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TRAVEL AND RESCUE IN CREVASSED AREAS

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IN CREVASSED AREAS

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This manual is offered as an aid for travel in crevassed areas and for rescuing men who have fallen into crevasses. This manual should be studied before going into the crevassed area. Though the methods outlined are relatively simple, they cannot be used effectively without study and practice. A short practice session for knot tying, rope handling, and study of rescue methods is recommended for all personnel who will be in crevassed areas.

This manual is not meant to scare the reader, but to make him reasonably cautious, and prevent him from being helpless if an accident should occur. Travel in crevassed areas will become progressively safer for the reader as he gains experience and confidence in his ability.

I. General Description of Crevasses

The three types of crevasses most common on glaciers are transverse, longitudinal, and marginal crevasses. The transverse crevasses are simple tension cracks which occur at approximately right angles to the direction of flow of the glacier. In other words, they lie across the slope of the glacier. This is the most common type. Also common are longitudinal crevasses which run downslope, or parallel to the flow of the glacier. These cracks are formed when the snow and ice spreads outward at the mouth of a valley. Marginal crevasses are formed near the edge of a glacier, but may sweep in arcs all the way across some valley glaciers. They point diagonally upslope toward the center of the glacier, usually at an angle approximating 45 degrees.

Some crevasses are as deep as 100 to 150 feet, but the majority reach 50 to 100 feet. Crevasses in the snow-covered parts of glaciers are the most dangerous. They are often hidden by snow bridges—layers of snow which cover the void. In temperate zones, travel is most dangerous in early summer, after the snow bridges have begun to lose their strength but before they have collapsed or melted away enough to easily define the surface outlines of the crevasses. In arctic areas such as the Greenland Ice Cap, there is often little melting. Therefore the bridges don't melt away enough to reveal the crevasse pattern even in late summer. Hidden crevasses can often be recognized by slight depressions on the surface or by the slightly dull appearance of the snow over the crevasse. Sometimes only part of the snow bridge will have collapsed revealing the direction of the crevasse.

In snow-covered areas, crevasses often have their maximum width a few feet below the surface. The formation of such a crevasse is illustrated in Figure 1. For this reason, extreme caution should be exercised near the edge of crevasses.

II. Precautions in Crevassed Areas

1. Foot travel

The safest method of foot travel in crevassed areas on snow-covered glaciers is on skis with the individual members of a party roped up. The average skier exerts a force of less than 1/2 pound per square inch on the snow surface as compared with the approximately 4 p.s.i. of a man walking. Since most skiis are about 7 ft. long, narrow crevasses which are bridged can ordinarly be crossed safely at right angles by a man on skis.

For most groups, three or four men equally spaced on each standard 7/16 in. by 120 ft. climbing rope is the ideal roping arrangement. This combination offers the party adequate safety plus ease of mobility.

In an area where hidden crevasses are suspected, the lead man probes ahead as the group moves. He should always be roped to the rest of the party while probing. Probing is usually done with an ice axe or a special long steel probe about 1/4 in. in diameter and 10 to 12 ft. long. When, on hard snow, the probe suddenly goes through without meeting much resistance, the existence of a bridge which is too thin to allow crossing can be deduced.

Travel should be at right angles to the crevasse pattern if possible, with the men following the leader in single file. If it is necessary to travel parallel to the crevasse pattern on a snow-covered glacier, the members of the party should move en echelon, which prevents more than one man falling into any one crevasse. En echelon movement is a little slower than single file, since each man must probe for himself.

While moving, the rope must be kept nearly taut constantly. Do not allow it to drag in the snow. If the rope is kept taut, a man cannot fall far into a crevasse before his fall is arrested.

There are many knots which suffice for tying the members of the party to the climbing rope. Here only a few of the simpler, more practical ones will be shown. The bowline (Fig. 2) is the standard knot used by the end men on the rope. The simple overhand noose (Fig. 3) is commonly used for the middle man. Since one may accidently slip out of the single waist loops formed by the knots described above if they aretoo loose, many climbers prefer both waist and shoulder loops. For this purpose, a bowline on a bight (Fig. 4) serves equally well for either end man or middle man. This knot forms two loops one goes around the waist while the other fits over the chest and shoulder.

2. Vehicle Travel

For vehicle travel through crevassed areas, probing of the route is essential. The lead vehicle should be preceded either by a roped party on skis (the leader doing the probing) or by a lone man who is belayed (anchored by a climbing rope) from the vehicle.

If it becomes necessary to cross snow bridges whose strength is at all in doubt, it is advisable to change the point of crossing after every few vehicles since accident reports indicate that snow bridges are weakened by the crossing fo several vehicles.

In dangerous areas, it is often advisable for the vehicle passengers to get out and travel roped on skis, since foot travel is generally safer than vehicular travel. In crevassed areas, the passengers should not jump out of a vehicle at random, because of the danger of jumping onto a snow bridge covering ahidden crevasse.

To lessen the chance of serous injury should a vehicle fall into a crevasse, seat belts are recommended for the occupants of vehicles traveling in badly crevassed areas.

When vehicles travel in trains, it is mandatory that crevasse rescue equipment (ropes, ice axes , rope ladders, etc.) be distributed as equally as possible among the vehicles. This eliminates the possiblity of one vehicle falling into a crevasse with all the rescue equipment.

III. Rescue Techniques.

A. Rescue of a Member of Roped Party

1. Preparation for Rescue

When a member of a roped party falls into a crevasse, his fall must first be arrested by the other members of his party. This act of arresting the fall of the victim is known as belaying. If the party is on skis, the men should drop to thier hips and brace themselves by digging their ski poles and the edges of their skis into the snow. If the snow surface does not slope stooply toward the edge of the crevasse, this method is very effective, since the friction of the rope sliding over the lip of the crevasse is so great that not too much strain is put on the belay.

For roped parties traveling afoot without skis, the ice axe is essential for belaying on snow. The method commonly used while traveling requires that each member of the party make a loop (simple overhand noose, Fig. 3) of about 6-inch diameter in the climbing rope about arm's length ahead of him. If a member of a party falls into a crevasse, the other men immediately brace themselves and (on the

snow, keeping a firm grip on the axes. In areas where the crevasse danger is great, it is often advisable to hold the ice-ax shaft through the loop while moving. The belay can be made faster if this is done.

After the arrest has been made, it is important to fasten the rope so that the man that has fallen through will not go down any further. If the belay was made with an ice-axe shaft through a loop in the rope, this position may be maintained by the man who is best situated to be used as an anchor point. If there is no hand loop in the rope, put the rope around the shaft of the axe and wrap it over the head of the axe in a figure of eight. Under no circumstances should all members of the party untie from the victim's rope, nor should any unroped person approach the edge of the crevasse.

If the party has skis and the accident occurs in a snow-covered area, the skis should be used to anchor the rope, because they hold better than an ice axe in most types of snow. The butt end of the ski should be forced into the snow (up to the binding if possible) leaning away from the crevasse. The rope is generally anchored to the ski at the surface of the snow with a couple of wraps.

One of the party, securely held by a rope, should approach the crevasse, try to locate the fallen man, get in touch with him, and ascertain his conditon. This is sometimes difficult because of the bad transmission of sound in a crevasse. The fallen man should be eased as much as possible by pulling his rucksack, skis, ice axe, etc. to the surface on a separate line. The edge of the crevase directly above the victim should be rounded off with an ice axe or shovel or stamped down with the feet, taking care not to fall while doing so. At the same time, the rope should be freed from its friction cut if possible. Here care should be taken that falling snow and debris do not injure the man below. If he can touch the sides of the crevasse, the fallen man may ease his position by cutting hand and foot holds in the wall.

2. Methods of Rescue

a. Rescue with single rope (Fig. 5) --The rope is anchored to an ice axe or ski by a simple single wrap around the shaft of the axe or around the ski. Two or more men then

pull up on the rope to get the fallen man out of the crevasse. The single wrap used will have just enough tension on the ice-ax shaft or ski that the rope can be pulled in easily by the belayer yet can be held against any pull with little effort. The men who are pulling should stand close to the edge of the crevasse to decrease the friction between the rope and the snow. They should be belayed at all times. This group should pull up with regular movements under the direction of the man in charge of the rescue. As they pull up the rope, the belayer should bring it in, utilizing his wrap belay. The men who are pulling up may rest at any time because their load will be supported by the belayer. If the climber is not injured, he may be able to aid the group which is pulling up by getting occasional hand or foot holds on the side of the crevasse.

This method is extremely difficult without a party of three or more men. It is almost impossible for one man to pull a companion out in this way and two men would have great difficulty. Also, other help should be available to belay the men who are pulling up the man in the crevasse.

b. Rescue with the aid of a karabiner and a spare rope (Fig.6)

In this method, the man in the crevasse is held fast by the main rope. Secure one end of a second rope (at least twice long enough to reach the man in the crevasse) to an ice axe or ski jammed into the snow. Clip a karabiner (Fig. 7) on this rope and lower the karabiner on the middle of the doubled rope to the man in the crevasse. He attaches the karabiner to his waist loop. This second rope goes, therefore, from the anchor point down to the man in the crevasse and back up to to members of the rescue party who will be pulling up. The individual ropes should be at least a foot apart at the edge of the crevasse to avoid entanglement. The men at the surface pull up on the free end of the second rope and haul the victim to the surface utilizing the 2-to-1 mechanical advantage offered by the karabiner, which acts as a simple pulley. As the man in the crevasse is hauled toward the surface, the belay with the main rope should be kept taut at all times.

c. Rescue by the double-stirrup method — (Fig. 8) If the victim is not seriously injured and a second rope is available, this is the most efficient of the rescue techniques. After a belay has been put on the fallen man, utilizing the main rope, a small loop (large enough for a man's foot) tied at the end of the second rope is lowered to him. This rope is anchored to a second belay point. It is a good idea to lay an ice axe or ski or similar article under this rope at the point where it goes over the edge of the crevasse. This eliminates friction between the rope and the snow.

The man in the crevasse pulls the loop in the second rope through his waist loop and steps into the small loop with one foot. The second rope is then pulled tight by the belayer controlling it. The fallen man calls for slack in the main rope and ties an overhand noose in this rope about 4 or 5 feet from his waist loop. He then pulls this loop down through the waist loop and puts his foot in it. While the main rope is slack, it should be pulled out of its groove at the edge of the crevasse and allowed to slide over the ice axe that was placed for the second rope.

The victim is then brought to the surface in the following manner: By resting all his weight on the first rope, the other becomes slack and may be pulled up about two feet and then secured by the belayer controlling it. The victim then transfers his weight to the foot loop in the second rope, and the first goes slack, is pulled up about 2 feet beyond the second rope, and secured. He thus "walks" up out of the crevasse.

During this operation, the man being pulled up must stand vertically in the foot loops. He must allow his companions ample time to secure the ropes above between each step. The timing of the operation works better if the victim is within speaking distance of the belayers. The ropes must be pulled only step high or the victim may be upended. The ropes must be secured for each step so that they don't slip back or twist around each other.

This method extricates the victim from the crevasse with a minimum of effort since there is no loss of energy due to friction. The work is all done by the victims legs. Also, this method is safer than the previously mentioned ones because the rescuers don't have to stand right on the edge of the crevasse. As both ropes go through the victim's waist loop, his body

cannot fall backwards. The ropes cannot become jammed on the edge of the crevasse because they are free from weight as they are pulled up.

d. Self-rescue by the Prusik method (Fig. 9) -- The above methods are mainly intended for parties of three or more men. If two men should have to travel alone on a glacier, the Prusik-knot method should be used for crevasse rescue. After the fallen man has been belayed, he utilizes three short lengths of line (¼ inch or even smaller) about 6 feet long to climb the main rope to the surface. He ties bowline foot loops in two of the short lengths of line and attaches these lengths to the main rope at about shoulder height by means of a Prusik knot (Fig. 10). The lenght of the rope from the Prusik knot to the bottom of the foot loop should roughly correspond to the height from the man's feet to his shoulders. The third length of line (which may be a little shorter then the other two) is fastened by a Prusik knot to the main line a foot or so above the other two knots. The end of this length is tied into a loop around the man's chest. The Prusik knot is used in this method because these knots can be slid up the main rope when they are free of drag, and they will remain fixed under tension.

Then by moving first one stirrup and then the other, it is possible to climb the rope with little exertion, and at the same time, by pushing up the chest loop, the victim can prevent loss of balance and can rest at any time by leaning back on the loop.

It should be noted that it is difficult to move the knots when the climbing rope is wet or frozen, and the problem of surmounting an overhanging lip is difficult unless assistance can be given from above.

For travel by parties of two or three members in crevassed areas, it is recommended that each man carry the three 6-foot lenghts of line with him for use in a Prusik-knot rescue. Since these lines are very light, they add little weight to each man's load. The stirrups and chest loop should be tied in the lines before starting, to simplify the procedure after the fall.

If the fallen man is seriously injured and unable to rescue himself by the Prusik-knot method, the problem is indeed serious. If the man on the surface can go for help and return in an hour or two, he should do so. Before leaving the man in the crevasse, he must be sure that the victim's rope is securely anchored. Also, he should leave some landmark on the surface near the crevasse so that he will be able to find it again. This should be some object that can be seen for a considerable distance, e.g. a shirt or jacket draped over an ice axe.

If no help is nearby, the man on the surface should try to make the rescue himself. If the victim is light in weight, it may be possible to merely pull him up out of the crevasse. If not, the rescuer should make sure the rope is well anchored, and, utilizing the prusik-knot slings , he should climb down the rope to the injured man. This is done exactlyas described above except that the Prusik knots are slid down instead of up when they are free of weight. When the rescuer reaches the injured man, he should tie the victim to himself. T is can be done with a short piece of 1/4 inch line or by snapping their two waist loops together with a karabiner. Then the rescuer should climb back out of the crevasse with the Prusik-knot method, carrying the victim up behind him. Serious difficulty will be encountered at the lip of the crevasse. At best this method of rescue is both difficult and dangerous. In some cases it will be impossible to carry out. The difficulty encountered in this type of rescue is sufficient reason for not allowing two-man parties to travel alone in crevassed areas unless absolutely necessary.

B. Rescue of Unroped Man

It is of course hazardous to travel afoot in crevassed areas unless the party is roped up. If an unroped man falls into a deep crevasse, his chances of survival are not very good. Of course, many crevasses are not deep enough to necessarily cause injury. And, in the deeper ones, the fall may be broken by the remnant of a snow bridge part way down the crevasse. There have even been cases when a man has fallen 100 feet or further into a crevasse and not been seriously injured.

For these reasons, a rescue attempt should be made even though the victim's plight may seem hopeless . The first step is to try to locate the man and determine his condition. If his position is at all precarious, he should be cautioned not to move around. If he is not seriously injured, two ropes may be lowered to him and he can be rescued by the double-stirrup method (Fig. 8) or by one of the similar methods prescribed for rescue of a roped victim.

If the victim is seriously injured, a member of the rescue team must be lowered into the crevasse to aid him. The double stirrup method of rescue (Fig. 8) should be used for climbing down into the crevasse. The same principle is descent as for

ascent except that the two ropes are paid out step by step by the belayers instead of being brought in.

If the victim is unconscious, locating his position may be difficult. Usually the point of his breakthrough will be well marked, however. During his descent, the rescuer must be careful not to dislodge snow or ice while directly above the victim.

If the victim is so gravely hurt that moving him may injure him further, it is recommended that he be brought to the surface in a stretcher or similar litter in which he can be strapped so that there is no danger of falling out. It is generally difficult to get a man in a litter to the surface, but it can be done if enough ropes, manpower, and patience are available. The simplest method is to fasten a rope to each end of the litter and pull the ropes up in the single-rope technique (Fig. 5). A better method is to fasten a karabiner to each end of the litter, run a separate rope through each karabiner, and proceed as in Fig. 6. In these procedures, both ropes should be pulled up at the same rate so that the litter will remain horizontal. Simple slings may be devised to tie the ropes or karabiners to the litter so that it will be steady as possible. These depend upon the ingenuity of the rescuer.

As the victim is hauled toward the surface, the rescuer who is in the crevasse with him should climb at the same rate by the double-stirrup method and help to maintain the balance of the litter. Some difficulty will be encountered at the lip of the crevasse. Obviously the rescue of a man by litter will require several men and ropes. Care must be taken that the ropes will not become entangled.

An injured man in a crevasse is in danger of freezing and may be unable to tell his rescuers that he is cold. Therefore they must make sure that he is kept warm during the rescue. If he is brought up in a litter, he should be wrapped in blankets or a sleeping bag. Also his hands and ears should be kept covered to prevent frostbite.

C. Rescue of Party in Fallen Vehicle

This obviously is a major problem. In some cases the vehicle will be jammed between the walls and the top may be crushed so that the occupants cannot escape.

The initial procedure is somewhat the same as for the rescue of a single man who has fallen into a crevasse unroped. First the vehicle is located. Then one of the more experienced members of the party should climb down to the vehicle by the double-stirrup method (Fig. 8)

and evaluate the situation. Usually, if the vehicle is jammed between the walls of the crevasse, there is little danger of dislodging it.

If the occupants are trapped in the vehicle, tools and additional men may have to be lowered to the vehicle to extricate them. After they have been removed from the vehicle, the victims may be brought to the surface by the methods described for rescue of unroped persons.

IV. RESCUE EQUIPMENT

The minimum amount of rescue equipment to be carried by any party traveling in crevassed areas afoot or by vehicles should be approximately as follows.

1 ice ax per man
1 7/16 in. by 120 ft. climbing rope per man (nylon)
At least 20 ft. of 1/4 in. sling rope (preferably nylon) per man
1 karabiner per man.

In many crevassed areas where personnel are required to work or travel, a rescue party can have equipment at its disposal which is not available to the ordinary mountain rescue group. In areas such as the crevassed zones of the Greenland Ice Cap, for instance, oversnow vehicles, timbers, pulleys, ladders, stretchers, etc. might all be available to the rescue team. In fact it is recommended that items of this type be included whenever possible in the equipment of groups working or traveling in crevassed areas. Additional rescue gear (ropes, karabiners, etc.) and first-aid supplies should be ready at the main air base nearest to the crevassed areas for air drop at the scene of the accident.

INSERT: At the bottom of page 4., add the following:

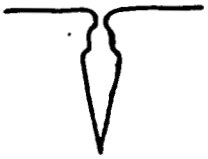
.... shafts of their ice axes through their individual loop and into the.....

a. Crevasse is beginning to form

b. Crevasse is bridged by new snow

c Snow bridge is broken in center by melting and by further opening of crevasse

d Another snow bridge forms



e. Snow bridge is broken by melting and further opening

FIGURE 1. HOW A CREVASSE FORMS

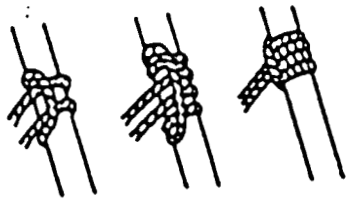
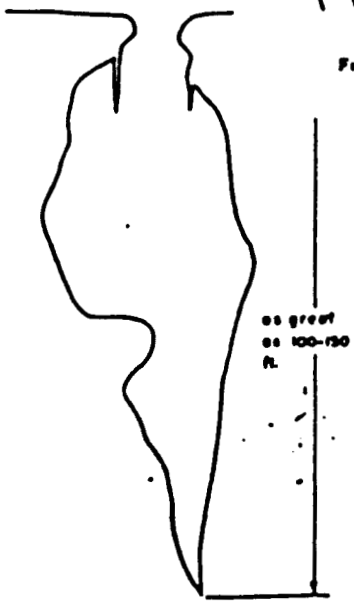


FIGURE 10. PRUSSIK KNOT



f. Cross section of a mature crevasse might look something like this.

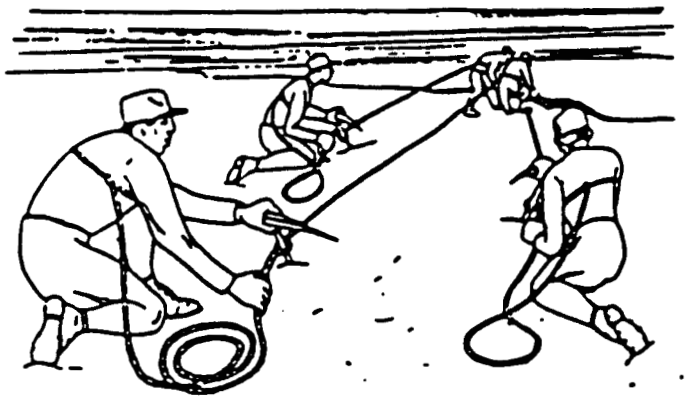


FIGURE 5 RESCUE WITH A SINGLE ROPE

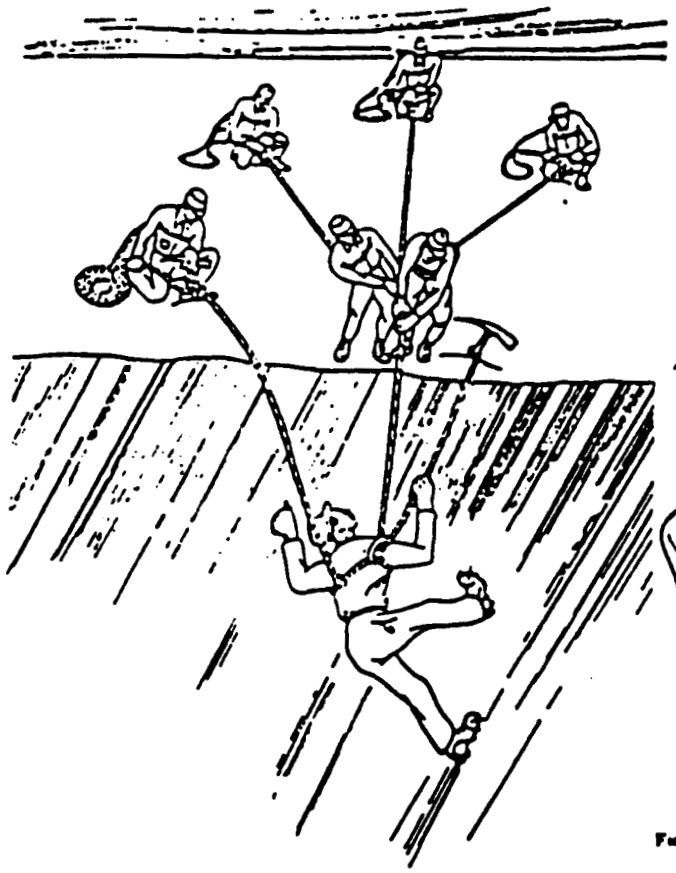


Figure 6. Rescue with the Aid of a Karabiner and Spare Rope

Figure 8. Rescue by Double-Strand Method

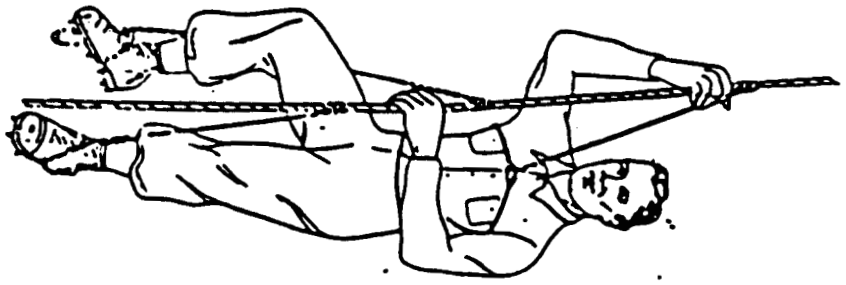


Figure 9. Self Rescue by Prusik Method