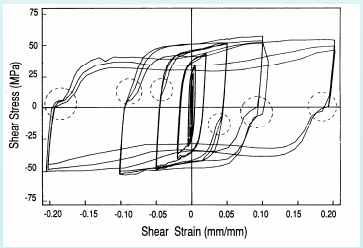
Aluminium Shear-Link as an Energy Dissipator for Truss Moment Frames

Department of Civil Engineering, Indian Institute of Technology Kanpur

Aluminium Shear-Link as an EDD

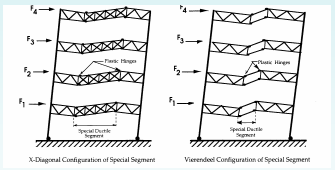
Shear-Yielding of Aluminium

- Ductile and large shearing strains (up to 10%) without buckling or tearing.
- Low yield strength allows thicker web reducing the problem of web buckling
- Maximizes material participation in plastic deformation



Hysteretic Response

- First yielding at 0.2% strain and stress at 20% strain is 2.6 times the yield stress. No buckling until 10% strain
- Stable response even after buckling due to tension field action.



Yield Mechanism

- Strong column - weak girder
- Inelastic activities contained in truss girder

Special Segment

- Located at mid-span where vertical shear is high
- Inelastic activities in this segment only

Time History Analyses

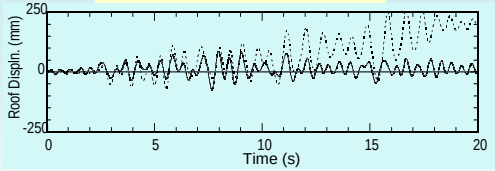
X-Diagonal STMF

- Drifting response for X-Diagonal STMF following yield mechanism.
- Pinching & degrading hysteretic behaviour

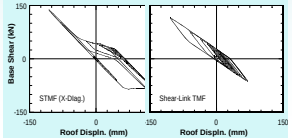
Shear-Link TMF

- Strain-hardening of shear-link ensured good post-yielding stiffness & strength
- Stable hysteresis energy loss in shear-link only

Miyagi-ken-Oki (0.51g)



Northridge, Sylmar (0.84g)



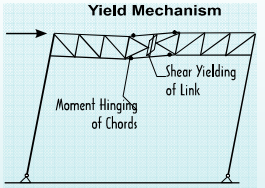
Conclusions

- Low alloy metals such Aluminium can be used for large cyclic plastic deformations.
- Aluminium shear-links have very ductile shear-yielding and can dissipate large amount of energy effectively and reliably even at large strains (up to 20% shear strain)
- Energy dissipation capacity of Truss moment Frames can be improved significantly with Aluminium shear-links and are suitable for earthquake type loads
- TMFs equipped with shear-links showed significant reduction in
- Seismic energy input, Base shear, Storey drift
- Shear-links can be easily replaced after extreme earthquakes and can be deployed in existing TMFs for seismic strengthening.

Shear-Link Truss Moment Frames

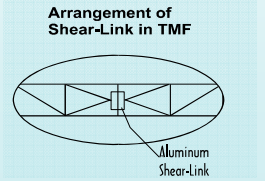
Shear-Link in TMF

- Shear-Link located inside the special segment at mid span
- Link is placed between horizontal vertices of diagonals of adjacent panels



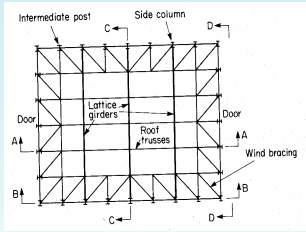
Yield Mechanism

- Strong column - weak girder
- Aluminium Link yielding in vertical shear due to lateral loads
- Inelastic activities pedominately in Shear-Links
- Moment hinging in chords to form a collapse mechanism
- Easy link replacement after extreme events of earthquakes



Framing for Large Span Areas

- Open large span areas for factories, warehouses and shopping malls
- Main Truss Girders support secondary traingular roof trusses running in perpendicular direction.
- Truss moment frames (TMF) resist lateral forces from wind and earthquakes.



Seismic Resistance of TMF

- UBC assumes a Strong girder - Weak Column yield mechanism
- Designed as SMRF or OMRF
- Poor response in Mexico city Earthquake.