



IMPROVED PATHS AND TRACKS

PART 3

The improvement of paths and tracks in steep, hilly, and mountainous terrain presents a particular challenge. It is precisely in these areas, of course, that roads are few and rural communities depend heavily on paths and tracks for many of their journeys. So, improving paths and tracks in steep terrain can bring significant benefits to local people by making them both easier and safer to use. The main problem in steep areas is that paths and tracks can become slippery and eroded as a result of rainfall, making them dangerous to negotiate. This technical brief examines ways of improving paths and tracks by: reducing gradients by realigning steep sections; constructing steps on steep sections; and combating erosion by constructing water bars.

Reducing gradients

The most obvious method of improving a very steep section of a path or track is to reduce its gradient by choosing a new alignment. This can be achieved by constructing a path which ascends a slope diagonally, either as an oblique path or through a series of zig-zags, rather than directly up the slope.

A new route can be selected by following this basic procedure:

- Decide on the maximum desirable gradient.
- Mark this on the ground using pegs and a clinometer or other angle-measuring device.
- Walk the route to inspect for obstacles and hazards.

Desirable maximum gradient

The desirable maximum gradient is one that users of the path or track can negotiate without major difficulty. For a pedestrian, the desirable maximum gradient is 12 per cent or about 1 in 8. For wheeled vehicles and heavily loaded porters, the desirable maximum gradient is lower. General guidelines are given in Figure 1.

User	Desirable	maximum gradient
Bicycles with trailers	5%	1 in 20
Bicycles	7%	1 in 14
Animal-drawn carts	8%	1 in 12
Loaded porters	10%	1 in 10
Pedestrians	12%	1 in 8
Pack animals	12%	1 in 8

Figure 1: Desirable Maximum Longitudinal Gradients for Paths and Tracks

Marking the route

The new route can be set out on the ground using wooden pegs and a clinometer. A clinometer is a small, hand-held instrument with an eyepiece through which the angle of the line of sight can be read off. A simple, but effective clinometer can be made with a spirit level, straight pole and plastic protractor, as shown in Figure 2.

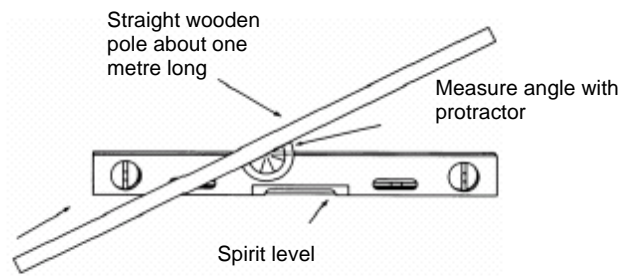


Figure 2: A simple clinometer

It is most important to walk carefully the whole of the marked-out route to inspect for hazards and obstacles, such as gullies, unstable soils, and areas of hard rock. Time spent in adjusting and refining the route at this stage can save a lot of time and effort later. It is particularly important to look at the slope from the top downwards, as it is usually easier to spot potential difficulties from above.

Zig-zags

Reducing the gradient on long, steep slopes often requires the construction of a series of zig-zags. These are sections of gradient alternating in direction up the slope, called 'limbs', joined by sharp bends, called 'hairpins'. There are a number of points to bear in mind with regard to the arrangement and details of zig-zags. Repetitive limbs of the same length between hairpins are not recommended, as each hairpin will discharge directly onto the hairpin below, creating drainage problems. Also, it can encourage users descending the path to cut across between the hairpin bends, further exacerbating slope erosion. Varying the length of the limbs, as shown in Figure 3, is the preferred arrangement.

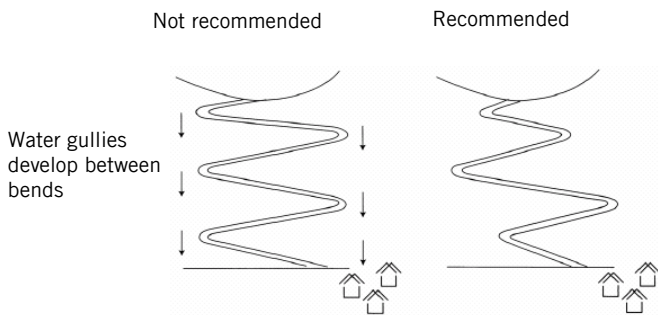


Figure 3. Vary the length of the limbs to prevent gullies

in bends

etting-out and ruction of hairpin bends : of the trickiest tions in path and track vement. They are the s that are most rable to erosion, and d always be positioned stable part of the slope. urning area needs to be flat, and the least steep of the slope should be n if heavy earthworks are avoided. The gradient of limb should be ased (made steeper) just e and just after each where possible. This urages people from g across the inside of the bend. Typical details are shown in Figure 4.

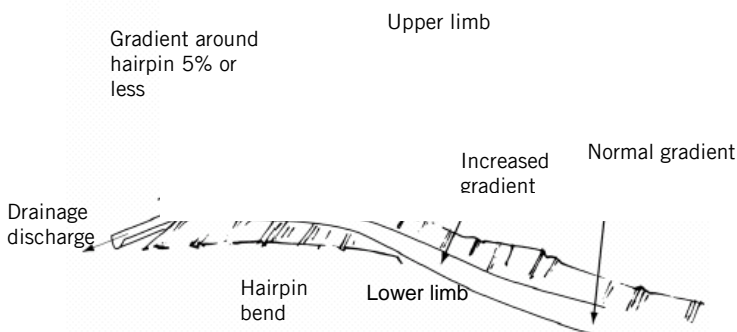


Figure 4: Layout of hairpin bend

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Steps

The construction of steps is another method of improving the steep sections of footpaths. Steps enable moderately steep slopes to be ascended and descended safely. They do have a number of drawbacks, which must be considered before taking a decision to construct steps. The main points to consider are that steps:

- can be difficult to negotiate for anyone carrying a headload and unable to look down at their feet;
- will block the route to any wheeled vehicle;
- can be difficult for pack animals, particularly when they are going downhill; and
- will require frequent maintenance.

The tread length should be either one metre, equivalent to two paces, or half a metre, about one pace. This enables people carrying heavy loads to keep to a constant rhythm when ascending or descending the steps. For comfort, the rise of the steps should be in the range of 160 to 250mm. In any flight of steps, the rise of each step should be kept the same



Figure 5. Typical timber pole or bamboo steps

throughout. The steps should be wide enough so that users do not have to move off to the side to pass each other, so this encourages the development of a parallel path which may erode quickly. One metre provides a comfortable width of step. The top surface of the step should slope slightly downwards from the back to the front of the step. This helps drainage by preventing the formation of puddles on the treads. The steps themselves can be constructed of stone, timber poles, or bamboo. Wooden steps should be secured by two stakes about 500mm long. They should be driven into the ground in front of each step and positioned about 200mm from each end of the step. The top of the stakes should be level with the top of the step. Typical details of timber/bamboo steps are illustrated in Figures 5 and 6.

Combating erosion

Erosion becomes more of a risk to paths and tracks as the terrain steepens, because the erosive power of water increases with the increased speed of flow. As paths and tracks are not covered by a protective layer of vegetation, such as grass, they are particularly prone to

erosion. They can even become waterways themselves, resulting in an accelerated cycle of gully formation, rapidly destroying the surface of the path. To reduce the risk of erosion on paths and tracks it is necessary both to control surface run-off and to avoid excessive concentrations of water flowing over their surface. One common and inexpensive method of diverting surface water off paths is to construct water bars across the path. Similar methods can be used on tracks, but water bars are less convenient for the passage of wheeled traffic. The principle of the water bar is that it intercepts surface water

flowing along the path and diverts it off the path to one side. Water bars can be constructed in stone or timber. The desirable angle of the water bar to the path varies with the steepness or longitudinal gradient of the path: the steeper the path, the greater the angle necessary. A typical timber pole water bar is illustrated in Figure 7.

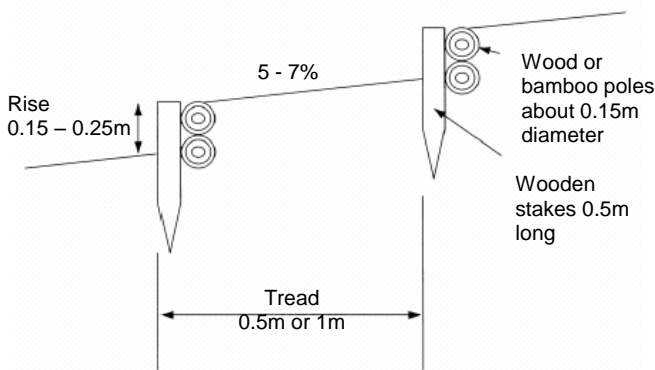


Figure 6: Construction detail of timber pole or bamboo steps

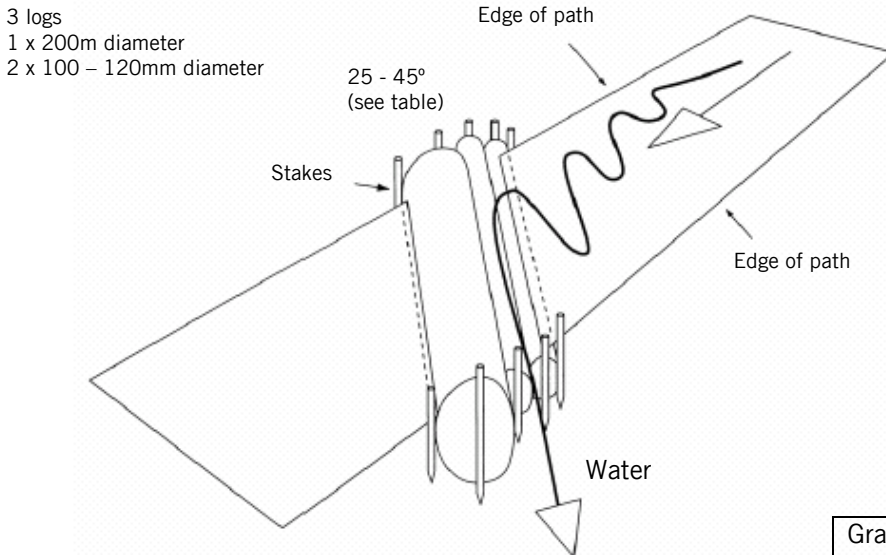


Figure 7. A timber pole water bar

Gradient of path %	Angle of Water bar
5	25°
10	35°
>15	45°

Recommended spacing of water bars (metres)

Type of soil	longitudinal gradient %						
	2	4	6	8	10	12	15
Loam	100	50	30	20	15	*	*
Clay – sand	150	100	60	50	30	15	*
Clay or clay-gravel	–	150	90	60	50	30	20
Gravel/rocky	–	–	230	150	100	80	50

* gradient not recommended in this soil type
– water bars not usually required

References and further reading

- [Improving Paths and Tracks Part 2](#) Practical Action Technical Brief,
[Improving Paths and Tracks Part 1](#) Practical Action Technical Brief,
[Dry Stone Causeways](#) Practical Action Technical Brief,
[Rural Transport Services](#) Beenhakker, H., with S. Carapetis and others, IT Publishing, 1989.
[Roads are not Enough](#), Dawson, Jonathan and Ian Barwell Practical Action Publishing, 1993.
[Earth Roads: Their construction and maintenance](#), Hindson, J., revised by J. Howe and G. Hathway, Practical Action Publishing, 1983.
[Low-cost Vehicles: Options for moving people and goods](#), Gordon Hathway. Practical Action Publishing, 1985.
[Low-cost Load-carrying Devices: The design and manufacture of some basic transport technologies](#), Ron Dennis, Practical Action Publishing, 1995.
[Labour-based Road Construction: A state of the art review](#), Paul Larcher (Ed.), Practical Action Publishing, 1998
[Road Maintenance and Regravelling \(ROMAR\) Using Labour-Based Methods: Handbook](#), Claes-Axel Andersson et al, Practical Action Publishing, 1996,
[Footpaths and Tracks: A field manual for their construction and improvement](#), Ron Dennis et al, I.T. Transport Ltd., March 2002,
[Upland Pathwork Construction Standards for Scotland](#), Upland Path Advisory Group,

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The International Forum for Rural Transport and Development is a global network of individuals and representatives from government, academia, multilateral and bilateral donor agencies, consultancies and technical institutions, national and international NGOs and groups of community organisations in 83 countries in Africa, Asia, Europe and North and South America. There are over 1800 members in the network. The Forum's long-term vision is of a world in which rural communities, particularly those who are poor and disadvantaged, have improved accessibility and mobility.

Forum News is produced by the Secretariat, four times a year in English, French and Spanish. Members receive the newsletter free of charge. Each issue of the newsletter is based on a specific theme. Themes addressed in past newsletters have included sustainable rural livelihoods, gender and transport, engineering for transport, networking, maintenance, and community participation

[International Labour Office](#), Employment Intensive Investment Programme – useful publications and case studies on labour intensive road construction; not specific details on paths and tracks.

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