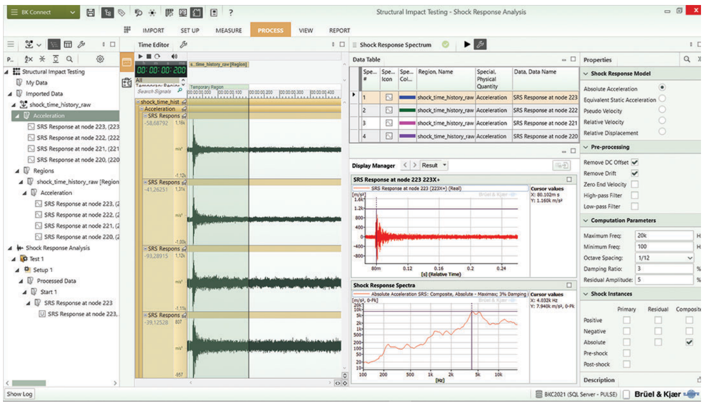
PRODUCT DATA

BK Connect Structural Dynamics

Shock Response Analysis Type 8429

A transient (shock) event, such as pyroshock or a structural impact, has the potential to damage components in a structural system. Just as with any motion input to a system, the response can be amplified by structural resonances, increasing the damage potential. BK Connect® Shock Response Analysis Type 8429 computes the shock response spectrum (SRS) from transients in the time domain in order to determine the damage potential of these transient events.



Uses

- Compute the SRS from transients in the time domain in order to determine the damage potential of transient events such as pyroshock
- Predominantly for the aerospace and defence industries, but applicable in any industry where a component or system must be proven to survive a known shock environment
- Test of shock-sensitive devices (a human in a vehicle, avionics, guidance equipment, etc.) to reveal the expected g forces to which these devices would be exposed
- Earthquake engineering

Features

- Import of acceleration, velocity and displacement transients. Velocity and displacement data are automatically differentiated to acceleration data before the SRS calculation
- Five shock response spectrum models: Absolute Acceleration, Equivalent Static Acceleration, Pseudo Velocity, Relative Velocity and Relative Displacement
- Preprocessing that includes DC removal, accelerometer drift correction and, for pyroshock applications, zero velocity change (forcing the end velocity of the input to zero before computing the shock response)
- Compatible with the ISO 18431-4:2007 standard for shock response analysis
- Ramp-invariant z-transform to reduce errors at high frequencies for pyroshock applications
- Dynamic oversampling, which reduces bias error and improves the accuracy of peak detection
- Determination of the velocity change during impact using the pseudo velocity shock response spectrum model

The SRS calculation

The aim of the SRS calculation is to convert motion input to a set of single-degree-of-freedom (SDOF) damped oscillator responses calculated in the time domain. The response amplitudes of the oscillators are plotted as a function of SDOF frequency to produce the SRS.

The frequency and damping values of the SRS calculation can be chosen from a priori knowledge of the test object. The frequencies are generally logarithmically spaced, typically with 1/n-octave spacing. The amplitudes of the SRS are derived from the individual SDOF responses (at user-defined frequencies) by taking the maximum response (positive, negative or absolute), either during the primary shock event (during forced motion), or during the residual response to the event (free response). Most commonly, the overall maximum response, which includes both primary and residual responses (termed “maximax”), is used.

All five SRS models mentioned in ISO 18431-4:2007 are implemented. With these five SRS models and nine standard criteria for amplitude calculation, you can configure up to 45 different response types for full flexibility to match your needs.

Use scenarios

SRS is used predominantly in the aerospace and defence industries, but is applicable in any industry where a component or system must be proven to survive a known shock environment. For example:

- Testing a component’s ability to survive a particular real-world shock event. The event is measured and the SRS derived, but the dynamic limits of the vibration test system may not allow the original shock to be reproduced in a controlled and repeatable way. The SRS from the real-world shock can be used to develop a new shock pulse with the same SRS, which can then be applied using a vibration test system. This is a technique known as Shock Response Synthesis, which is available in vibration control software such as LDS® $\text{LASER}_{\text{USB}}$™
- Redesigning a support structure to, for example, reduce weight. The objective is to ensure that components mounted to the support structure will be no more vulnerable to shock inputs than they were with the original design. This can be done by measuring the accelerations during a prescribed shock event and comparing the resulting SRS with those from the previous design. Tolerance curves generated from the original design can then be applied to the new design as an acceptance criterion
- Using the absolute SRS to reveal the expected g forces to which a shock-sensitive device would be exposed. To calculate the stresses in structures, the relative deflections of the springs of the different SDOFs need to be determined. Combined with the knowledge of spring stiffness, you can determine the stresses. The damage potential of structures has been claimed to be a function of the energy dissipated during impact. For this purpose, the velocity change during impact needs to be determined, which is most conveniently revealed in the pseudo velocity spectrum

System

SYSTEM REQUIREMENTS

- Operating System: Windows® 10 or 11, Pro or Enterprise, 64-bit, with either Current Branch (CB), Current Branch for Business (CBB), Semi-annual Channel (Targeted) or Semi-annual Channel servicing model
- Microsoft® Office that includes Microsoft Access®. This can be Office 2019 or 2021 (x32 or x64) or Microsoft 365® Desktop version (x32 or x64)
- Microsoft® SQL Server® 2019 or 2022 (**NOTE:** SQL Server 2022 Express included with software)

RECOMMENDED PC

- Intel® Core™ i9, 3 GHz processor or better
- 32 GB RAM
- 1 TB Solid State Drive (SSD) with 100 GB free space, or better
- 1 Gbit Ethernet network*
- Microsoft® Windows® 10 Pro or Enterprise (x64) with CB
- Microsoft® Office 2021
- Microsoft® SQL Server® 2022
- Screen resolution of 1920 × 1080 pixels (full HD)

Software Prerequisites

- BK Connect 2024.0 or later
- BK Connect Data Viewer Type 8400

Calculation and Analysis

Compatible with ISO 18431-4:2007

INPUT

Acceleration, velocity or displacement data. Automatic conversion of velocity and displacement data into acceleration data

PREPROCESSING

Time Editor: Select shock events from long time histories, allowing avoidance of contaminated data
Data Correction: Three user-selectable methods can automatically correct simple problems. Effects on the data are shown in graphical displays. Corrections are done in the following order:

- DC Offset Correction: Automatic removal of DC offsets from input data. Requires that the input record contains some data acquired before the shock starts. DC estimation is based on the average of the first 64 samples, with max. 5% of record
- Drift Correction: Accelerometer drift detected by recording some data past the shock when the acceleration should have reached zero again. Drift estimation uses an average of 64 samples at the end of the record. The whole time history will be corrected linearly for drift. The estimation does not include the shock pulse itself
- Zero Velocity Change (for pyroshock applications): When required, the end velocity after a shock is forced to zero by integrating the total time history to determine the velocity change over the complete record. This change is corrected for by adjusting the acceleration with a constant amount over the time history

SHOCK RESPONSE DIRECTION

Positive: Maximum in the positive direction
Negative: Minima (or maxima in the negative dir.)
Absolute: Maxima irrespective of direction

SHOCK RESPONSE INSTANCES

Primary: Computation during the shock (forced response)
Residual: Computation after the shock (free vibration)
Composite/Maximax: The worst case extrema for both instances. The composite shock response for the absolute maxima is the maximax. Nine combinations of the three shock directions and three shock instances available. One or more of these combinations can be selected at the same time. The resulting shock spectra will be overlaid in the preview display

SHOCK RESPONSE MODELS

All models in the ISO 18431-4 standard are implemented. Depending on application, select:

- Absolute Acceleration
- Equivalent Static Acceleration
- Relative Velocity
- Pseudo Velocity
- Relative Displacement

DAMPING RATIO SELECTION

A percentage of the critical damping. The value is a real number in the range [0.0, 100.0[% (that is, 100% value not allowed)
Sometimes expressed as a quality factor Q. Relation between values: *Q* = *1*/(*2** critical damping)

FREQUENCY SELECTION

Frequency Range: Start (f_{min}) and end (f_{max}) freq.
Density of Frequencies: Define density within range: 1/1-, 1/3-, 1/6-, 1/12-, 1/24- or 1/48-octave.
Standard fractional octave band centre frequencies supported

RESIDUAL AMPLITUDE

Value used to automatically determine the end of the shock in a time history. The record is scanned for the max. input and when the magnitude falls for the last time below the given percentage of that max., the shock is considered over and the search for residual results will start from that time value

GRAPHICAL FEEDBACK

Preview preprocessed acceleration time history and shock response for the selected model, frequency range and damping
Interactivity: Graphs update when any parameter changes
Axis: View frequency axis as a logarithmic of linear axis. The SRS shown on a linear or logarithmic axis

UNIT SYSTEMS

User-definable in displays
Defaults: Acceleration shown in g, velocity in in/s, displacement in inches

* For data acquisition: A dedicated data acquisition network (LAN or WAN) is recommended. A network that only handles data from the front end improves the stability of the data.

Ordering Information

Type 8429-X* **BK Connect Shock Response Analysis**

PREREQUISITE
Type 8400-X* BK Connect Data Viewer

SOFTWARE MAINTENANCE AND SUPPORT
M1-8429-X* Agreement for Type 8429

Other BK Connect Products

For an overview of all HBK Structural Dynamics applications, visit the Structural Dynamics solutions page. For an overview of BK Connect Core software, visit the BK Connect page.

* X = licence model, either N (node-locked) or F (floating)

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