Contents of Disaster Reduction Technology List

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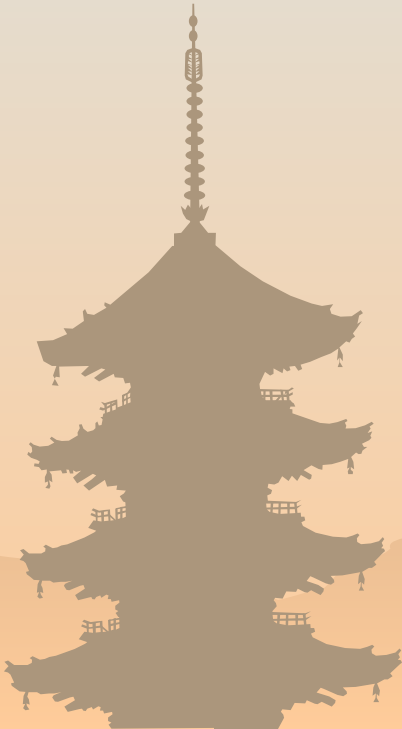
Foreword (T. Nakamura, MEXT)

1. Introduction (H. Kameda, WG Chair)
2. Format of the Disaster Reduction Technology List (R. Shaw & H. Arai, WG Secretariat)
3. Summary List of Disaster Reduction Technologies
4. Description of Disaster Reduction Technologies
5. Research and Development Projects for Disaster Reduction Conducted by MEXT

Roster of the WG for Development of Disaster Reduction Technology List and the MEXT Team

Types of Hazards Focused in the List

- Earthquake and Tsunami
- Flood and Debris
- Multi-Hazards Including Both



Types of Technologies in the List

- Category A: Technologies Developed under Implementation Strategies

  A1: - Features of the Developed Technology & Next Step Developments

  A2: - Future Technology - ongoing or planned

- Category B: Transferable Technologies

  - Features of the Developed Technology & Next Step Developments

For both Hardware (Science and Engineering) and Software (Social and Process)

Numbers of Technologies in the List

Category	Type of Hazard			Total Number
	Multi-Hazard (MH)	Earthquake & Tsunami (ET)	Flood & Debris (FD)	
A1	**3**	**12**	**2**	**17**
A2	**2**	**3**	**4**	**9**
B	**2**	**6**	**8**	**16**
Total	**7**	**21**	**14**	**42**

Making Process of the List

- Preparation and distribution of questionnaires (from late in Aug. to early in Sep., 2004)
- Submission of the filled-up questionnaires (in mid-Oct.)
- First screening and requesting supplementary documents and illustrations (to early in Nov.)
- Submission of the supplements (in mid-Dec.)
- Second screening and finalization (to late in Dec.)
- Publication (today in mid-Jan., 2005)

3. Summary List of Disaster Reduction Technologies

(1) Category A1: Technologies Developed under Implementation Strategies
- Features of the Developed Technology & Next Step Developments

Hazard	Ser No.	Title of Technology	Contact Person	Affiliation / Organization	Contact Details
Multi-Hazard	A1-MH-01	Development of Comprehensive Disaster Reduction Planning Scheme, Techniques and Tools Focusing on Stakeholder Involvement	Haruo Hayashihi & Norio Maki	Earthquake Disaster Mitigation Reseach Center, National Research Institute for Earth Science and Disaster Prevention	Human Renovation Museum, 4th Floor 1-5-2 Wakinohama-kaigan-dori, Chuo-ku, Kobe 651-0073, JAPAN hayashi@drs.dpri.kyoto-u.ac.jp maki@edm.bosai.go.jp
	A1-MH-02	Implementation of Risk Adaptive Regional Management System by Spatial-Temporal GIS "DiMSIS" and Application of Information Processing in Normal-Emergency Situations of City/Municipality	Shigeru Kakumoto	EDM-Kawasaki Laboratory, National Research Institute for Earth Science and Disaster Prevention	1-2 Minamiwatarida-cho, Kawasaki-ku, Kawasaki 210-0855, JAPAN kaku@kedm.bosai.go.jp
	A1-MH-03	Disaster-Monitoring Using Earth-Observation Satellites	Yukio Haruyama	Earth Observation Research and Application Center, Japan Aerospace Exploration Agency	Harumi Island Triton Square, Office Tower X 23rd Floor 1-8-10 Harumi, Chuo-ku, Tokyo 104-6023, JAPAN haruyama.yukio@jaxa.jp
Earth-quake & Tsunami	A1-ET-01	Economic and Efficient Method for Strengthening Unreinforced Masonry / Adobe Structures in Developing Countries	Kimiro Meguro	Institute of Industrial Science, University of Tokyo	4-6-1 Komaba, Meguro-ku, Tokyo 153-8505, JAPAN meguro@iis.u-tokyo.ac.jp
	A1-ET-02	Development of Seismically Improved Design for the Non-Engineered RC Frame with Masonry Wall Structure Utilizing Ethnographical Approach	Satoshi Tanaka	Fuji Tokoha University	325 Obuchi, Fuji, Shizuoka 417-0801, JAPAN tanaka_s@fuji-tokoha-u.ac.jp

Each technology is presented by both the filled-up questionnaire and illustration pages in Chap.4.

An Example of Filled-up Questionnaire Pages in Chapter 4 (A1-ET-01)

(A1-ET-01)

Category A1: Technologies Developed under Implementation Strategies

(a) Features of the Developed Technology

Hazard : (X) earthquake & tsunami / ( ) flood & debris / ( ) multi-hazard including both			
1. Title of Technology	Economic and efficient method for strengthening unreinforced masonry / adobe structures in developing countries		
2. Title of Project	Hundred-dollar retrofitting method for unreinforced masonry / adobe structures		
3. Name & Organization	Kimiro Meguro IIS, University of Tokyo	**4. Contact Details**	4-6-1 Komaba, Meguro-ku, Tokyo, 153-8505 meguro@iis.u-tokyo.ac.jp
5. Contents of Technology with relevance to disaster management	Presently, 30% of the world's population lives in a home of unbaked earth. Roughly 50% of the population in rural areas of developing countries lives in unreinforced masonry houses. During the last century, more than 60% of the fatalities during earthquakes were due to the collapse of masonry structures. The technology developed in this project aims at increasing the human survival rate by strengthening unreinforced masonry / adobe structures at a very low cost and with high efficiency. In this way, it is expected that a large portion of the inhabitants living in the existing low earthquake resistant houses will be able to afford the improvement of their dwellings.		
6. Development process with specific focus on the implementation strategy	The project was executed in several stages: 1) Post-earthquake damage surveys in several countries (El Salvador, Peru, India, Iran) together with local counterparts to identify the issues to be addressed to increase the seismic resistance capacity of local dwellings. 2) The feasibility of using the proposed retrofitting methods was investigated from the experimental and numerical points of view by international students seeking graduate degrees at the University of Tokyo (UT). 3) A collaborative research between the UT and the building construction regulatory institute of Iran, Building and Housing Research Center (BHRC), is been established to enrich the research carried out at the UT with the features of the local construction at the target sites. 4) Further investigation of the proposed technology at the UT by invited post-doctoral researchers from countries to which the developed technology can be applied.		

(A1-ET-01)

7. Regional Perspective	The proposed technology makes special emphasis on the use of locally available materials and workmanship. Due to the nature of the addressed problem, high-tech methodologies are not applicable. Therefore, the use of an easy to install and inexpensive material was the main concern. Polypropylene bands (PP-bands), commonly used for packing, are resistant, cheap, durable, worldwide available, easy to handle and have a high deformation capacity. Due to these excellent characteristics, they were chosen for strengthening unreinforced masonry structures.
8. Specific stakeholders' involvement	During the different stages of the technology development, representatives from countries such as Iran, Peru, Nepal, India, etc. have been directly involved as graduate students, post-doctoral researchers, or advisors. The implementation of the proposed technology to the real site conditions has been carefully considered during the whole development process in order to make this technology feasible at the site.
9. Free or Cost-incurred (purchase cost, royalty, etc.)	Under Discussion
10. Copyright and Ownership	Meguro and PP-band maker (Sekisui Jushi)
11. Cost incurred for application (application cost except 9. in US$)	Approximately 100 US$/houses
12. Time and Human Resources required for Technology Application (in terms of person-month)	On the process of evaluation in different countries where the technology is applicable
13. Maintenance and upgrading of technology (Cost, human resources, others)	On the process of evaluation in different countries where the technology is applicable
14. Other requirements for introducing / application	No additional requirements
15. Application Examples	Currently, the direct verification of the applicability of the proposed technology for adobe and brick masonry houses in Iran is being done. Eventually, this technology will be applicable to any country in which low earthquake resistant adobe / unreinforced masonry structures require upgrading.
16. Other features	Although the initial target of the proposed technology are existing structures, the applicability of the technology may be extended to new constructions as well as the intervention of historical or archeological monuments in seismic prone regions.

(A1-ET-01)

(b) Next Step Developments

17. Proposed plan	The next step in the development of the proposed technique is to undertake on-site verifications at several countries representative of their regional characteristics. For instance, Peru, Nepal, and Iran as representatives of Latin America, the Indian region, and the Middle East, respectively. The implementation in the latter country is currently under way.
18. Effects of Technology Development with focus on implementation strategies	Although masonry is worldwide used, it has regional characteristics that should be considered in order to make the necessary adjustments of the proposed technology to correspond to each reality.
19. Cost for Technology Development (US$)	Under evaluation
20. Time and Human Resources for Development (in terms of required person-month)	In the Peruvian case, approximately 180 person-month
21. Regional Perspective of cooperative research	Currently, the direct verification of the applicability of the proposed technology for adobe and brick masonry houses in Iran is being done with Iranian research institutes. Also, some joint research projects with other countries are under planning.
22. Stakeholders' involvement	As mentioned in item 18, the local customization of the developed technique is most important. For this purpose, a human network at different countries has been constructed to perform this activity. This human group is highly motivated to adopt the proposed technology to enhance their local houses.
23. Others	The participation of the final users, i.e. decision makers, masons and residents, in the process of adjustment of the proposed technique to the regional characteristics is considered. This will serve not only to demonstrate the easiness of the installation process but also the beneficial effects of the proposed retrofitting technique.

An Example of Illustration Pages in Chapter 4 (A1-ET-01)

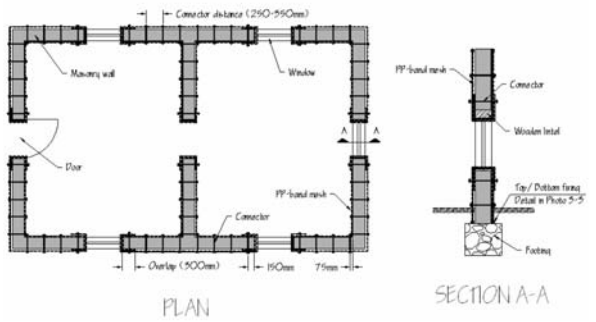
Technology List on Implementation Strategies for Disaster Reduction (Illustration)

Ser No. A1-ET-01
TITLE OF THE TECHNOLOGY
Economic and efficient method for strengthening unreinforced masonry / adobe structures in developing countries
CONTACT
Kimiro Meguro, Institute of Industrial Science, The University of Tokyo 4-6-1 Komaba, Meguro, Tokyo

1. FEATURES OF THE TECHNOLOGY

Presently, 30% of the world's population lives in a home of unbaked earth. Roughly 50% of the population in rural areas of developing countries lives in unreinforced masonry houses. During the last century, more than 60% of the fatalities during earthquakes were due to the collapse of masonry structures. The technology developed in this project aims at increasing the human survival rate by strengthening unreinforced masonry / adobe structures at a very low cost and with high efficiency. In this way, it is expected that a large portion of the inhabitants living in the existing low earthquake resistant houses will be able to afford the improvement of their dwellings.

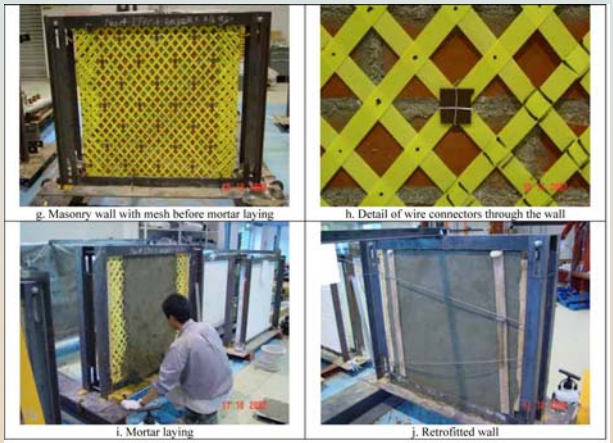
The proposed technology makes special emphasis on the use of locally available materials and workmanship. Due to the nature of the addressed problem, high-tech methodologies are not applicable. Therefore, the use of an easy to install and inexpensive material was the main concern. Polypropylene bands (PP-bands), commonly used for packing, are resistant, cheap, durable, worldwide available, easy to handle and have a high deformation capacity. Due to these excellent characteristics, they were chosen for strengthening unreinforced masonry structures. The retrofitting scheme consists on arranging the PP-bands on a mesh fashion and then installing them on both sides of the walls, connected through wires. The detailed installation procedure is shown in the next section. A simple retrofitting scheme is shown in the figure below.



2. ILLUSTRATIVE EXAMPLES

The installation process of PP-band retrofitting is described in the photos below

a. Retrofitting raw material
b. Polypropylene band mesh
c. Detail of the mesh edge top-bottom connection
d. Drilling holes through the masonry wall
e. Mesh attached to one side of the masonry wall
f. Connecting the meshes on both wall sides



g. Masonry wall with mesh before mortar laying
h. Detail of wire connectors through the wall
i. Mortar laying
j. Retrofitted wall

3. SPECIFIC OBSERVATIONS IN THE DEVELOPMENT PROCESS

The tests performed so far showed the reinforcement effect on the masonry wall behavior. Although the reinforcement did not increase the structure peak strength, it contributed to improve its performance after the crack occurrence. The reinforced walls exhibited a larger post-peak strength and were capable of better sustaining their strength even for large drifts. The importance of the connectors and the mortar overlay for the retrofitted wall performance was recognized.

REFERENCES

1. Mayorca, P. and Meguro K. (2004). Proposal of an efficient technique for retrofitting unreinforced masonry dwellings, 13th World Conference on Earthquake Engineering, CD-ROM, Paper No. 2431.
2. Mayorca, P. and Meguro, K. (2003). Efficiency of polypropylene bands for the strengthening of masonry structures in developing countries, Proc. of the 5th International Summer Symposium, JSCE, 125-128.
3. Mayorca, P. (2003). Strengthening of unreinforced masonry structures in earthquake-prone regions, PhD Dissertation, University of Tokyo, 2003.