

Seismic Rehabilitation & Retrofit of Structures
in the Central U.S.

***2001 Retrofit and Preservation of the
National Civil Rights Museum
Memphis, Tennessee***

2012 EERI Annual Meeting/
National Earthquake Conference
Memphis, TN
April 13, 2012

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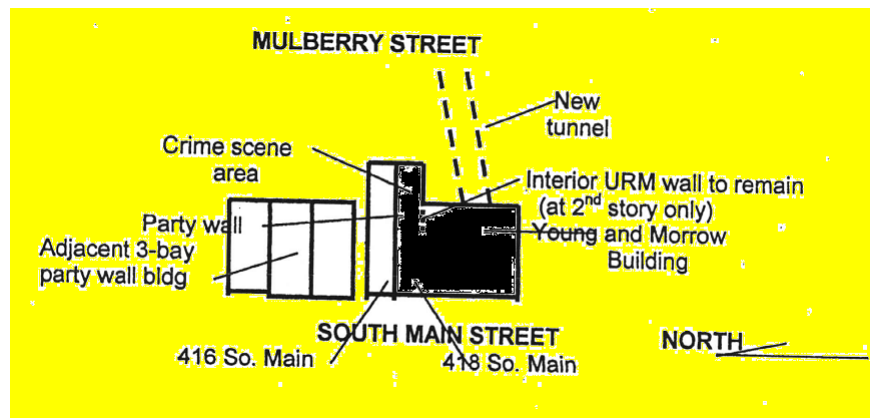
CLIENT

- **National Civil Rights Museum**
- **Principal funding from the Hyde Foundation**
 - Heavy influence of Pitt Hyde/founder of AutoZone – and Foundation executive John Pontius
 - Both with track record of being cognitive and proactive relative to Memphis area seismic risk

DESIGN TEAM

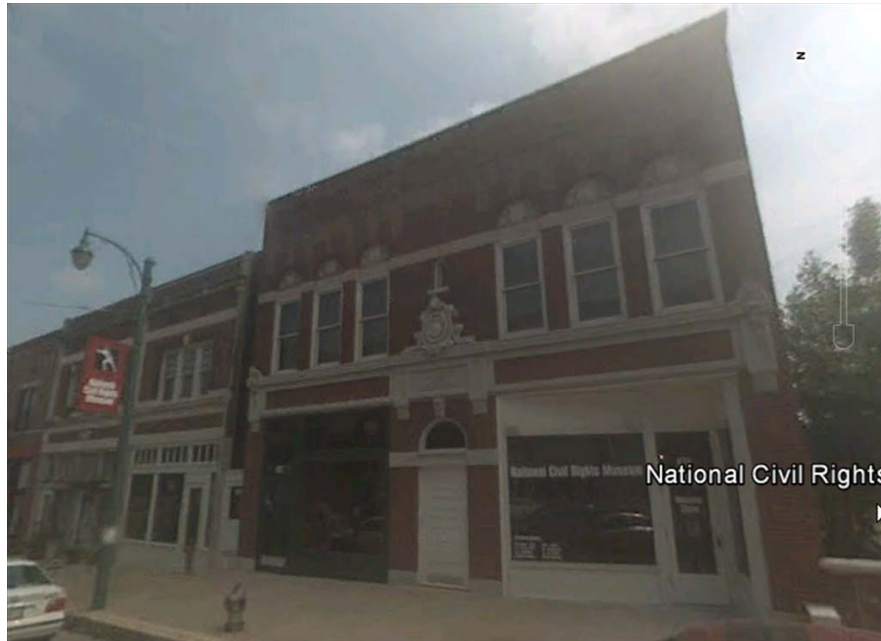
- **ARCHITECTURE**
 - Looney Ricks Kiss, Memphis, TN – Architects
 - Self Tucker Architects, Memphis, TN
- **EXHIBIT/MUSEUM DESIGN**
 - Ralph Applebaum & Associates, New York City
- **STRUCTURAL CONSULTANT**
 - Stanley D. Lindsey & Associates, Nashville, TN
 - Structural Engineer-of-Record:
Richard W/. Howe, PE
(now R.W. Howe & Associates – Memphis, TN)





418 South Main – artist Ellis Chapelle
416 South Main – artists Greely & Tracy Myatt





Seismic Considerations & Challenges

- Historic Preservation Issues
 - National Register's South Main Historic District
 - National Civil Rights Museum (NCRM) – national museum occupancy with delicate historical context and exhibits including finishes and partition walls in the crime scene
- Multiple Structures – all classic open storefront URM's with *party walls*
- Multiple Ownership – privately owned contiguous property (*joined by party wall*)

Seismic Considerations & Challenges (cont.)

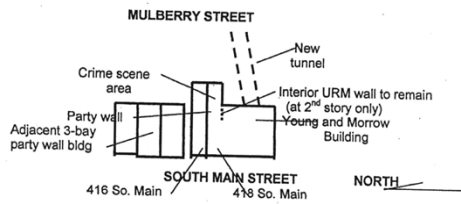
- Building code interpretation – seismic and historic
- Appropriate design standards
- “New Buildings” or “Existing Buildings”
- Seismic objectives and levels of ground motion
- Multiple seismic lateral force-resisting schemes/systems
- Highly perforated existing URM walls

Seismic Considerations & Challenges (cont.)

- Multiple technologies for URM walls, including MR steel frames w/stud wall brick “veneer” back up, shotcrete, adhesives and stainless steel helical anchors (**Helifix**)
- Sequence of general interior demolition vs. strengthening and bracing of historic walls/facade to remain
- Budget constraints (including constraints on *building materials assessment* and *design fees* thus precluding sophisticated structural/seismic analysis and design)

Design Concept

Stiffness of lateral force resisting systems compatible with that of existing elements that must remain due to historical



East-West (front-to-back) – stiff

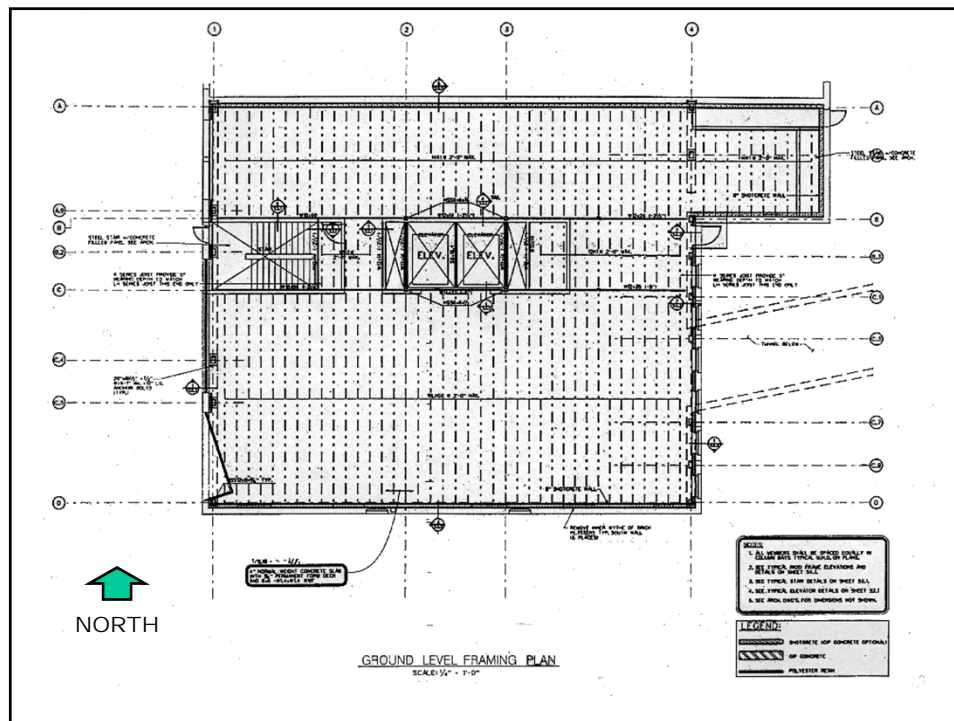
- Reinforced concrete – shotcrete techniques– HeliFix anchors
- Load-bearing walls

North-South (transverse)– no stiffness – seismic “weak story” parapet wall w/terra cotta

- Moment-resisting steel frames
- **HeliFix** masonry stitching and anchors

Basement wall girder-type foundations not load-bearing

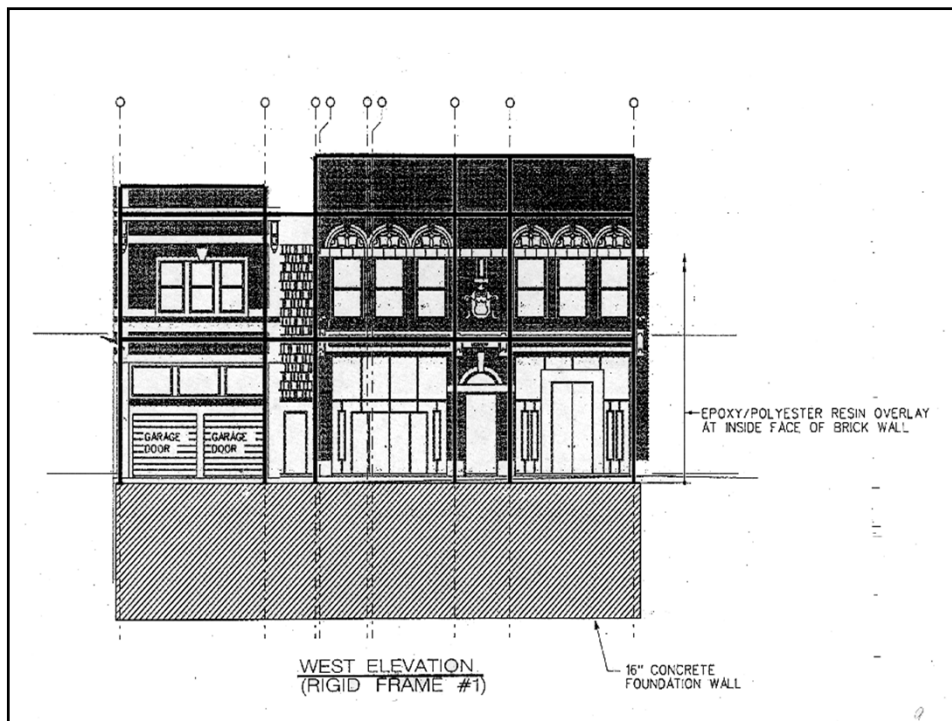
- Historical considerations
- Legal conflicts

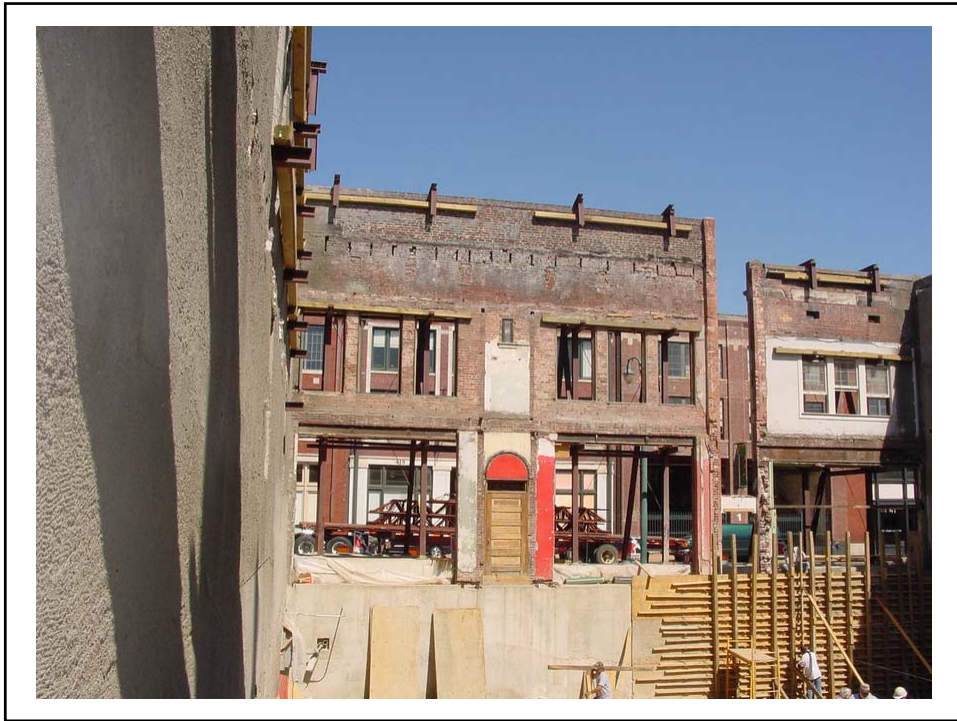


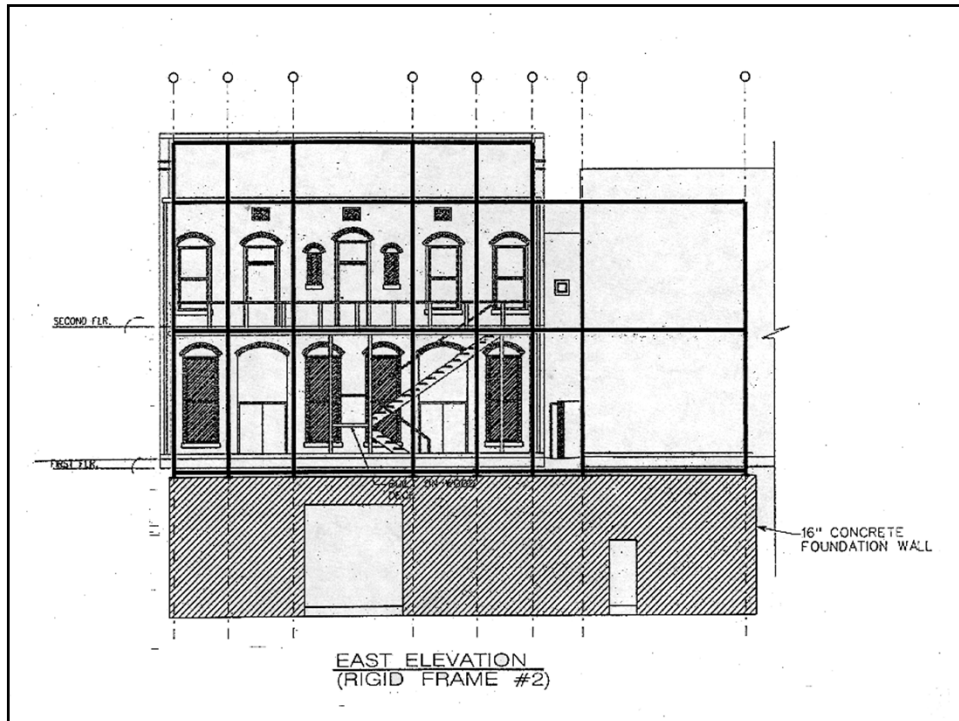
Design Approach

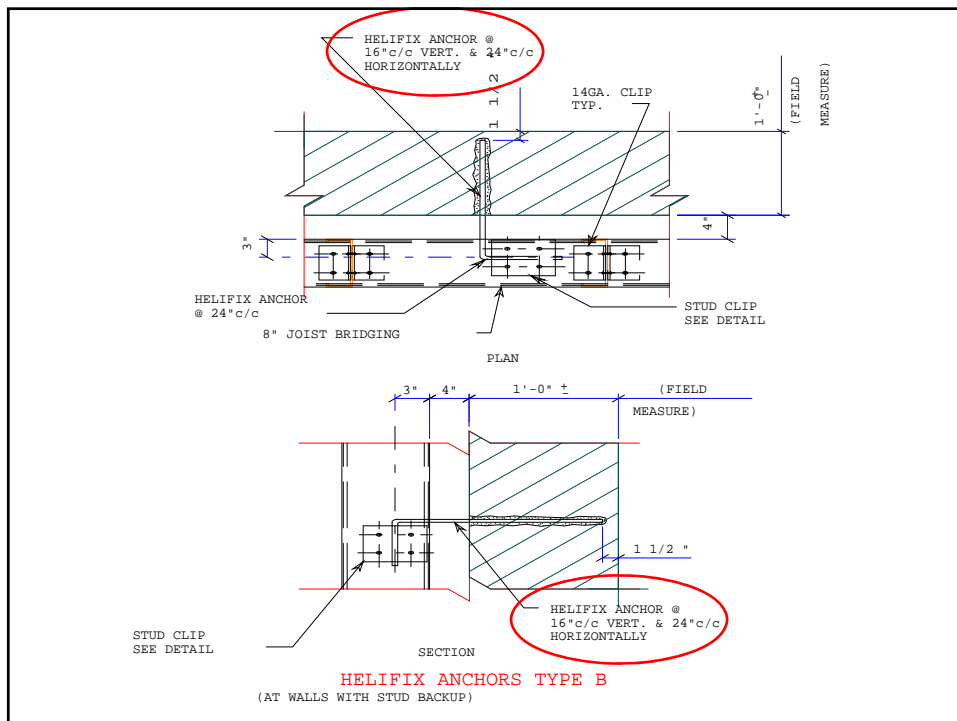
Transverse Direction (N-S)

- Combination special (ductile) moment frame and ductile out-of-plane shotcrete walls
- Inertial forces from adjacent building considered
- Inertial forces from other buildings not included due to assumed brittle behavior
- Special confinement detail for out-of-plane ductility
- Moment frames resist >25% of lateral loads





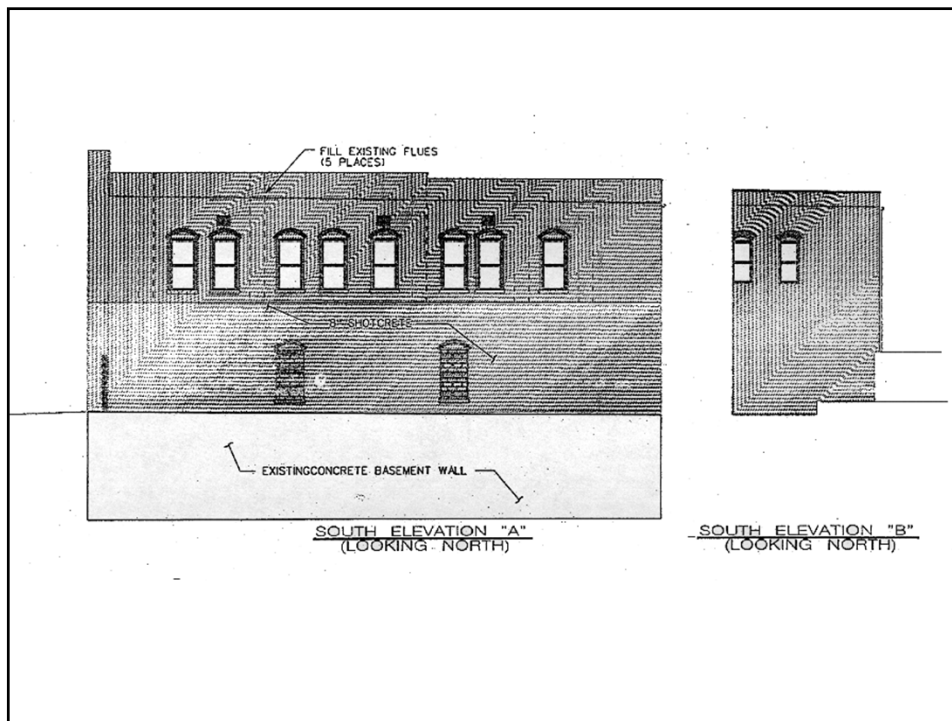


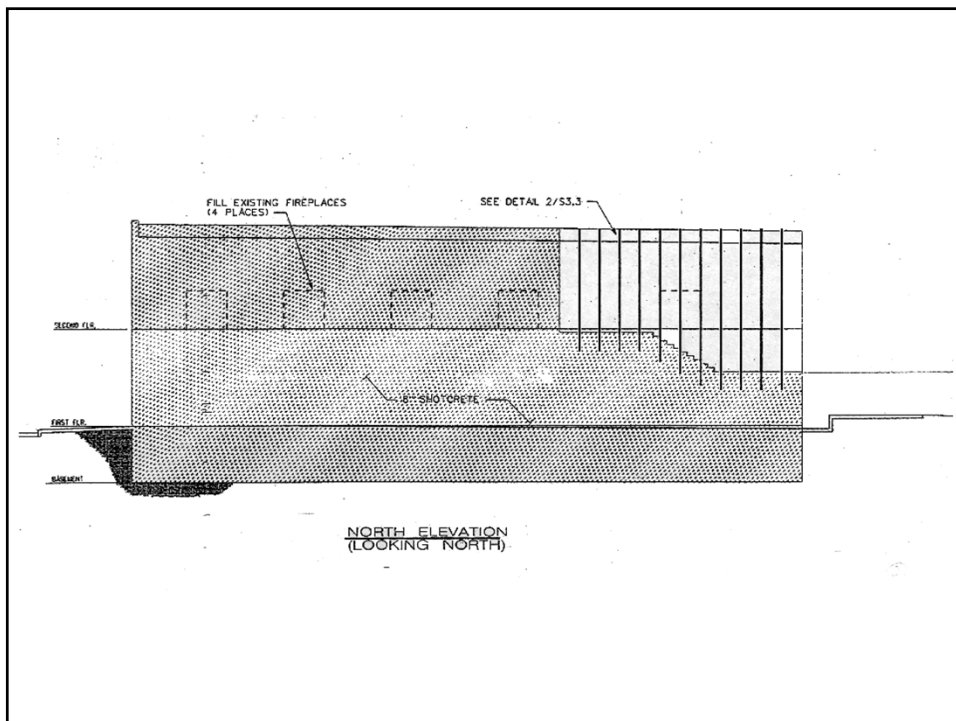


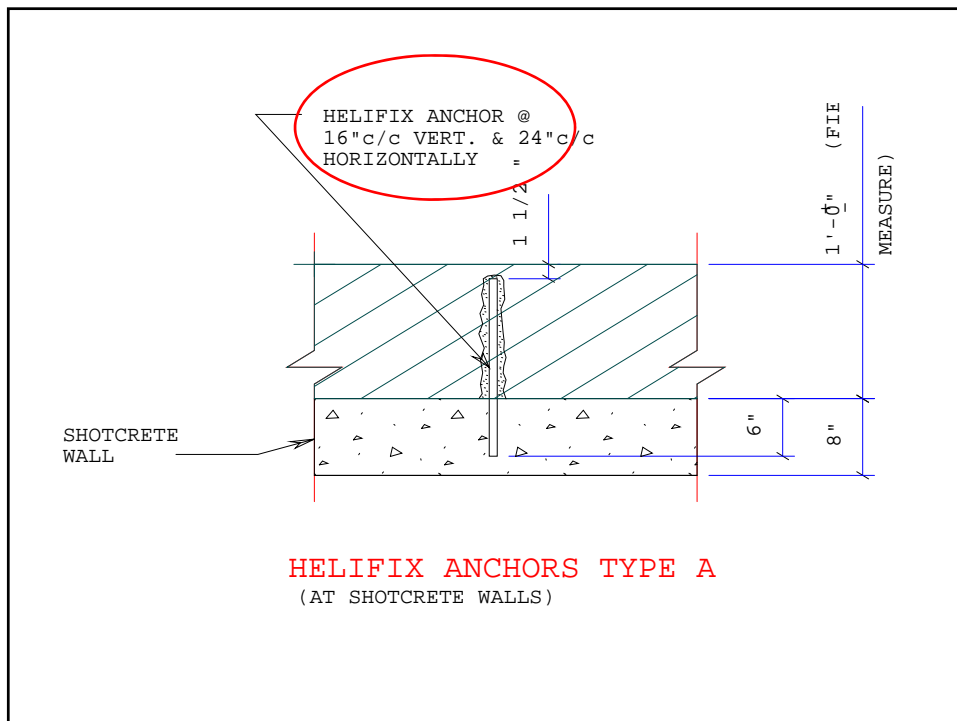
Design Approach

Longitudinal Direction (E-W)

- Shotcrete shear walls (doweled into URM walls)
- Disregard URM stiffness: Mass only
 - Severely degraded mortar and open joints (**GOOP** them??)
 - New walls stiff => disregarding does not result in unconservative inertial forces
- Inertial forces from adjacent building included
- Inertial forces from other 3-bay building not included due to ¼ inch gap (tension) and unlikely transfer thru 416 So. Main





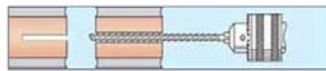


Installation

Example Application: Replacing wall ties using RetroTies (Reference: ANZ-RT02)

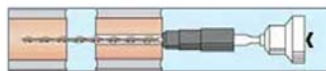


1. Drill a small pilot hole (diameter to suit remote leaf requirements) through the near leaf and into the remote leaf...[Learn more >](#)



2. Enlarge the hole through the near leaf (typically to 10-12mm diameter) and then clean of spoil and dust using a brush and airjet.

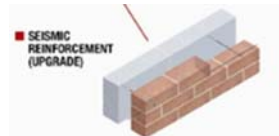
3. Load the RetroTie into a Power Driver Attachment or HRT support tool fitted to an SDS hammer drill.



4. Drive the tie into the remote leaf.



5. Fill the hole in the near leaf with EpoxyPlus resin, allow resin to cure and make good.



HELIFIX ANCHORS

TECHNICAL SPECIFICATIONS

Standard Material	Diameter	Length
Grade 316 stainless steel	8mm	To order
"	10mm	To order

http://www.helifix.com.au/retr_o_tie.html



Styrene-butadiene or styrene-butadiene rubber (SBR) is a [synthetic rubber copolymer](#) consisting of [styrene](#) and [butadiene](#). It has good [abrasion](#) resistance and **good aging stability** when protected by additives, and is widely used in car [tires](#), where it may be blended with [natural rubber](#). It was originally developed prior to [World War II](#) in Germany.^[1]

Poly(styrene-butadiene-styrene), or SBS, is a hard [rubber](#) that's used for things like the soles of shoes, tire treads, and other places where **durability** is important.

[SBR 1502](#) is a cold polymerized, 23.5% styrene SBR polymer made with a mixed-acid emulsifier, nonstaining stabilizer, and salt-acid coagulation. [SBR 1502](#) exhibits the **excellent tensile strength**, **abrasion resistance**, **flexibility** and **recovery properties** that are characteristic of "cold" rubbers.

(CONSIDERED - NOT USED)