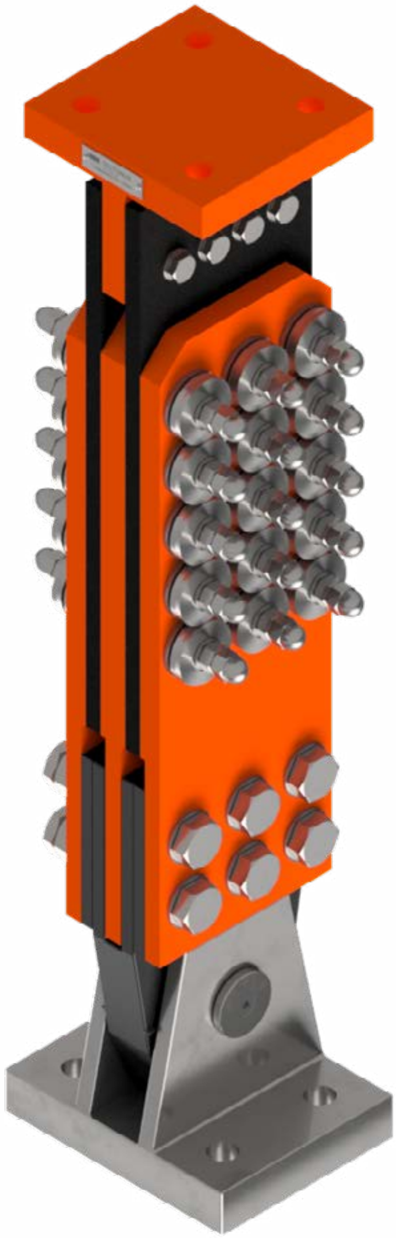
TECTONUS
RESILIENT SEISMIC SOLUTIONS

DFFJ DAMPER

High damping, extremely durable,
cost effective, great for new & retrofit.

INTRODUCTION & DESIGN GUIDE



DAMAGE FREE FRICTION JOINT (DFFJ)

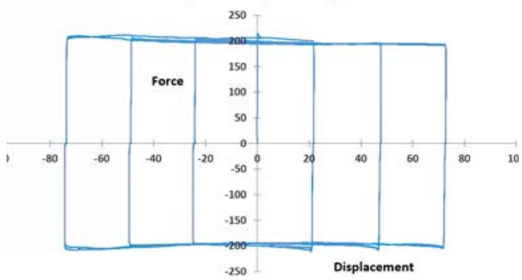
A friction damper optimized with Tectonus technology

High Damping
Stable Load Deformation
Reliable & Durable

Friction dampers have the advantage of providing very high levels of damping without any yielding components. This means that they can provide stable and repeatable load-deformation behavior without need for replacement.

Depending on the friction surface technology used, the dynamic performance of these dampers can be predictable and stable for the range of frequencies that are typical of earthquake events. However, friction dampers can suffer performance issues due to friction surface degradation and loss of clamping force.

The Tectonus DFFJ overcomes this by application of a proprietary surface layer to the steel plates and use of disc springs which maintains clamping force in the event of any friction surface degradation.



TECTONUS RANGE

DFFJ and RSFJ dampers can be used in parallel to achieve both resiliency and high damping.

DFFJ

Damage Free Friction Joint

High damping (up to 50%)

Cost effective

Fast leadtime

For low damage buildings

RSFJ

Resilient Slip Friction Joint

True self-centering behavior

Damping 15-20%

Near zero residual drift

For ultimate seismic resilience

PROJECTS

AGRESEARCH

- **Location:** Lincoln, New Zealand
- **Engineers:** BECA
- **Application:** CLT shear walls
- **Installed:** 2021

ASHBURTON CIVIC CENTRE

- **Location:** Ashburton, New Zealand
- **Engineers:** BECA
- **Application:** CLT shear walls
- **Installed:** 2021

66 OXFORD TERRACE

- **Location:** Christchurch, New Zealand
- **Engineers:** Structure Design
- **Application:** Retrofit concrete walls with DFFJ and RSFJ
- **Installed:** 2022

BAYFAIR SHOPPING CENTRE

- **Location:** Tauranga, New Zealand
- **Engineers:** BCD Group
- **Application:** Steel Brace Retrofit
- **Installed:** 2023

DFFJ DEVICE COMPONENT TEST DYNAMIC PERFORMANCE (as per EN15129)

Background

The efficiency of friction-based dampers depends on stable frictional resistance on the sliding surfaces to provide reliable energy dissipation. Providing consistent performance has been one of the challenges with friction-based dampers, given possible strength degradation due to surface erosion and wearing under cyclic loads or dependency of the interface coefficient of friction to the sliding velocity under dynamic loads (dictated by the building frequency during an earthquake).

The Tectonus DFFJ is not based on the conventional steel-on-steel arrangement of plates. There is a unique frictional surface incorporated which does not rust, is highly heat-resistant, has outstanding resistance to wear, excellent stability and high durability.

To demonstrate this, the dynamic performance of Tectonus DFFJ was tested at the Structures Lab of Auckland University of Technology (AUT). Tests were witnessed by an independent Chartered Professional Engineer who is also a member of the New Zealand Society of Earthquake Engineering (NZSEE).

Test Specifications

The Tectonus damping device tested comprised of 2 bolts with a capacity of about 60 kN/13.5 Kip. The loading protocol was specified as per EN15129 providing a rigorous testing regime (more severe than ASCE7-16 given the higher number of averaged full cycles) to verify the dynamic performance of the device.

The number and amplitudes of the loading cycles were as follows:

- 5 cycles at +/- 6.25mm (25% of the maximum displacement)
- 5 cycles at +/- 12.5mm (50%)
- 10 cycles at +/- 25mm (100%)

The testing program included four different tests with the following sequences and frequencies. The quasi-static tests were performed at five full cycles and the dynamic tests as per the above loading protocol:

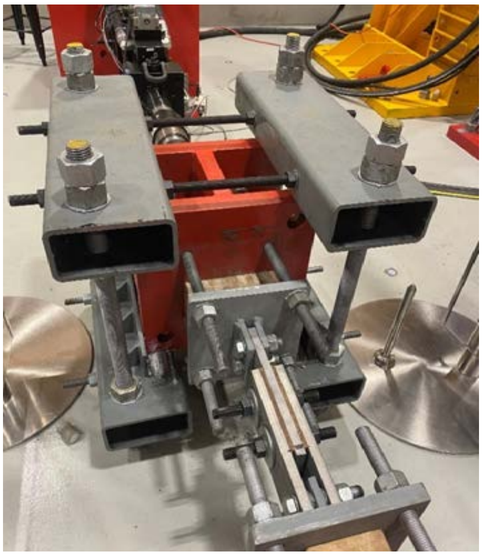
- Test #1: Quasi-static at 0.1Hz
- Test #2: Quasi-static at 0.2Hz
- Test #3: Dynamic at 1.0Hz
- Test #4: Dynamic at 2.0Hz

Dynamic Testing Results

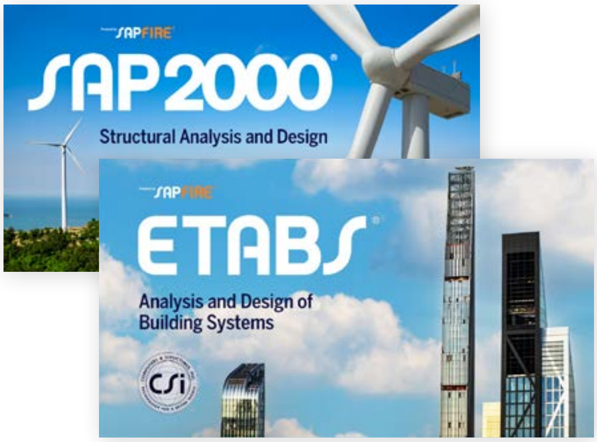
The results of the device dynamic performance (at 1.0 & 2.0 Hz) and quasi-static performance (at 0.1 & 0.2 Hz) are presented demonstrating the compatibility of the hysteresis curves after simulated severe events without stiffness and strength degradation.

Comparing the dynamic testing with quasi-static shows the velocity independence of the Tectonus DFFJ performance.

A full test report is available upon request.



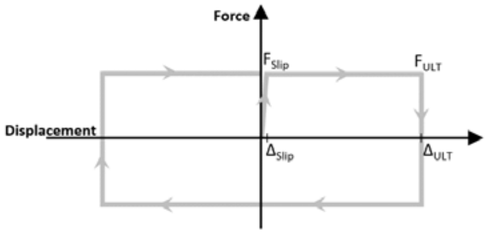
STRUCTURAL MODELING GUIDE



Tectonus DFFJ can be integrated in ETABS and SAP2000 structural analysis and design software.

This allows engineers and designers to accurately calibrate the parameters according to the requirements of the project.

In ETABS/SAP2000, two methods can be used to model the Tectonus DFFJ, both of which yield similar results in terms of performance and hysteretic response. These functions accurately represent the hysteresis of a device provided that their parameters are properly calibrated in accordance with the design parameters of the Tectonus DFFJ.



The design parameters of Tectonus DFFJ are:

F_{slip} Slip force of the device

F_{ult} Ultimate force of the device

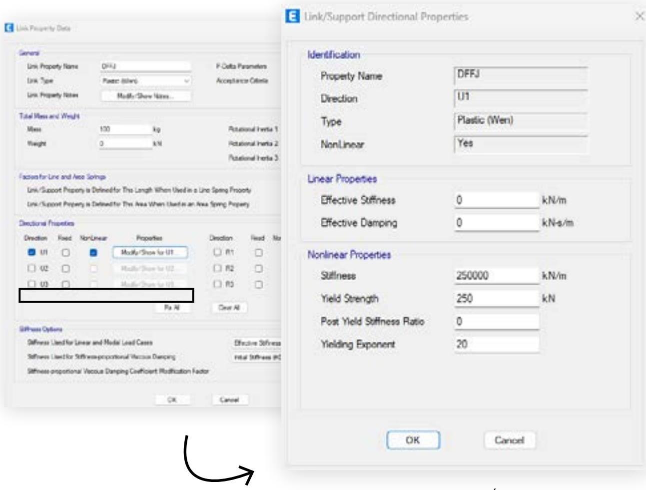
Δ_{slip} Initial elastic deflection of the device before slip

Δ_{ult} Ultimate displacement of the device

Modelling using the Plastic-Wen link element:

Tectonus DFFJ can be accurately modeled via the non-linear "Plastic (Wen)" link. The respective degree of freedom should be designated (U1 is selected if the device functions axially) and under the non-linear properties the device parameters must be entered as follows:

- Stiffness = F_{slip} / Δ_{slip}
- Yield Strength = F_{Slip}
- Post Yield Stiffness Ratio = 0.0
- Yielding Exponent = 20

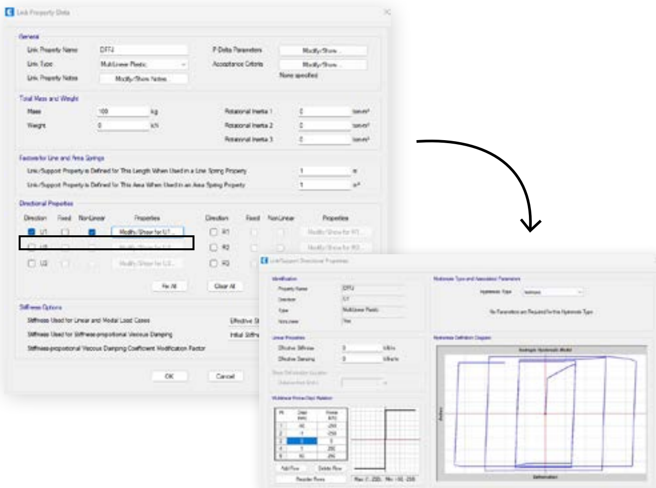


Note: Screenshot of ETABS/SAP2000 windows with imperial units is not shown.

Modelling using the Multi-linear Plastic link element:

Tectonus DFFJ can be accurately modeled via the non-linear "Multi-linear Plastic" link. The respective degree of freedom should be designated (U1 is selected if the device functions axially) and under the non-linear properties "Isotropic" hysteresis type must be selected while entering the required device parameters into the Force-Displacement relation table as follow:

Pt	Displacement (mm)	Force (kN)
1	$-\Delta_{ULT}$	$-F_{ULT}$
2	$-\Delta_{Slip}$	$-F_{Slip}$
3	0	0
4	Δ_{Slip}	F_{Slip}
5	Δ_{ULT}	F_{ULT}



BRACE DAMPER

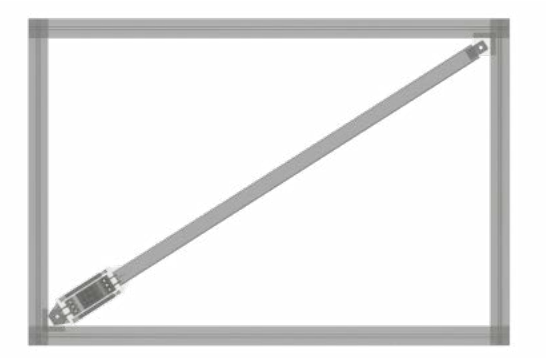
Product Code*	Capacity		Design Dispalcement range****	
	kN	kips	mm	inch
DFFJ-BR-50**	50	10	± 25 to 300	1 to 12
DFFJ-BR-100	100	20	± 25 to 300	1 to 12
DFFJ-BR-150	150	35	± 25 to 300	1 to 12
DFFJ-BR-200	200	45	± 25 to 300	1 to 12
DFFJ-BR-250	250	55	± 25 to 300	1 to 12
DFFJ-BR-300	300	65	± 25 to 300	1 to 12
DFFJ-BR-350	350	80	± 25 to 300	1 to 12
DFFJ-BR-400	400	90	± 29 to 300	1 to 12
DFFJ-BR-450	450	100	± 25 to 300	1 to 12
DFFJ-BR-500	500	110	± 25 to 300	1 to 12
DFFJ-BR-550	550	125	± 25 to 300	1 to 12
DFFJ-BR-600	600	135	± 25 to 300	1 to 12
DFFJ-BR-650	650	145	± 34 to 300	1 to 12
DFFJ-BR-700	700	155	± 25 to 300	1 to 12
DFFJ-BR-750	750	170	± 25 to 300	1 to 12
DFFJ-BR-800	800	180	± 25 to 300	1 to 12
DFFJ-BR-850	850	190	± 25 to 300	1 to 12
DFFJ-BR-900	900	200	± 25 to 300	1 to 12
DFFJ-BR-950	950	215	± 25 to 300	1 to 12
DFFJ-BR-1000 ****	1000	225	± 25 to 300	1 to 12

** The DFFJ-BR range has equal displacement in tension and compression*

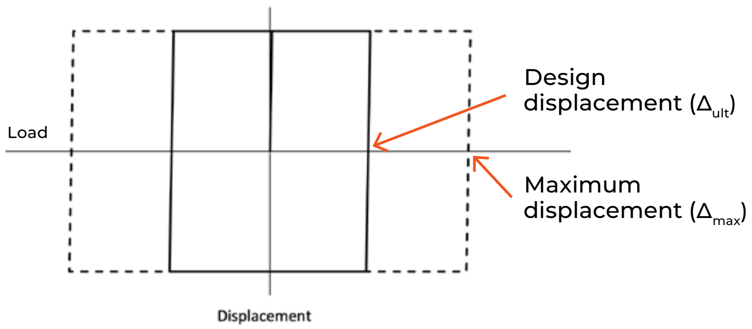
*** The design displacement can be specified*

**** The Maximum Displacement available in the device is typically twice the specified design displacment*

***** For design capacities above 1000 kN, customized devices can be desgined (at no extra cost) and/or multiple devices can be used in parallel*



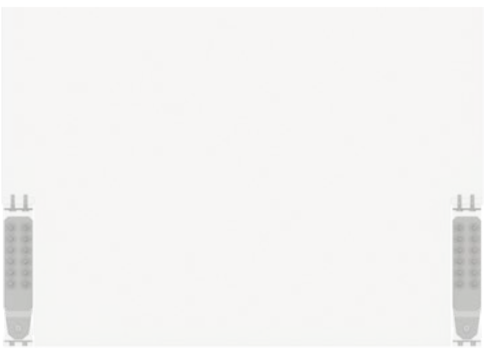
Tectonus DFFJ-BR range can be installed in parallel to increase the capacity of the brace. Customized DFFJs with Fslip>1000 kN can be designed according to the requirements of the project.



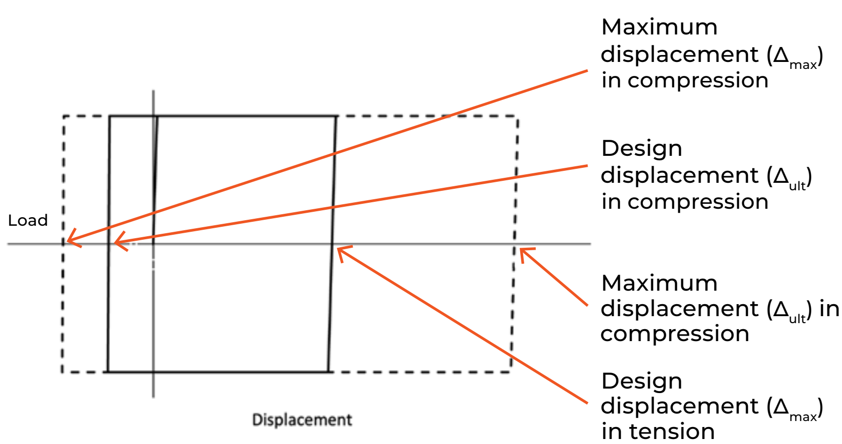
SHEARWALL DAMPER

Product Code*	Capacity		Design Dispalcement range****	
	kN	kips	mm	inch
DFFJ-SW-50***	50	10	± 25 to 300	1 to 12
DFFJ-SW-100	100	20	± 25 to 300	1 to 12
DFFJ-SW-150	150	35	± 25 to 300	1 to 12
DFFJ-SW-200	200	45	± 25 to 300	1 to 12
DFFJ-SW-250	250	55	± 25 to 300	1 to 12
DFFJ-SW-300	300	65	± 25 to 300	1 to 12
DFFJ-SW-350	350	80	± 25 to 300	1 to 12
DFFJ-SW-400	400	90	± 25 to 300	1 to 12
DFFJ-SW-450	450	100	± 25 to 300	1 to 12
DFFJ-SW-500	500	110	± 25 to 300	1 to 12
DFFJ-SW-550	550	125	± 25 to 300	1 to 12
DFFJ-SW-600	600	135	± 25 to 300	1 to 12
DFFJ-SW-650	650	145	± 25 to 300	1 to 12
DFFJ-SW-700	700	155	± 25 to 300	1 to 12
DFFJ-SW-750	750	170	± 25 to 300	1 to 12
DFFJ-SW-800	800	180	± 25 to 300	1 to 12
DFFJ-SW-850	850	190	± 25 to 300	1 to 12
DFFJ-SW-900	900	200	± 25 to 300	1 to 12
DFFJ-SW-950	950	215	± 25 to 300	1 to 12
DFFJ-SW-1000 *****	1000	225	± 25 to 300	1 to 12

** The DFFJ-SW range is typically specifed for shear wall applications and has a swivel bearing to provide out-of-plane displacement compatibility*
*** The DFFJ-SW range has higher displacement in tension and lower in compression to be used as shear wall applications*
**** The design displacement can be specified*
***** The Maximum Displacement available in the device is typically twice the specified design displacments in tension and compression*
****** For design capacities above 1000 kN, customized devices can be desgined (at no extra cost) and/or multiple devices can be used in parallel*



The Tectonus DFFJ-SW range can be installed in parallel to increase the capacity of the hold-down. Customized DFFJs with Fslip>1000 kN can be designed according to the requirements of the project.



TECTONUS
RESILIENT SEISMIC SOLUTIONS

Specialists in seismic engineering, we are driven to set a higher standard for earthquake resilience. Let's work together to make our cities and communities safer.

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