

Retrofitting and Reconstruction for Resilience

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A frequent sight



A rare sight

Sangzao Middle School Anxian county Mianyang city



Survived!

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Years of Disaster Risk Reduction saved the school



Headmaster Ye Zhiping

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Mr Ye's story

- A teacher at Sangzao Middle School from 1980s
- Observed the shoddy construction of laboratories and other school buildings
- Appointed headmaster in 1997
- Had already set about retrofitting and earthquake response and evacuation
- 12 May 2008: all 2,323 students and teachers survived, although 70 teachers lost their homes

How disaster risk reduction (DRR) was achieved

- *Knowing* the risk
- *Identifying* structural weakness
- *Retrofitting* buildings for seismic resilience
- *Planning evacuation* and *safety procedures*
- *Educating* students and teachers in school safety
- Conducting *evacuation drill* on a regular basis

Top Down + Bottom Up

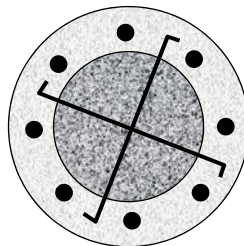
- Mr Ye provided the leadership and found the resources to implement DRR
- The students and teachers were involved in a continuing education program to understand the DRR and their part in it

Both are needed for success

- Can be replicated at the provincial level

Retrofitting Sangzao Middle School

- Laboratory building cost 170,000 Yuan to build, 400,000 Yuan to strengthen
- 22 key columns enlarged from 37 cm to 50 cm diameter



Retrofitting Sangzao Middle School

- Brick parapets on balconies replaced with steel railing
- Missing concrete and other shoddy features repaired



Emergency management

- Objects which could topple are secured
- As soon as an earthquake is felt the teachers tell the students to shelter under their desks
- Teachers open doors so that they do not jam shut
- When the shaking stops the students evacuate the building in a planned order and sequence to avoid dangerous congestion on the stairs
- Evacuation drill every semester since 2005

Key issues

1. Adoption of risk reduction targets
2. Rebuilding a disaster resilient community and infrastructure in Sichuan
3. Reducing disaster risk for the rest of China to an acceptable level
4. The time factor in implementation

Risk Reduction Targets

For **all** risks – earthquakes, floods, landslides, etc.

- **Facilities which must function after disaster strikes**
 - Hospitals & clinics, power stations & powerlines, emergency services, bridges, communication systems, water supply and treatment, post disaster refuges
 - May require emergency supplies and standby power
- **Facilities which must not collapse when disaster strikes**
 - Schools, apartment buildings, factories, shopping precincts
- **Personal refuge and evacuation plans**
 - For when prevention of collapse or inundation is not certain

The implementation of Disaster Risk Reduction (DRR) is different *after* disaster in Sichuan from *before* disaster in the rest of China

Rebuilding in Sichuan

Some issues:

- Residual strength and safety of standing buildings – expertise and training required
- Disposal and recycling of rubble
- How to adapt traditional construction for earthquake resistance
- Development of manuals for earthquake resistant reconstruction which engage and use local community skills and resources

An example of a construction manual for use by the community

Developed by the University of Gadjah Mada in consultation with the community

After the Yogyakarta earthquake, 2006
(Only US\$15 aid per victim pledged internationally)



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The framing system



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How to mix concrete and recycle reinforcing bars

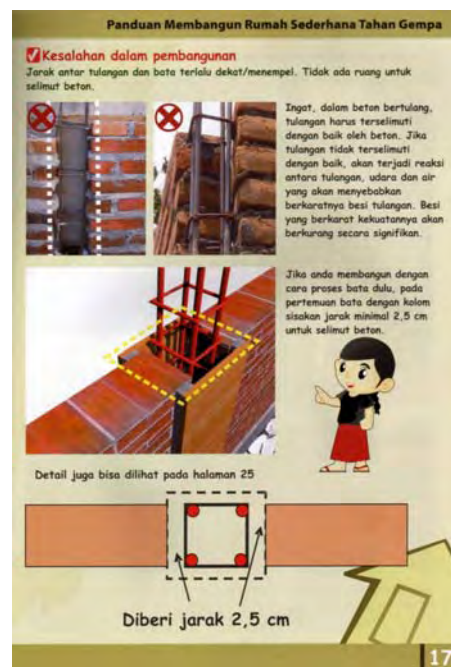


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How to integrate reinforced concrete columns into recycled brickwork



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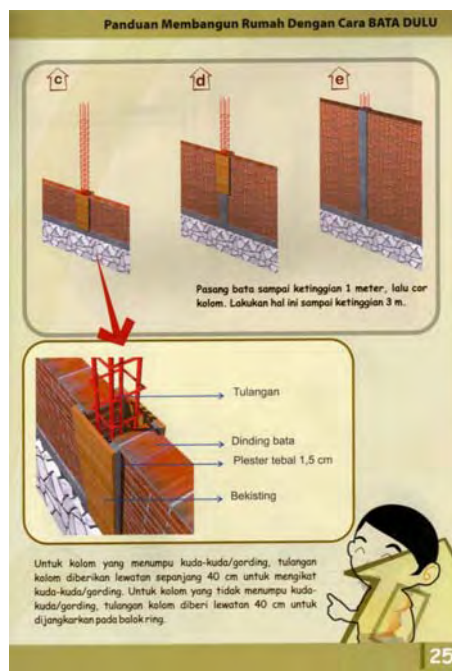
How to prepare the foundations and base courses



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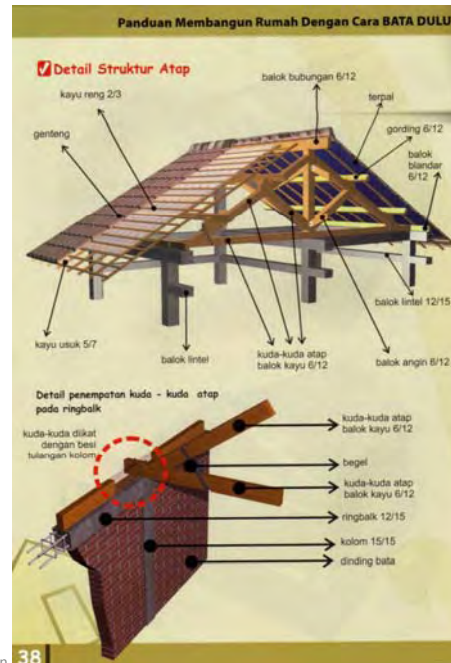
Staged construction method



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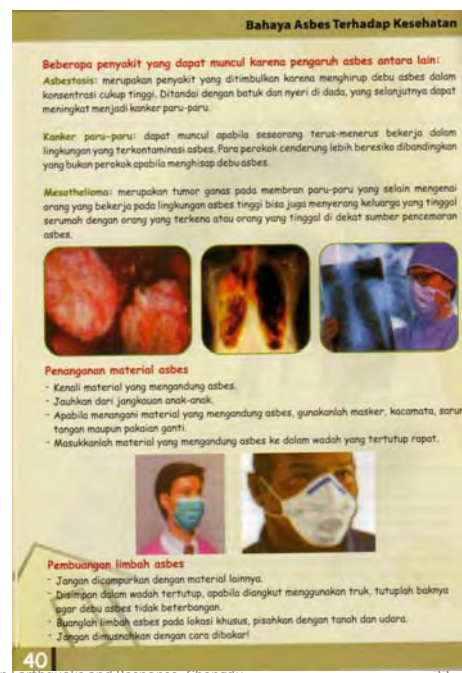
Roof system and connections



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Warning on handling asbestos (still used in roof sheeting)



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DRR for the rest of China

Some issues:

- Assessing the magnitude/intensity of the hazards
- Recognition of post disaster importance of key infrastructure and facilities
- Assessing vulnerability of infrastructure and fragility of buildings (e.g., FEMA Handbook 154)
- Devising retrofitting which respects tradition and can be executed by local communities (serious lack of research)
- Activating community participation in DRR (education, school curriculum)
- Interim DRR during retrofitting

The time factor

From Mr Ye's experience adequate Disaster Risk Reduction takes persistence, education, funds – and time.

Assuming it takes 15 years to implement a comprehensive Disaster Risk Reduction Plan what affordable interim measures should be taken?

Surviving the first shocks

In Sangzao Middle School students sheltered under desks until the first shocks passed, and then evacuated the building in an orderly fashion.

This strategy would not work in buildings not retrofitted to resist earthquakes. The children would have been buried.

This risk applies to all such buildings before retrofitting

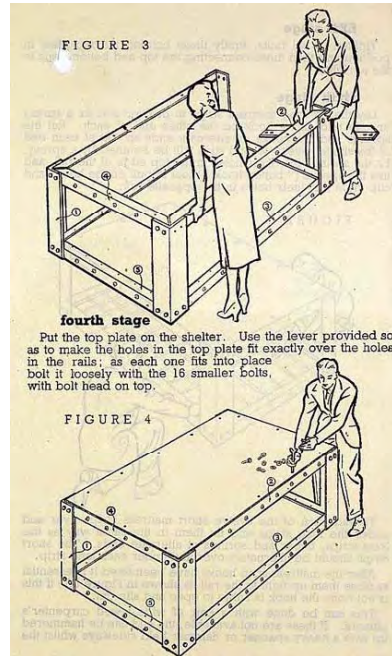
Desk as shelter

The Morrison Shelter – essentially a table made of steel parts bolted together – was designed by Prof J F Baker to provide a safe enclosure when buildings in London and other cities collapsed during air raids in World War II. 600,000 shelter kits were distributed. Deaths only occurred when a bomb made a direct hit on the people.

Adapting the Morrison Shelter

Combined with air raid drill the Morrison shelters were very successful life savers.

A similar concept, with emergency response education and drill could be adopted for schools in China.



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Conclusions

We recognise the following issues:

1. The need for a cooperative bottom-up and top-down approach
2. The need for education in, and understanding of, the risk reduction process
3. The need for nationwide Disaster Risk Reduction as well as targeted recovery and reconstruction in Sichuan

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Conclusions

4. The need for rapid methods of assessing structural capacity of damaged and non-engineered buildings to resist earthquakes
5. The need for upgraded standards and methodologies to ensure that key infrastructure and institutions remain fully functional and safe after major hazards
6. The need to develop and implement methodologies for sustainable reconstruction and retrofitting buildings and key infrastructure

Conclusions

7. The need to recycle building rubble in future construction
8. The need to consolidate and apply the worldwide knowledge on making masonry structures earthquake resistant
9. The need for disaster risk reduction in the school curriculum

Thankyou

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(web site for Disaster Reduction on Coasts)

