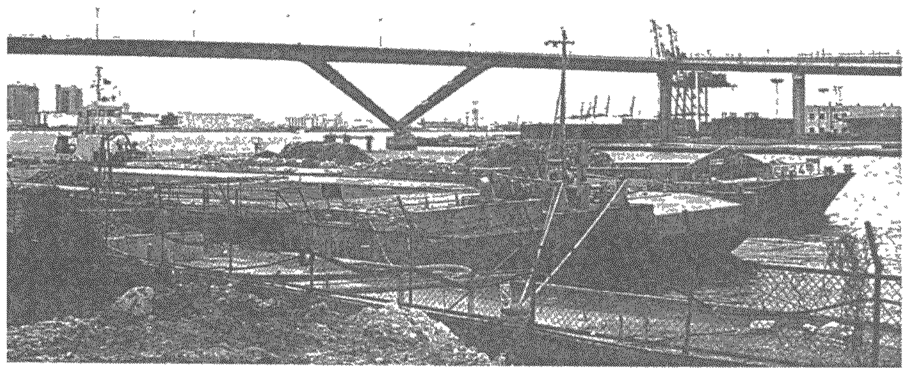
Management of Earthquake Wastes

John H. Skinner, Ph.D., President ISWA

The International Symposium on the Management of Earthquake Wastes sponsored by JWMCA, ISWA and UNEP-IETC, held in Osaka in June 1995, reviewed the important experiences from the management of wastes generated by the Great Hanshin-Awaji Earthquake and other earthquakes and disasters elsewhere in the world. Over the next few years, the industry and government officials in Japan will continue to deal with the large quantity of wastes generated by the Hanshin-Awaji earthquake.

Before drawing general conclusions, it is important to point out that the team of international experts spent only one day on-site in the Kobe area reviewing the concrete waste processing facilities, the wood processing facilities and incinerators, and the residue disposal site at the Phoenix Project This effort was not intended to be a detailed technical evaluation or audit. Instead, the goal was to identify successful activities as well as areas for improvement, and to use the situation in Kobe to illustrate some lessons learned and frame some broader issues that may provide guidance for future actions.

In developing this article, I have made extensive use of the materials provided by the international experts including paraphrasing sections of their reports. I refer the reader to the full reports from Mr. John Gullege, Mr. Dick W. Eerland and Mr Erik K. Lauritzen for a more thorough presentation of these ideas.



Transfer station for demolition waste in Kobe port where clean blocks are transported by barge to artificial islands in the port area. The bridge in the background has been rebuilt

WASTE MANAGEMENT IN THE PERSPECTIVE OF EMERGENCY RESPONSE

The initial response to an earthquake or other disaster must place its emphasis on saving human life. This includes emergency rescue activities as well as emergency demolition work to secure unstable buildings and structures to prevent additional loss of life. At the same time, critical infrastructure, including water, sewage and waste collection, health care, communication and transportation, must also be re-established to provide life and health sustaining services to people living in the area.

After the initial response with respect to emergency actions, the management strategies for dealing with the earthquake debris must be implemented. An important step is preparing a realistic assessment of the quantities and types of wastes generated. This is necessary for the development of collection and disposal systems and evaluation of potential markets for wastes that may be recycled. Prior identification of markets and requirements for recycling and reuse will assist in the development of waste management strategies to utilize wastes in a manner that may benefit the local community.

RECYCLING AND REUSE AS A STRATEGY MANAGING EARTHQUAKE WASTES

In the Kobe and Osaka area the Phoenix Project had been established to dispose of normally occurring domestic and industrial wastes and surplus soil and sand through the reclamation of land from the sea. This option, at least on an initial basis, was available for disposing of the significant volumes of concrete and other noncombustible wastes generated in the aftermath of the earthquake Since the waste generation and disposal effort is expected to last a period of years, it is now possible to evaluate other disposal options as well as potential markets for recovered materials.

During the initial stages of response to the earthquake there was open burning of wood waste which has subsequently been curtailed. The remaining wood and other combustible wastes are to be burned in several existing and planned incinerators but without the recovery of energy from the combustion process. Energy recovery offers another possibility of reclaiming value from these wastes and the energy savings could partially offset processing costs.

ACTIVITIES DURING THE DEMOLITION STAGE

The progress of the demolition in Kobe clearly demonstrated the high quality efforts with respect to the speed of the demolition and clearance of damaged buildings and structures The demolition work is carried out with considerable regard for environmental protection and health and safety. The current methods of shielding the demolition sites is very impressive with respect to reduction of noise, dust and negative aesthetic impacts The system includes professional and well managed transportation, handling and transfer of waste materials over the roads from the demolition sites to transfer sites, and then by barge to the land reclamation areas in Osaka Bay.

Because of the high quality of this work it was observed that the costs of demolition and transportation of materials were relatively high as compared with costs in Europe and the US Because this work will continue into the future, the options for the development of capacity for recycling of materials and recovery of energy could be considered. This could produce revenues to offset some of the demolition and transport costs.

PROCESSING EARTHQUAKE WASTES FOR RECYCLING AND REUSE

There are several opportunities for recycling and reuse of demolition waste materials. For example, crushed demolition waste materials can be substituted for natural aggregates and quarry materials in the reconstruction of damaged or demolished structures. The reconstruction of port facilities and other infrastructure need considerable amounts of natural quarry gravel material of which considerable amounts might be substituted by recycled materials. In principle the need for materials for the reconstruction will reach the amounts of materials which have or will be demolished and disposed of.

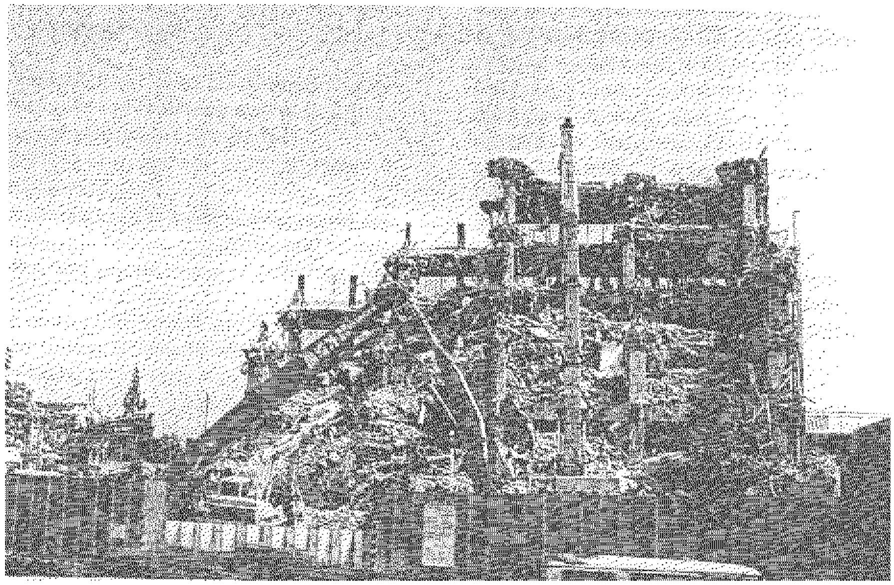
Experience in other countries has shown that if construction and demolition waste are processed carefully as much as 80 to 90 per cent can be suitable for reuse. Careful processing would involve:

- separating hazardous wastes and materials such as paints, adhesives, asbestos, tars etc. from wastes to be recycled; this is important to protect the health and safety of local residents and operating personnel,
- pre-separation of different wastes at the demolition site, such as concrete, wood, gypsum, mineral wool, etc.
- selective demolition of structures such as wooden roofs and floors to enable reuse,
- avoiding mixing of wastes such as asphalt and concrete during demolition; separately both types of waste are easily recyclable but mixed they become a low value material.

A great deal of mixed waste is produced during demolition work including building bricks, mortar, concrete, sand, building wood, packaging materials, insulation material, PVC piping, metals, roofing tiles, glass etc. Separation of demolition waste can begin when the waste is being made ready for transportation. At that stage materials can be broken down into various parts; reusable wooden beams and steel girders can be separated, coarse material can be segregated, and rubble can be reduced to manageable size.

Another example of the need to avoid the mixing of incompatible wastes was observed in the residue from the earthquake in Japan. There were many floor mats made of straw, that are commonly used in Japanese family homes, that had to be separated from wood wastes because they would cause problems in the wood shredding operations. Therefore it is important to avoid mixing the straw mats with wooden material before shredding.

The processing of disaster debris can be accomplished through both manual and mechanical means and various equipment can be used for these purposes. Different separating technologies are available including processing for separating fines from



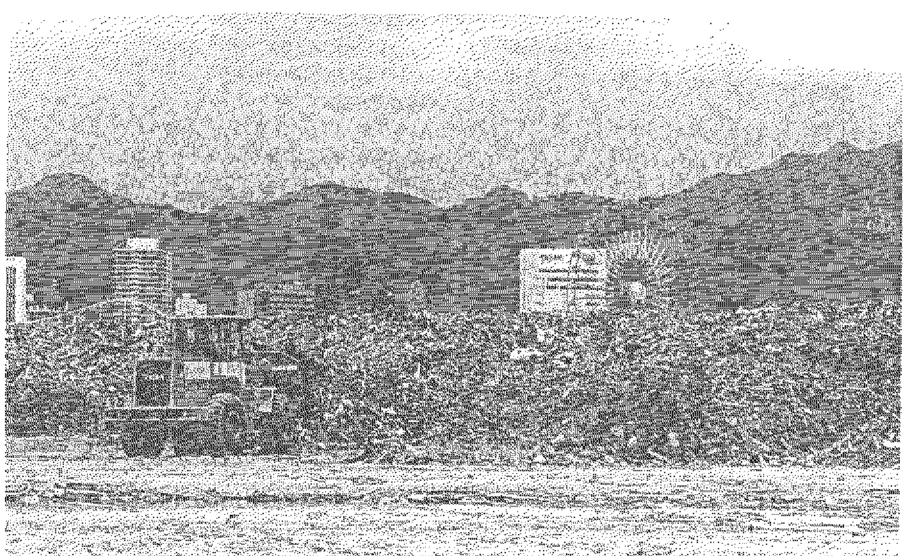
Demolition of earthquake damaged building by the use of modern Japanese demolition tools, concrete crushers mounted on hydraulic telescope arms.

coarse wastes, washing, wind sifting to remove light materials, hand-picking, screening and magnetic separation. The appropriate approach will be a function of the type of debris, available personnel and equipment, potential end use markets and the availability of locations for stockpiling and processing operations. While additional mechanical processing may be necessary to generate materials to meet the specifications of various reuse markets, the costs of this processing could be offset by the value of recovered materials.

MARKETS FOR RECYCLED MATERIALS

There is extensive experience in successful operational application of recovery of secondary materials from wastes containing asphalt, concrete, granulate, cement, and masonry. Reuse applications are found mainly in the road building and concrete industries. The following secondary materials can be potentially derived from earthquake waste:

- old asphalt, with contaminants such as stone materials removed, can be used in hot mixtures for new asphalt production,
- asphalt and stone mixtures can be used as a granulate in asphalt cemént,
- crushed secondary concrete can be reused as gravel in newly produced concrete,
- secondary concrete and concrete masonry mixtures can be used as granular road bases for both asphalt and concrete roads,
- secondary sand can be used in sub-base layers in road building and as fine aggregate in concrete.



Provisional storage of wood waste at Kobe port before treatment in temporary incinerator plants at the site. It was estimated that approximately 400,000 m^3 wood waste arising from the earthquake should be treated.

Because mixed construction waste and demolition waste are often similar in composition to earthquake wastes, the knowledge and experience gained in other countries in producing reusable materials from demolition and construction wastes could be helpful to the demolition waste management and reconstruction efforts in Kobe. The European Union has issued directives on management and handling of waste, and recycling of demolition and construction waste has been practised in many European countries.

In evaluating the opportunities for producing various products from recycled materials it is essential to know the market specifications for these products.

EARTHQUAKE WASTE MANAGEMENT AS AN ELEMENT OF AN INTEGRATED WASTE MANAGEMENT AND DISASTER RESPONSE PLAN

Detailed planning for waste management systems should take place as an integrated part of the emergency response and remediation planning for earthquakes, disasters and other emergencies. This planning should include an identification of temporary waste storage sites and other location for various waste management activities. Such planning should be carried out by experts with experience in the management of the different types of wastes expected to be generated during an emergency. The organization, management and handling of demolition waste, including use of waste treatment facilities should be based on preplanned, integrated waste management emergency plans which include cooperation between all local and regional authorities.

The elements of a disaster waste management system include:

- detailed planning of the optimal allocation and use of waste treatment facilities, including suitable alternatives,
- pooling of equipment, especially mobile equipment,
- organization of waste management responsible bodies, authorities and activities, and prioritization of activities.

Since earthquake wastes are in many ways similar to regular construction and demolition wastes, an existing waste management system for the recycling of normal construction and demolition wastes could be modified and expanded to deal with similar wastes produce from earthquakes and other disasters. In the aftermath of an earthquake or other disaster, efforts can be directed at increasing capacities of the existing system and establishing storage, stockpiles and expanded logistical services.

The planning for an integrated waste management system should be based on cost-benefit analysis of all the streams of waste materials that are expected to be generated in the damaged area during the period of emergency response and reconstruction. This analysis should consider:

- establishment of norms and standards for the acceptance of recycled materials substituting for other raw materials,
- the cost of supplies of quarry material including the cost to transport to construction sites,
- the cost of crushing construction and demolition waste materials and transportation to processing sites,
- the costs of processing such materials to produce products for use in construction works and the costs of transporting these products to the construction sites, and
- the costs of transportation and disposal of waste materials of land reclamation, landfill or incineration.

Such planning should involve the local recycling industry for processing of construction and demolition wastes as well as the industries that could provide markets for recycled materials.

SUMMARY

In summary, the emergency management and handling of solid wastes is one of the greatest challenges of the earthquake and emergency response. It is important to establish an emergency waste management system, before the disaster, as part of the integrated emergency response system and coordinated with normal waste management operations in the region. The emergency waste management system must focus on the different options for the use of facilities including establishment of temporary storage areas and cooperation of local and regional authorities. Wastes should be considered as resources, and the opportunities for recycling and reuse should be carefully evaluated in order to conserve energy, resources, time and money. The pre-planning and organization of the disaster waste management system is essential for responding to waste management problems that occur during the chaos that is inevitable following an earthquake or other disaster. ■

---

continued fron page 10

not indicate the time scale over which the gas will be generated. Obviously if the gas production occurs over very many years then the concentrations attained are likely to be low.

There are practical problems associated with measurement of gas in boreholes where gas generation rates are low, since depletion of gas may occur during the measuring operation which can give rise to low and erratic readings using a conventional sampling technique. It has been found that a satisfactory solution to this problem is to fit two tubes to the top of the closed borehole casing. One of the tubes extends 0.5m into the borehole; gas is pumped from this through a portable infra-red instrument such as an Analox IR Gas Analyser. Gas from the instrument is introduced back into the borehole via the second tube so that no gas is consumed during the monitoring process. However, if required, gas can be extracted into sampling tubes for laboratory analysis using gas chromatography or infra red analysis.

Numerous measurements have been taken over a period of several years from a number of landfill sites in the Black Country and the results correlated and analysed using specially developed computer software. The main conclusions which can be drawn from these data can be summarised as follows:

- Generation rates are low with the evolved gases containing mainly nitrogen (> 90%) and carbon dioxide, but with only low concentrations of methane and oxygen
- There is no statistical correlation between the concentration of various gaseous constituents nor between any of these gases and atmospheric pressure
- Considerable variations in mean methane, carbon dioxide, nitrogen and oxygen concentrations are found between individual boreholes
- Marked variations in concentrations of gases are found in the same borehole from day to day. ■

Joint Research and Training Activities at the All India Institute of Local Self-Government

In collaboration with Loughborough University of Technology, the Institute has developed it own solid waste management training center in Bombay and has substantial reference materials and audio visual aids.

For more information, contact:

Sneha Palnitkar,
All India Institute of Local Self-Government,
11 Horniman Circle,
Botawala Building, 3rd Floor, Fort,
Bombay 400 023, India.
Tel. +91 22 620 6716 /
Fax. +91 22 262 0766.