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ORGANIZATION AND ACTION OF EARTHQUAKE RESCUE TEAMS

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Abstract

This paper tries to present a general outline of the organization and action of earthquake rescue teams. The organization of rescue teams within the framework of public services and the description of the chain of command comprise the first part of the paper. The second part deals with the selection and training of team members, indicating the special problems that must be faced during training. The third part presents the stages of an earthquake rescue operation, the particular situations that will have to be faced, and a description of the various skills and techniques required. The fourth and last part includes a catalogue of the heavy and light equipment necessary for earthquake rescue teams.

Introduction

Although earthquakes occur suddenly, the potential for earthquake disasters does not occur overnight. It builds up gradually, due to our inability to appreciate the risks involved.

Characteristically, disasters are man-made in terms of the type of structures we build, how we construct them, where we place them, and how we maintain them. For the same reasons, the quality of our response to an earthquake tomorrow, is being determined by our preparations today. One of the most important aspects at our state of preparedness is the organization and efficiency of rescue teams, the lack of which comprises one of the major defects of our response to earthquakes. This problem exists fairly generally throughout the world.

1. Earthquake rescue teams

There are three basic conditions necessary for effective earthquake rescue:

a) Organization and training
b) Procedures to be used during rescue operations
c) Recourses necessary for rescue operations

Organization

In any country there are many types of rescue teams (for example fire squads) who can assist and extend the work of special teams formed specifically for earthquake rescue, but whose role and responsibilities should not be affected . However, earthquake rescue capability must be developed by whatever governmental Department is responsible for rescue functions generally. If there is no such department, responsibility may be assigned to the police, fire or public works departments, always keeping in mind that this special service must retain an organization and training of its own.

The Chief of an earthquake rescue team should be designated by the head of the Department to which earthquake rescue is assigned, and the whole earthquake rescue operation should be under his general direction. The chain of command should be the same for earthquake rescue as for other divisions of the major department to which rescue is assigned. One of the special duties of the earthquake rescue chief will be to form a co-ordinating plan for all public services liable to help earthquake rescue operations. For example, even though earthquake rescue may be under the Public Works Department, firemen will continue to rescue persons from burning buildings as a part of their normal duties. Therefore, operating plans for earthquake rescue (see Fig. 2) should take into consideration operating plans of other services, with whom proper communication must be established.

The services which must be co-ordinated for an effective earthquake rescue operation are:

- Earthquake rescue teams
- Medical services
- Fire brigades
- Police and army
- Public works department of the area affected
- Services assuring the maintenance of the affected area's lifelines.

Within the chain of command, an earthquake rescue officer should be designated to command each rendez-vous area (pre-arranged assembly point for earthquake rescue teams and equipment). The rescue officer will be charged with organizing and co-ordinating the various services involved in rescue

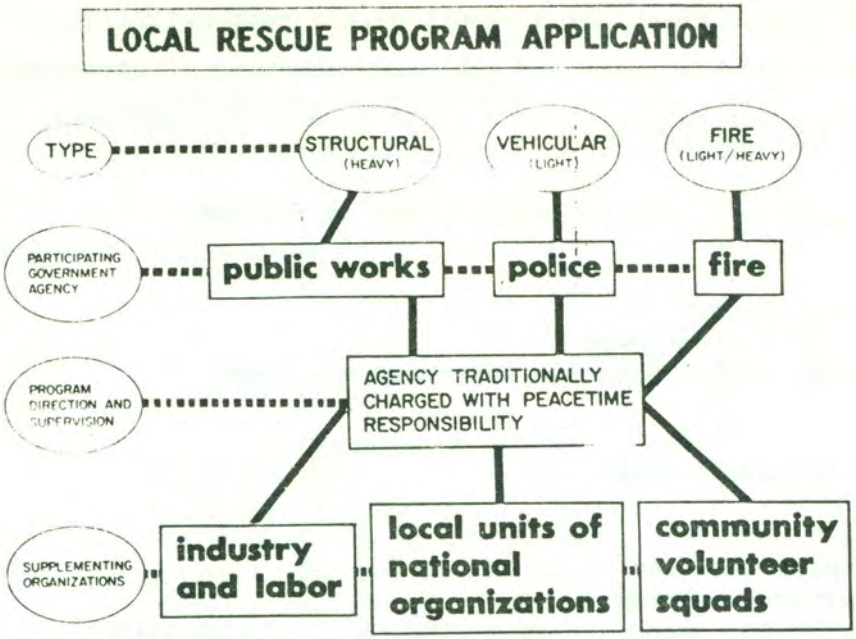

Fig. 1 Local rescue programme applications. Rescue Skills and Techniques, Defence Civil Preparedness Agency (1972).

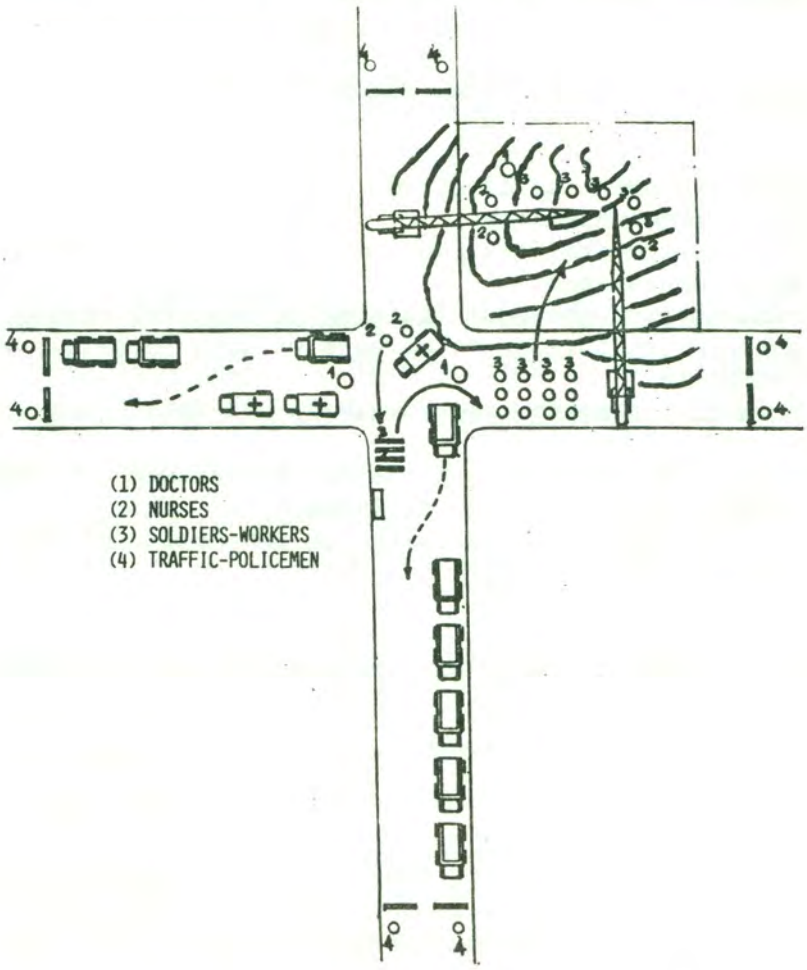

Fig. 2 Co-ordination on the disaster spot of services participating in earthquake rescue operations.

operations in the disaster area. As a result of his responsibilities, the earthquake rescue officer must have a global understanding of earthquake damage (ideally the chief rescue officer could be a civil engineer).

Earthquake rescue teams should be organized as follows:

- a team leader
- 5 to 10 team members
- a truck loaded with the necessary equipment

The team leader must be prepared to:

- organize the team
- supervise training
- develop and enforce regulations for team operation
- supervise the procurement and maintenance of equipment
- conduct reconnaissance and inspection, locating and identifying special hazards in his area
- direct the team during exercises

During an emergency the team leader should:

- report the event as directed
- conduct reconnaissance
- assign responsibilities/duties to team members at the site of operations
- arrange for on-the-spot training of expanded rescue forces (neighbours or volunteers willing to help), as appropriate
- ensure that correct rescue methods and techniques are used
- request additional men, tools and assistance, if needed
- arrange for the rotation of teams
- report as required, following the completion or suspension of operations

Certain special responsibilities are assigned to qualified members of the team:

a) <u>The deputy team leader</u>:

The deputy team leader assists the team leader in carrying out his duties. The deputy must be able to take charge in the leader's absence and direct part of the team when it is split into smaller operational units.

b) Rescue truck driver and storekeeper:

In addition to his duties as a regular team member the driver-storekeeper is responsible to the team leader for the maintenance and operation of the team's rescue truck.

He should:

- keep the truck clean and in running order
- maintain the truck and accessories according to handbook instructions
- keep each tool in its proper place ready for operational use at all times
- report repairs and supplies needed to the team leader.

c) Selection of the team members:

Team members must be acquainted with the various building trades. Another parameter to be considered is the physical condition of the team members.

Training

Complete and thorough training in rescue techniques and in the use of equipment is vitally important. Team leaders and other key members of the rescue organization should plan and direct rescue training in co-operation with the civil defence training officials. Initially each team member must gain general background knowledge of the job he will have to perform. Seminars providing basic knowledge are indispensable.

Team members must use a common vocabulary in order to achieve efficiency in their work. Co-operation with teams handling heavy equipment must be ensured through appropriate training. After initial training is completed, frequent practice sessions should be held to maintain interest, proficiency and discipline.

Each man must be individually trained in rescue techniques and operations, and in working as a team member. He must know what he is to do during each rescue phase. Team training will develop mutual trust and understanding among members, team spirit and confidence in leaders. It will also benefit

leaders by giving them experience in making decisions while teams are in action. After team members have learned the fundamentals of rescue and the value of team work, they should participate in practice sessions that approximate actual rescue operations. Buildings under demolition can be used for training in tunnelling debris, trenching, breaching walls, and clearing debris. Some exercises should be carried out in darkness and in smoke. Simulated casualties should be used in these exercises.

In short, training should be as frequent and realistic as possible. Besides the training of the individual teams and team members, training must be carried out with a wide range of other teams and persons concerned in order to check the degree of integration of preparedness programmes. Team training must be organized weekly. Team training with excursions to sites must occur monthly, while a wider exercise which includes the public, dummy casualties and the participation of other teams from local authorities further afield must be carried out at least once a year. In the beginning drills must be more frequent in order to test various parts of the preparedness plan.

Special care should be given to the simulation of actual rescue operations for an additional reason: fear is a normal reaction to danger. Although fear can be overcome by understanding and through training, people suffering from certain phobias such as fear of height, claustrophobia, etc. are potentially very dangerous as members of a rescue team. Frequently one may not suspect fear which will be revealed under threatening conditions.

Rescue members must be familiar with the legal aspects of their responsibilities. During times of emergency governing bodies may provide additional legal authority to enhance rescue operations and resources. These laws and regulations are promulgated and put into effect upon declaration by the appropriate executive office of government. Rescuers should be familiar with these laws and how they affect operations prior to disasters.

The outline of training courses hsould include the following topics:

- use of ropes, knots and rigging (see Fig. 3)
- use of pulley systems and winches
- use of gribbing and wedges

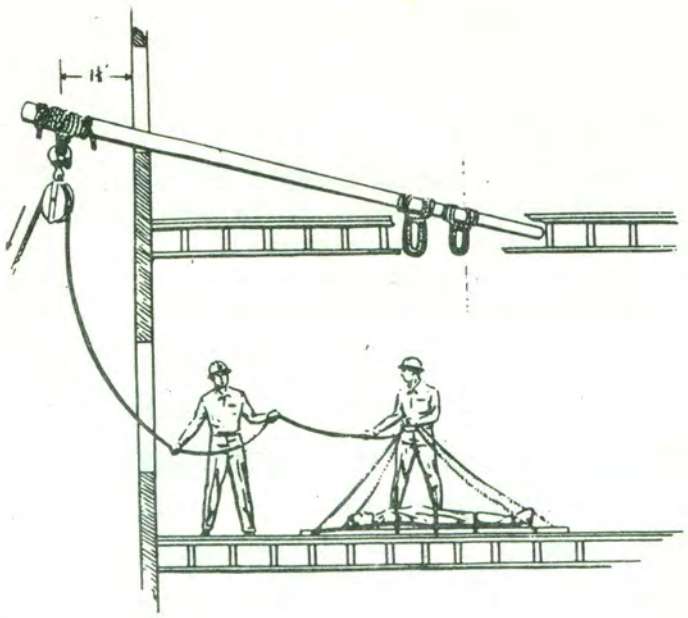

Fig. 3 Use of ropes, knots, pulley systems, winches. Rescue Skills and Techniques, Defence Civil Preparedness Agency (1972).

Fig. 4 Rescue equipment for locating and saving people buried alive under debris, Ali Sekhavat (1977).

- use of cutting and prying tools
- use of hydraulic tools
- use of lifting and hoisting tools
- use of ladders
- use of shoring
- construction of debris tunnels and trenches
- identification of special tools and equipment
- sub-surface rescue techniques
- transportation emergencies
- high-rise and elevator problems

Stages and procedures in earthquake rescue operations

In every disaster a period of time elapses before rescuers are organized. In order to speed the flow of necessary rescue equipment, materials and personnel into the disaster area, police and army forces must take control of the access roads to the perimeter of the affected area. Authorities responsible for the earthquake rescue operations over a wide area must conduct reconnaissance of the extent of damage using helicopters. The helicopters must carry projectors for reconnaissance operations at night. In general, operations after nightfall cause serious problems which must be properly considered in earthquake rescue operational plans.

Control points must be established along the roads giving access to the area in order to control possible traffic congestion. It is of paramount importance to plan for potential access problems. Following a major earthquake many roads will be blocked. The roads become littered with debris or cracked and disrupted. Some access problems are generally very obvious (such as bridges and overpasses, electricity pylons, collapsed buildings accross roadways, unbridgeable cracks, landslides, etc.), but these are often so obvious as to be forgotten. All the available machinery (bulldozers, excavating machines, etc.) liable to resolve access problems during the first hours of a disaster must be identified and located beforehand so that time will not be lost in trying to find them.

Another problem which may arise is that streets may be too narrow to permit access to the disaster area. The rescue organization must have examined the width of the area's streets beforehand in order to use machinery and vehicles with dimensions compatible with those of the streets. Marking street maps with colours indicating accessibility for each type of

machine and rescue vehicle is an indispensable measure.

Services responsible for lifeline systems must be able to mobilize their personnel and equipment to restore a minimum degree of lifeline operation for rescue work.

Projectors are needed for night work. First aid to rescuees can be provided by the rescue team but subsequent medical care and transportation to hospitals must be provided by qualified medical services on the spot.

The task of rescue teams must be divided into four steps:

Stage 1 : Immediate rescue: releasing persons who can be seen or heard.

Stage 2 : Exploration: searching places where casualties may still be alive.

Stage 3 : Selected debris removal: careful removal of debris to release persons still known to be missing.

Stage 4 : General rubble clearance: stripping the area systematically as a last resort when persons are still unaccounted for.

Releasing persons who can be seen or heard is comparatively easy. The main problem of earthquake rescue arises with victims who cannot be seen or heard. Different methods have been developed to locate victims buried deeply in debris. On many occasions rescue dogs have proved to be efficient. Equipment for the location of victims is also available. For example a special device has been designed to locate victims by carbon dioxide detection (see Fig. 4). The device injects air into the debris and records any CO_2 exhaled by survivors.

Even though many means of locating victims are available, methods must be established to minimize searches by starting with the most obvious areas and locations. Rescuers must be familiar with the plans of buildings destroyed. Useful information can be given by neighbours, but building plans should be available at the local town planning office.

Knowledge of life styles is also of extreme importance for locating victims: where were people most likely to be at the time of the earthquake?

Rescuers must be familiar with different types of collapse in order to predict where possible voids may occur in the debris. When floor supports fail floors and roof may collapse in large sections. These

sections may form voids. If they are in one piece but remain supported on one side, they form lean-to-type collapses. When the weight of heavy loads (such as furniture, equipment, rubble and debris) is concentrated near the center of a floor, a V shape of collapse can occur. Moreover, heavy equipment or furniture may support a collapsed section of floor or wall, creating further voids (see Fig. 5).

The failure of bearing walls causes floors and roofs to collapse one on the top of the other onto lower floors. This is referred to as "pancake collapse". Persons may be trapped between the layers of "pancakes". There are different methods of approaching trapped persons depending on their position under the debris of collapsed structures.

Tunneling (see Figs. 6 and 7) is a means used to reach casualties, usually when their location is known. It is slow, dangerous work and should be undertaken only after all other methods have been exploited. It is used primarily for connecting existing voids. Tunneling should be carried out from the lowest possible level, and should not be used for general search; nor should it be aimless. Occasionally, however, tunneling may be used to reach a point (such as a void under a floor) where further search is to be conducted. A tunnel must be of sufficient size to permit rescuers to bring out casualties. It should not be constructed with sharp bends. Whenever possible, tunnels should be driven along walls or between a wall and a concrete floor, so as to simplify the supports required. Debris tunneling is quite different from tunneling through undisturbed earth, although strutting and bracing are necessary in both cases. The speed at which a debris tunnel is constructed varies with the nature of the debris and the size and shape of tunnel required. Because debris is unstable and certain key beams have to be left in place, the shape of a tunnel through debris is often irregular. In debris tunneling, constant watch must be kept for key timbers, beams and girders, the disturbance of which could cause movement and subsequent collapse of the tunnel. Disturbance of the key debris beams may cause collapse of voids preserving victims trapped under the debris.

When there is doubt regarding the quickest means of access to trapped persons, two or more methods may be used simultaneously. For example, a basement may be rached by more than one tunnel. Tunnel atmospheres known to be contaminated with toxic gases or deficient in oxygen will require self-contained breathing apparatus.

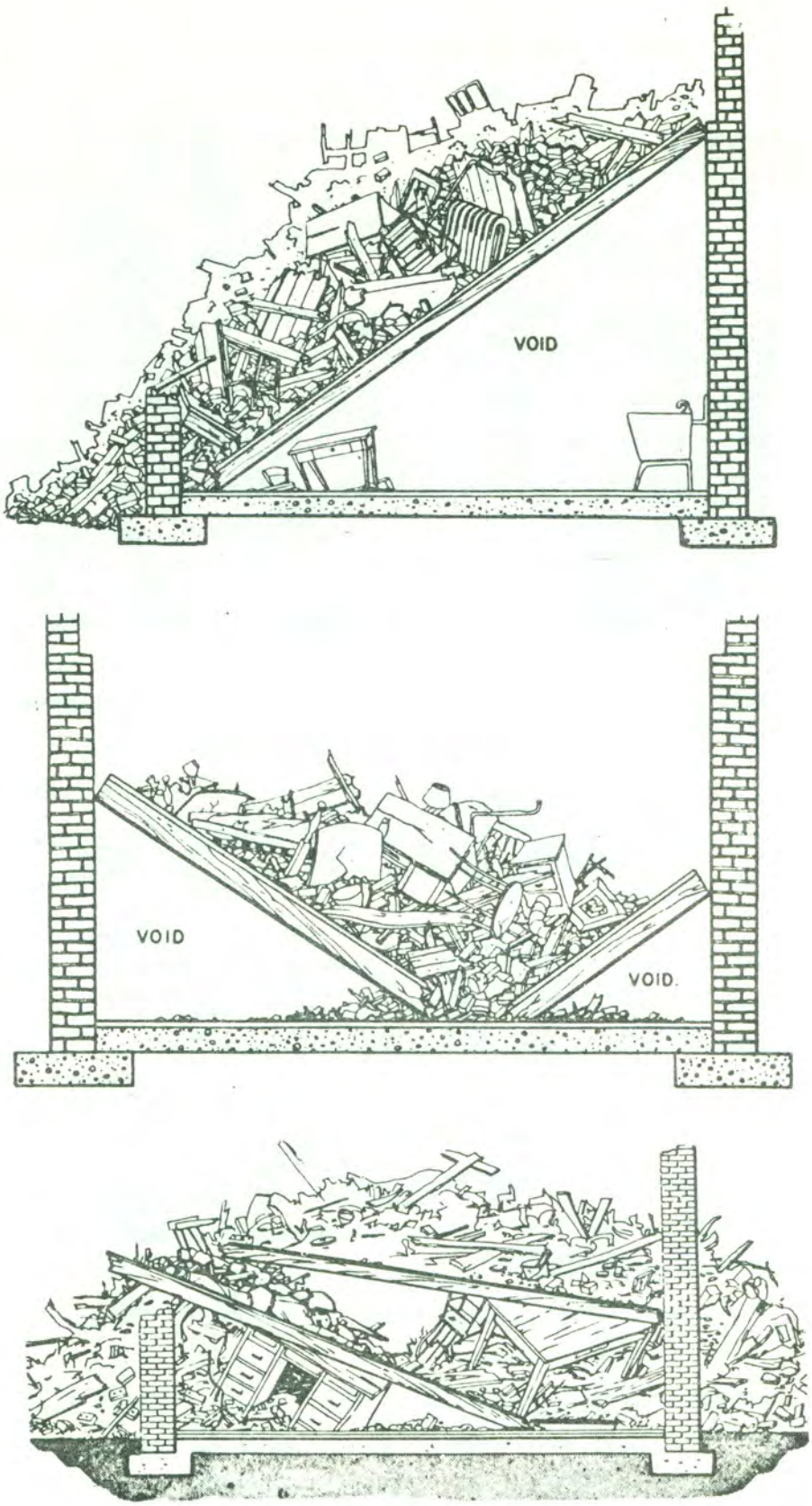

Fig. 5 Types of collapse. Rescue Skills and Techniques, Defence Civil Preparedness Agency (1972).

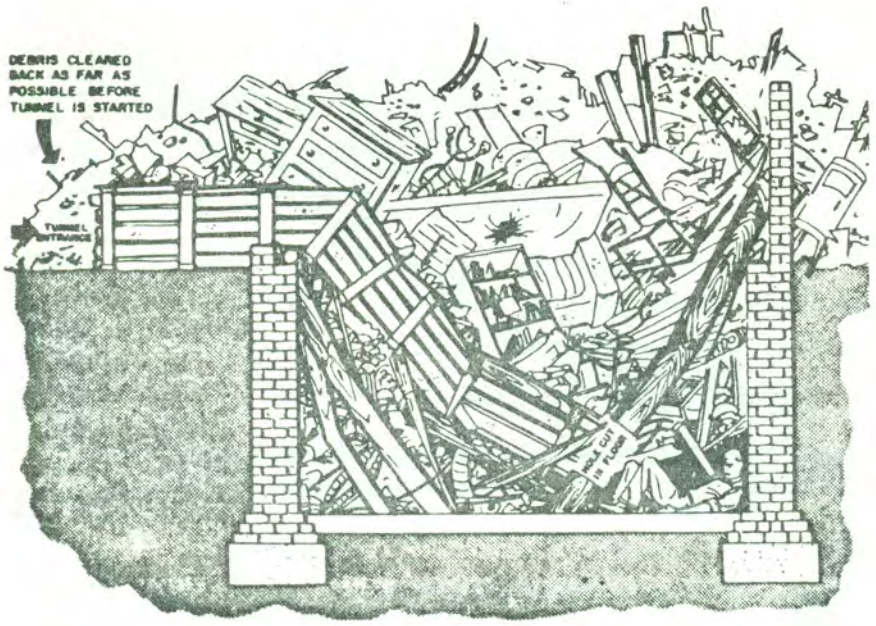

Fig. 6 Tunneling to reach void. Rescue Skills and Techniques, Defence Civil Preparedness Agency (1972).

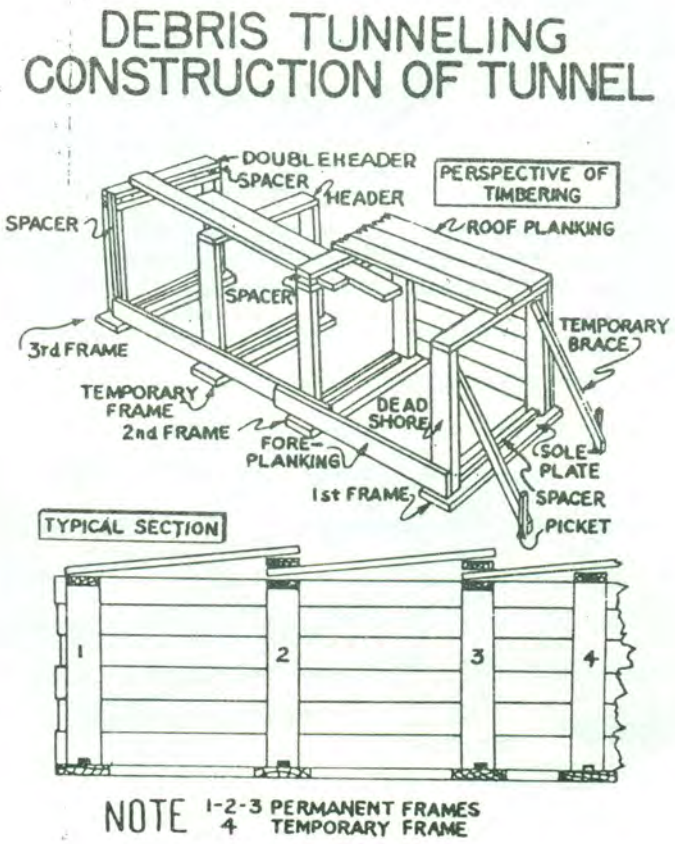

Fig. 7 Tunnel constructions. Rescue Skills and Techniques, Defence Civil Preparedness Agency (1972).

An open trench can often be dug more quickly than a tunnel if debris is not piled up too high. Trenching is used to reach a specific point, not for general clearance. Trenching and tunneling may sometimes be combined, with the tranch extending into the debris until a tunnel becomes necessary.

Shoring is the erection of a series of timber beams to stabilize walls or prevent further structural collapse. Only temporary shoring can be done by rescue teams. Permanent shoring is the responsibility of the competent engineering services. Before removing walls in order to reach a specific location, the safety of trapped persons must be considered. The team leader should carefully study the problem before a wall is removed so that its removal will not further weaken the structure.

Shovels, picks and other standard hand tools are to be used in debris removal only when the location of victims is definitely known and all other casualties have been accounted for. Recognizing a body in debris is sometimes difficult. Therefore, tools (especially picks), if used at all, should be used with great care to avoid further injury. Debris close to casualties should be removed by hand only. Debris should be removed in baskets, buckets and wheelbarrows to areas well clear of the damaged building.

Only when it is reasonably certain that rubble or portions of buildings to be removed do not conceal other casualties, should cranes, power shovels and bulldozers be used for debris clearance to gain access to casualty locations, or to prevent further damage or collapse likely to hinder rescue operations. Such heavy equipment should be under the operational direction of the rescue leader. Although it may be necessary to pile debris in the street, blocking traffic must nevertheless be avoided. All debris that has been removed should be marked and guarded in order to facilitate post-disaster damage analysis to be carried out later by the engineering services.

Valuables and other property must be marked and stored in places according to their position in the debris, so that owners can identify them easily. Team leaders, with the help of the police, must exercise constant vigilance to prevent disorganized and unsupervised groups from digging around the area. Looting must be prevented by the constant vigilance of team leaders and policemen.

The proper care of casualties after release is as important as locating and freeing them from entrapment. Rescue men must be thoroughly trained in this aspect of rescue. There will be many instances in which rescue men, while extricating victims, can prevent further injuries and save lives: controlling bleeding, giving artificial respiration and proper treatment of fractures, burn and shock.

The method employed for casualty removal will depend on the location of casualty and the type of injury he has sustained. In some rescue operations casualties will have to be lowered from upper floors or buildings; in other cases they will have to be hoisted from below through holes in floors, or be removed by a combination of these techniques. After removal many will have to be carried over piles of debris and uneven ground before being turned over for transportation to first aid stations and hospitals. Some will be seriously injured. Some will be unconscious. Speed in removal is important but it should be consistent with safety and proper handling to prevent further injury.

When all live casualties have been released, the recovery of bodies must be undertaken. This is an unpleasant task for which rescue men must prepare themselves. Only rescue men temperamentally suited to such work should be assigned to it. Persons not directly concerned in the removal operations should be kept away. The team leader should see that this is enforced, and if necessary call on the police for assistance.

Rescue men are responsible for filling out an emergency medical tag and attaching it to every casualty, living or dead, initially examined or treated by them. If emergency medical tags are not available, rescue men should use a piece of paper containing the following information:

- Name
- Home address
- Sex and approximate age
- Location when injured, location where found, date and hour
- Type of injury and treatment by rescue men
- Name of first aid worker
- An empty space for other information, if necessary.

2. Materials and tools

There is a long catalogue of standard rescue tools and equipment. The Civil Preparedness Agency of the U.S. Defence Department has published the following detailed catalogue of heavy rescue tools and equipment per team of eight men:

- 2 Apparatus, self-contained, breathing, each w/3 canisters
- 2 Axe, 4-lb., single bit, w/handles
- 48 Bag, burlap, 60-lb. cap., sand
- 2 Band, webbing, for casualty handling
- 1 Bar, pinch, 30" long
- 2 Bar, wrecking, 3/4" gooseneck, claw and pinch point, 30" long, offset type.
- 2 Bit, 1" auger
- 1 Blanket, asbestos, protective w/canvas container
- 8 Blanket (cotton and wool)
- 8 Boots, rubber, pullover, shoe, short United States rubber or equal
- 1 Brace, ratchet head, 12" sweep
- 6 Bucket, glavanized, 14-qt. (heavy gage)
- 1 Can, safety, gasoline, 1-gal.
- 8 Canteen, wo/cup, 2 qt.
- 2 Chain, 6' long, 1700 lb. cap.
- 1 Chain, 6' long, 2-ton cap., w/grav hook and ring
- 2 Chisel, hand, cold, 7/8" x 8"
- 2 Chisel, hand, cold, 3/4" x 12"
- 2 Chisel, hand, 3/4" x 18"
- 8 Coat, rain jacket, medium length
- 8 Container, debris, bucket type
- 1 Container, water, drinking, 5' gal. cap.
- 1 Container, gas, safety, 5-gal. cap.
- 5 Cord, extension, 100', for flood-lights, w/twist lock, water-proof connectors
- 2 Cord, extension, 50' for flood-lights, w/connectors
- 8 Cord, sash, cotton braided, 15' long, No. 8
- 8 Coveralls, 4 medium and 4 large
- 12 Crayon, lumber marking, red and yellow
- 2 Crowbar, 66" length, w/chisel edge (pinch point)
- 2 Crowbar, 72" long, 1 1/2" hexagon handle, w/mushroom and flat ends
- 1 Cutter, bolt, 36" long, 5/8"
- 1 Cutter, pipe, 1/8" to "2, 3-wheel type
- 1 Gear, lifting tackle, 1½ ton cap., 112" lift
- 16 Gloves, heavy debris (pairs)
- 2 Gloves, rubber insulating (pairs)
- 8 Goggles, dustproof, shatterproof
- 1 Hacksaw, frame, w/10 blades
- 4 Hammer, claw, 16-oz. w/handle
- 2 Hammer, ball-peen, 3-lb. w/handle
- 2 Hammer, sledge, 4-lb. w/handle
- 2 Hammer, sledge, 8-lb. w/handle
- 1 Hammer, sledge, 16-lb. w/handle
- 2 Hatchet, carpenters

- 1 Heater, unit, single-burner, pressure type, gas burning for boiling water
- 8 Helmet, protective, w/lighting bracket
- 2 Jack, ratchet, 5-ton cap., w/level
- 2 Jack, ratchet, 15-ton cap., w/level
- 2 Jack, screw, 5-ton cap.
- 8 Kit, first aid, belt type, each w/8 refills in separate container
- 1 Ladder, roof, 12' w/folding hooks
- 1 Ladder, extension, 28' - 2 section
- 1 Ladder, collapsible, 10'
- 3 Light, flood, portable, generator powered
- 4 Light, red-flashing, battery powered
- 8 Light, safety approved, battery
- 4 Mask, gas, filter type, w/canister
- 1 Outfit, cutting, oxygen-acetylene, w/goggles and gloves, 2 spare oxygen tanks, 1 spare acetylene
- 2 Pick, point and chisel, w/handle
- 2 Pick, poll, or mining, w/handle
- 4 Pliers, 8", comb., slip joint w/cutter
- 1 Pliers, 8", wire-cutting, w/ins. handle
- 1 Pole, pike, 8'
- 1 Power unit, gas drive, 2½ Kw. portable, AC
- 1 Pump, stirrup, w/20' hose and jet nozzle
- 8 Rope, manila, ½" dia., 50' length
- 4 Rope, manila, ½" dia., 150' length
- 1 Rope, manila, 3/4" dia., 200' length
- 1 Rope, manila, 3/4" dia., 300' length
- 1 Rope, manila, 1" dia., 300' length
- 6 Rope, wire, 1/4" dia., 15' length, w/capped and eye ends for lashings
- 2 Rope, wire, 3/8" dia., 10' length, w/shackle and eye ends
- 2 Rope, wire, 5/8" dia., 50' length, w/hook and eye
- 1 Ruler, folding, caprtenper's, 6'
- 1 Saw, chain, elec., 18" w/extra chain
- 1 Saw, crosscut, 4½' blade
- 1 Saw, hand, 26" cutting edge
- 1 Saw, floor, silver steel, 10-pt., 18" long
- 1 Saw, power, elec., portable, 8" w/case
- 2 Blades: combination
- 2 Nailcutting
- 2 Carboloy
- 1 Saw, pruning, dbl. edge, 18" blade
- 1 Screwdriver, common, 16½"
- 1 Shears, tinners, 12" (snips)
- 8 Sheeting, rubber, black, 45" wide 84" long
- 2 Shovel, round, pointed, long handle
- 2 Shovel, square mouth, D-handle
- 2 Shovel, tunneling, short D-handle, 18" long
- 8 Stake, metal, 30" long, 1" dia.
- 4 Stretcher, latest Army type (canvas)
- 1 Stretcher, Stokes type
- 1 Tackle block, manila rope, 8" (snatch)
- 2 Tackle block, manila rope, 6" (2 sheave)
- 2 Tackle block, manila rope, 6" (3 sheave)
- 3 Tackle block, manila rope, 6" single sheave snatch

- 8 Tackle block, manila rope, 4" (2 sheave)
- 2 Tackle block, 5/8" wire rope (single snatch)
- 1 Tape, 50' metallic, graduated in inches and sixteenths
- 1 Tarpaulin, 8' x 10'
- 1 Telephone set, self-energizing, w/400' of wire, complete
- 2 Wrench, pipe, 24" Stillson
- 1 Wrench, adjustable, crescent, 12"

Conclusions

Earthquakes rescue teams are indispensable in order to prevent the further extension of damage and loss of life. The problem of their organization and performance must be examined carefully by State and local authorities, and appropriate provision must be made for their creation, organization and training.

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