

## 2.13. Proposal of Strengthening Masonry Structure with Scrap Tires (Ahmed Turer)

スクラップタイヤを活用した組積造の補強提案 (アフメット・トゥレー)

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### Proposal of Strengthening of Masonry Structure with Scrap Tires.

Asst. Prof. Dr. Ahmet Turer  
Middle East Technical University  
Civil Engineering Dept.  
Structural Mechanics Lab.  
Ankara - TURKEY

### Problem:

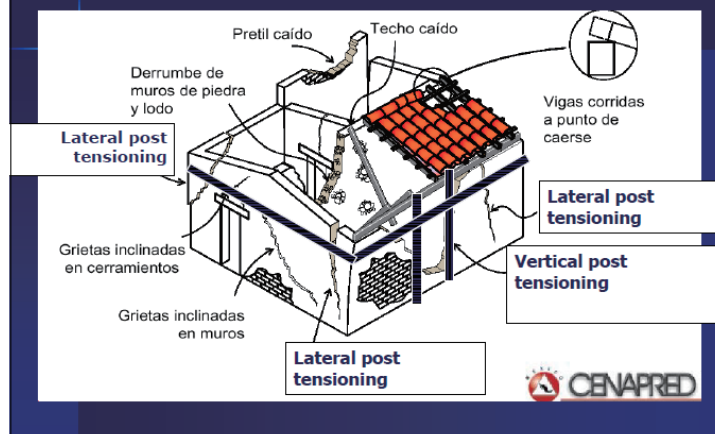
- "Non-Engineered" masonry structures are commonly weak against earthquakes.
- Masonry houses in developing countries are generally constructed by residents.
- Residents mostly have "low-income" and are "under-educated".
- A "simple" and "affordable" strengthening method is very much needed in seismically active regions.
- Most of the EQ research is concentrated on R/C buildings.
- There are large number of masonry houses, but insufficient resources (e.g., time, money, ...)

### Idea:

- Used (scrap) car tires are affordable (no cost), strong in tension, and elastic in nature.
- Post-tensioning is a well-known engineering application, for brittle material such as bricks/stone masonry or concrete.
- "Do-it-yourself" approach is desirable and possible if "low-cost" and "low-tech" approach can be found.

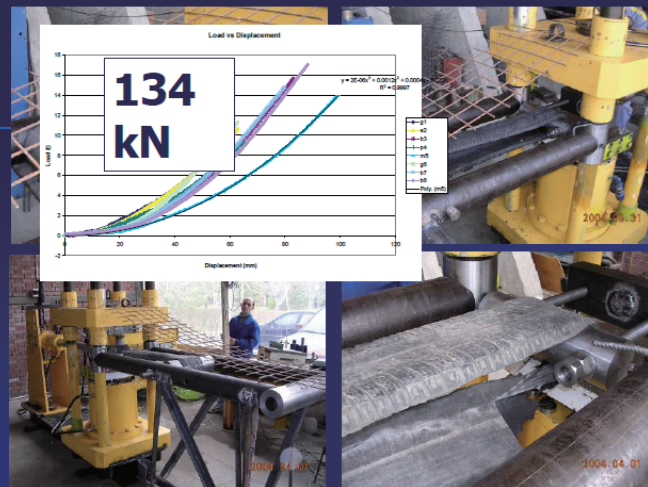


### Failure patterns of masonry houses

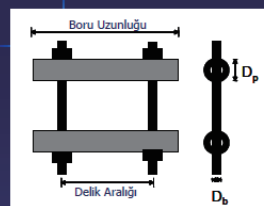


## Where can it be applied?

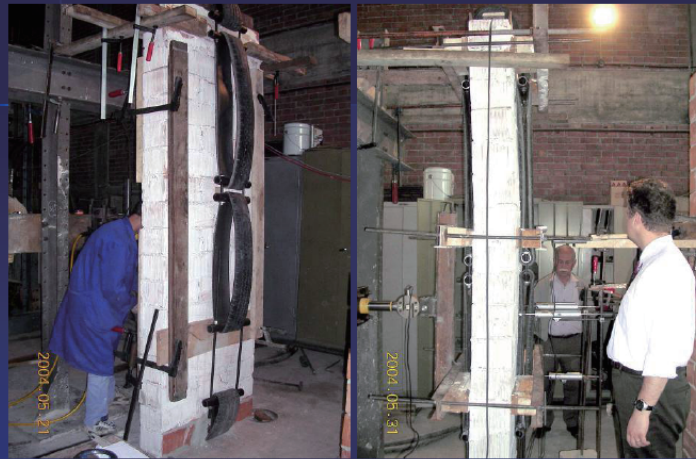
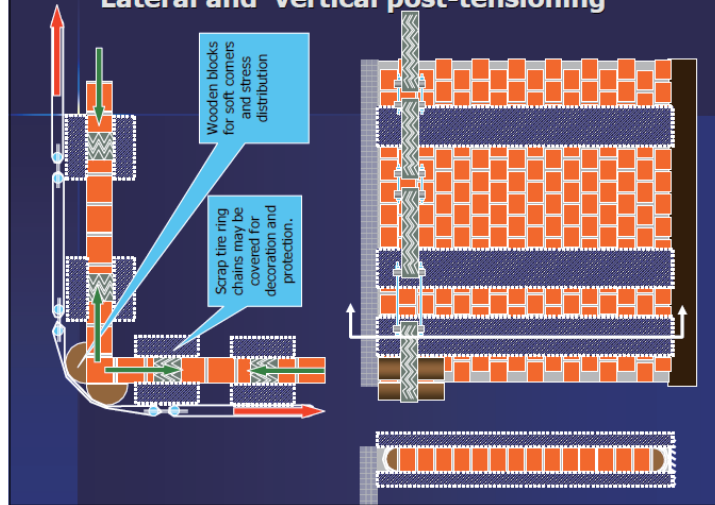
- Following conditions are considered:
  - Seismically active and developing countries are targeted (e.g., Turkey, Peru, Bangladesh, Indonesia, ...).
  - Countries that have used scrap tires.
  - Locally available metal pipes and bolts.
  - **Not rich enough** to reject tire strengthening but **not too poor** to not care about earthquakes.



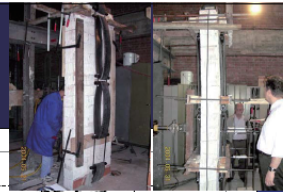
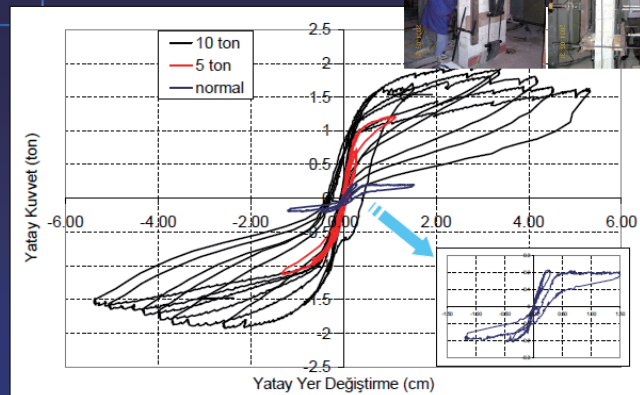
## Connection



## Lateral and vertical post-tensioning



## Strip wall out-of-plane bending tests



## Diagonal cracking and effect of post-tensioning



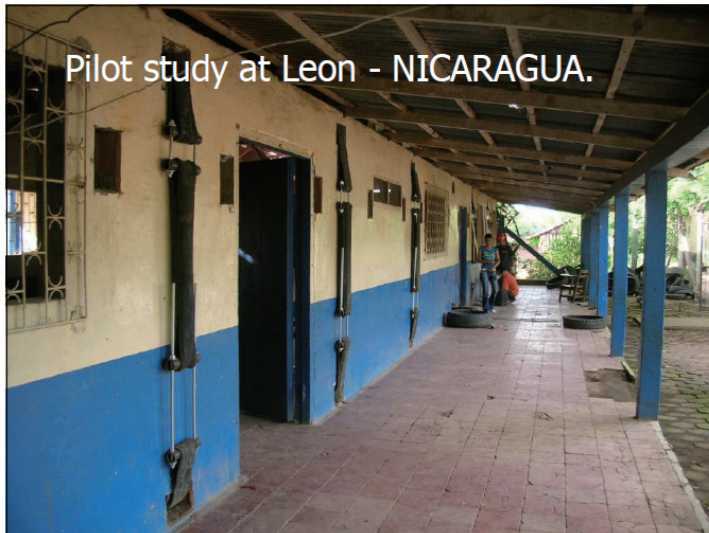
18° tilt → (0.31\*g)

34° tilt → (0.56\*g)

## Pilot study at Antakya – TURKEY.



## Pilot study at Leon - NICARAGUA.



## Conclusions

- Scrap Tire Ring (STR) based seismic strengthening is a “low-cost” and “low-tech” method.
- It recycles otherwise useless material of scrap car tires.
- The proposed method may be implemented in masonry houses, in a “do-it-yourself” approach (removing the need for large number of workers, for large number of existing houses).
- STR can be used for brick, block stone, adobe, clay type of masonry houses.
- Method relies on a sound and basic civil engineering concept of “post-tensioning”.
- Lab tests showed that
  - out-of-plane bending strength is improved more than 10 times, so does the ductility and energy dissipation capabilities.
  - More than 2 times in-plane strength increase.

- Nation wide strengthening campaign should be initiated to strengthen masonry houses,
- Cities that are seismically active, crowded, and have large masonry building stock should be given priority,
- Masonry house residents should be trained using posters, booklets, and TV programs.



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