RETROFITTING REINFORCED CONCRETE STRUCTURES

In lack of suitable seismic code, existing reinforced concrete structures had been traditionally designed for gravity forces only. These “pre-code” structures thus exhibit high vulnerability, i.e. low lateral resistance and limited ductility. Buckling Restrained Braces (BRBs) can be added to the existing structure as a secondary, seismic retrofit system, dissipating a large amount of seismic energy. By adding BRBs, deformations can be well distributed and damages can be significantly reduced throughout the building. Stiffness is added to the existing structure with no significant weight increase. Based on several studies, it is confirmed that BRB-retrofitted buildings can provide a cost-efficient alternative and perform better under strong earthquakes than conventional solutions, such as concrete jacketing or adding shear walls.

NEWLY ERECTED REINFORCED CONCRETE STRUCTURES

Buckling Restrained Braces (BRBs) can be installed in newly designed and erected reinforced concrete buildings and bridge structures to provide superior performance in moderate to severe seismic actions. BRBs are also applicable in highrise buildings, used as outrigger braces in order to transfer significant seismic forces to perimeter columns, linked to the concrete core. BRBs can not only reduce overall structural costs but also control structural damages. Star Seismic BRBs can withstand multiple design level earthquakes, therefore their replacement is typically not necessary after an extreme seismic event with several large aftershocks. Even in case repair work becomes unavoidable, its process is superior with respect to cost-efficiency and it is less time-consuming, compared to the replacement of a damaged shear wall.
RETROFITTING STEEL STRUCTURES

Buckling Restrained Braces (BRBs) are ideal for retrofitting seismically deficient “pre-code” or “low-code” steel structures. BRBs remarkably increase horizontal stiffness, strength, ductility and equivalent viscous damping of existing steel structures. BRBs are a viable option of supplemental bracing systems because of their stable energy dissipation capacity especially under moderate-to-high magnitude earthquakes, both in tension and in compression. Detailed non-linear analyses have demonstrated superior performance and extreme cost-efficiency.

NEWLY ERECTED STEEL STRUCTURES

As for steel structures erected in the last decades, with tens of thousands of Buckling Restrained Braces (BRBs) used around the world's most seismic prone regions, it is proven that the most rigorous seismic demands can cost-efficiently be satisfied. Using BRBs, not only seismic performance can be raised to the highest levels, but also significant time savings can be realized. Properly designed steel structures with BRBs will be capable of serving the community after a large earthquake with minimal disruption. Structural, non-structural and also inventory damages can be lowered with BRBs, such as expensive IT servers, medical equipment, etc.
BUCKLING RESTRAINED BRACED FRAME SYSTEM

Buckling Restrained Braced Frames (BRBF) offer an alternative to conventional braced frames which surpasses their energy dissipation capacity and thus is cost-effective. Excluding the buckling phenomenon - that is the basic idea of BRB - leads to a balanced, extremely ductile and dissipative cyclic behavior as illustrated below.

Three major components can be distinguished in the cross-section:
- steel core,
- bond-preventing layer and
- casing.

The bond-preventing layer decouples the casing from the core. Accordingly, the axial load of the brace is transmitted by the steel core only, while the casing - through its flexural rigidity - provides the proper lateral support against flexural buckling of the core.

The steel core is to resist the full axial force developed in the bracing. Along its length the core can be divided into three parts: the middle, so-called yielding length and the rigid, non-yielding parts on both ends. Increased cross-section of the non-yielding part ensures that it remains elastic, and thus plasticity is concentrated in the middle part of the steel core. Such configuration provides high confidence in prediction of the element behavior and failure.

The casing is made of concrete filled steel tubes. The design criterion for the casing is to provide adequate lateral restraint against the steel core buckling.

SECTIONS OF A BRB

COMPARISON OF CONVENTIONAL BRACED FRAMES (CBF) AND BUCKLING RESTRAINED BRACED FRAMES (BRBF)

THE CONCEPT OF BRB

OUR PRODUCTS

Star Seismic Europe’s Powercat pinned products allow the quickest and easiest building erection, with reduced material costs and man-hours associated with welding and crane time.

Wildcat BRBs are connected to the superstructure by field welds. Wildcat products are also available with connection plates, so they can be bolted to the superstructure, therefore field weld can be omitted.

No welding in the yielding region eliminates shrinkage stress

A choice of round or square configurations

Proprietary collars for stable connections

Radiused copes minimize crack propagation
COST-SAVING

Comparative studies as well as completed construction projects confirm the financial advantages of Buckling Restrained Braced Frame (BRBF) system, which can be superior to other common structures with global respect to cost efficiency due to the following reasons:

- High energy dissipation,
- High behavior/response modification factor,
- Low seismic loads,
- Smaller column and beam sections due to the lower seismic demand,
- Lower forces on foundations – cheaper foundation,
- Smaller and simpler connections,
- Lower seismic damages – lower losses,
- Easy and fast erection,
- Easy-to-adopt in seismic retrofitting,
- Easy post-earthquake investigation and replacement if needed.

Testing shows that Star Seismic BRBs are engineered to withstand multiple seismic events without significant damages. However, if a brace is selected for replacement, Star Seismic braces are significantly easier and less expensive to replace than shear walls, moment frames, columns, beams or link elements of eccentrically braced frames.

CERTIFICATES

Thanks to the extensive international cooperation with various institutes and industrial partners throughout the world, appropriateness of BRB elements and BRBF structures is deeply confirmed.

Austrian Standards plus GmbH, No. 0988-CPD-0817 certificate attests that all provisions concerning the attestation of conformity and the performances described in the Annex ZA of the standard EN 15129 (Anti-seismic devices) were applied and that Star Seismic Europe’s Buckling Restrained Braces fulfill all the prescribed requirements which entitle the manufacturer to affix the CE marking. CE affirms that a product is in conformity with European standards for safety, public health and consumer protection.

Our products are produced in ISO 9001, ISO 14001 and AS9100D-certified factory.

Test results of our Buckling Restrained Braces are also in compliance with the standards found in Appendix T of ANSI/AISC 341-05.
CONTACT

Enquiries from Europe and select markets in Central Asia, the Middle East and Africa:

Star Seismic Europe Ltd.
Budapest, Hungary
Managing Director: Zoltan Bago: zbago@starseismic.eu
+36 30 630 3037
www.starseismic.eu
General information: info@starseismic.eu
Design and engineering information: design@starseismic.eu

Istanbul, Turkey
Ömer Ülker: oulker@ulkermuhendislik.com.tr
+90 216 368 7541
www.ulkermuhendislik.com.tr

Enquiries from North America, Africa and Asia:

Star Seismic LLC
Park City, Utah, USA
Managing Partner: Argan Johnson, P.E.: arganj@starseismic.net
Managing Partner: Steve Powell, S.E.: stevep@starseismic.net
+1 435 940 9222
www.starseismic.net
brb@starseismic.net

Enquiries from Latin America:

Star Seismic Latin America
Mexico City, Mexico
Managing Director: Cesar Mendez Franco, SC: cmf@cesarmendezfranco-sc.com
+52 55 5663 14 90
www.cesarmendezfranco-sc.com