Appropriate Environmental Design and Construction of Low-Volume Rural Roads in Austria

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A major portion of Austria's network of rural roads, which has a total length of about 160 000 km, is situated in hilly and mountainous regions where protection of the existing landscape is a primary concern. Much of the criticism raised by conservationists against the disturbance of these regions by road construction is not unfounded. Builders are, therefore increasingly called upon to replace purely technology-oriented solutions with holistic, interdisciplinary approaches that take into account the need for wildlife and landscape conservation. This paper describes how consideration is given to these aspects in the three essential phases of a project: design, construction, and integration into the landscape. It identifies current standards and guidelines in Austria and provides examples of practical applications of bioengineering methods.

The low-volume rural road network comprises all roads that are neither federal nor provincial and provide access to rural areas.

The total length of the Austrian road network is about 200 000 km, almost 80 percent of which may be classified as low-volume or rural roads. The traffic volume on these roads is very low, typically less than 100 vehicles per day. Many of these roads are unpaved.

Austria's low-volume rural road network may be divided into the following categories of roads and road functions:

- Community-owned roads outside villages and towns;
- Farm-to-market roads connecting farm areas, single farm houses, or small villages with the higher road network, and
- Forest roads.

Responsibility for construction and maintenance lies with the communities or the road users (road owners) themselves, who form associations having responsibility for the financing of construction and maintenance. Financial assistance is provided by the federal and provincial governments.

A major portion of the rural road network is situated in hilly and mountainous areas, which are of great environmental sensitivity. This has, in some cases, caused serious problems and resulted in interventions by environmentalist groups. Even though protests have been associated with only a few negative examples, it is still necessary to improve planning and construction procedures and to find new ways of interdisciplinary cooperation.

In the execution of road construction projects three phases can be distinguished: planning and design, construction, and integration (bioengineering and landscaping). Constructing roads that integrate well with the surrounding countryside requires equal attention to all three phases. It is essential to minimize any disturbance of the landscape. Environmentally friendly correction of faulty design at a later stage is virtually impossible. Likewise, reckless and incompetent construction work may destroy the beneficial effects of even the most carefully selected road location. As a rule, any scars inflicted on the landscape can seldom be remedied by corrective measures later, and only at much higher cost.

The following discussion will briefly address those points to which special attention must be given in the phases mentioned to ensure that road projects are executed in an environmentally appropriate manner (*1*).

Planning and Design

The first steps to preserve the countryside while providing access to it must be taken in the planning and design phase. The planner must examine the necessity of a project and its relationship to other objectives, but it is the designer's task to execute concrete measures in a way that keeps disturbances of wildlife and the landscape to a minimum.

Special consideration must be given to the following points.

- General development planning: To avoid impractical solutions and uncoordinated parallel projects, preliminary master plans should be established for every defined planning region. These plans must take into account all the objectives that should be achieved to provide integrated planning of the process as a whole.
- Careful examination of alternatives: Before a final road location is selected, all alternatives and aspects available must be carefully studied in detail, including an assessment of the development effects of construction and maintenance costs as well as the effects of the technological aspects that are critically important in estimating the magnitude of the intervention required and the risks involved and a study of the ecological impact on the landscape (*2*).
- Road function—alignment: The selection of structures is determined by two factors: road class and function and difficulty of the project, particularly with regard to ground features and sensitivity of the terrain to construction work. As high alignment standards generally require massive intervention in difficult terrain, the primary objective in specifying the principal parameters should be to preserve the landscape as much as possible.
- Road function—road width: Especially in steep terrain, specification of the road width is an important factor in determining the magnitude of intervention to the terrain. The normal cross section should therefore be specified for maximum economy. The option of using narrow cross sections with road widenings at certain intervals should be considered again.
- Terrain-oriented road location: The "zero-line location method" (a step-by-step method for fixing the location line with a given longitudinal gradient directly in the terrain), which has been used for many years to construct roads in hilly and mountainous areas, is the ideal tool for fitting roads to the terrain. There are no real limits to project accuracy. If required in specific cases, detailed plans may accompany the general plans that are normally used. If the goal is to make roads flow with the terrain, this design technique is superior to map-based location and design.
- Allowance of special landscape features (blending): Roads have traditionally been prominent features in a landscape. When construction methods were limited by narrow technology, roads blended well with the existing landscape. The invention of earth-working equipment that can move entire mountains has frequently destroyed the harmony between roads and landscapes. From the design stage, therefore, roads should be aligned in a way that is appropriate to the character of the surrounding country and allows for landscaping measures (planting, fences, groups of trees, and so forth). This approach includes judicious location of routes along bodies of water or woods.

Under the auspices of *Forschungsgesellschaft für das Verkehrs- und Strassenwesen* (Research Association for Transport and Roads), a guideline for rural roads (*3*) was recently issued. This guideline incorporates the considerations of roads and landscape. It is essentially a technical guideline, but it was used to provide a framework for a reasonable and effective application of environmentally friendly design principles.

In 1988 the Federal Ministry for Agriculture and Forestry published standards for environmentally compatible rural road construction as part of the Council of Europe's campaign for rural areas (*4*). This pamphlet describes environmentally sound planning and construction practices for rural roads and provides numerous proposals on how to reduce or minimize undesirable effects on the landscape and the environment (*5*). It contains a variety of concepts that are described in the following sections.

Construction

The guiding principle of construction is that the main objective must always be minimum interference with

the landscape. The landscape must be given priority, even when conflicts arise with respect to rationalization measures, mechanization, or minimization of construction costs.

The main points in this context include the following (*6*).

- Minimization of intervention during construction (choice of width, shape of profile, felling of trees). Creating less disturbance of the landscape means smaller scars needing remedial action.
- Use of blasting methods with minimal disruptive effect on the bedrock to avoid deep-reaching loosening of the slope as well as other blast-related damage. Less destructive blasting operations mean less need for supporting and maintenance measures.
- Use of excavators instead of bulldozers in steep terrain to build a road structure with minimum cross section but maximum strength.
- Longitudinal removal of excess material that is not used in the cut-and-fill operation.
- Careful selection of sites for filling land with excess material and their integration into the landscape (i.e., recultivation).
- Responsible assessment of risks. This aspect is of particular importance in rural road construction because for cost reasons, high risks are often accepted. Consequential costs may be disproportionately high compared with costs of highway construction and the disastrous effects that may occur (e.g., landslides).
- Where appropriate with the risks involved, supporting measures should be taken in good time and preference given to ecological and flexible construction methods.
- Choice of suitable pavement. Unbound surface layers should be used wherever possible since they minimize the disconnecting effect of roads on microfauna, such as small rodents, creeping insects, and reptiles. The need for bound surface layers must be carefully examined, taking into account expected traffic volume, winter maintenance, the danger of erosion, and so forth. In some cases, partly paved cross sections ("track way") may be a good solution. Figure 1 shows a partly paved cross section, which is also included in the Austrian design guideline for low-volume roads (*3*).

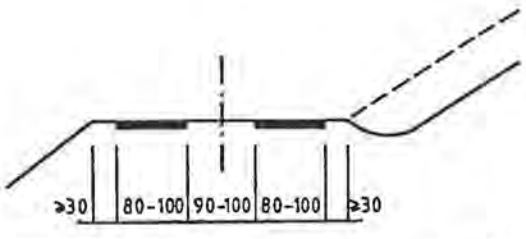

FIGURE 1 Partly paved cross section ("track way") (*3*).

Bioengineering and Landscaping

Bioengineering is an integral part of construction. However, because of its special importance to environment-oriented road construction in mountainous areas, bioengineering is treated separately even though it means environment-oriented construction methods to support and protect the road structure (i.e., protection against erosion, supporting structures, and so forth) and employing grass and other plants as revetment and for a better blending into the landscape. In many cases, an additional benefit is the draining effect of structures incorporating living plants. These "softer" methods are generally preferable to hard, purely technology-oriented methods such as concrete supporting walls.

In Austria, bioengineering has a long-standing tradition. Excellent literature is available in the field (*7–9*). In highway and motorway construction, these methods have been applied successfully for many years. Some of the bioengineering supporting structures are a continuation of traditional practices of rural road construction.

A few of these methods are discussed below (*10*):

- Revetment (for the prevention of soil erosion and the turfing of slopes), including sod work, seeding, and spray seeding methods (wet seeding, seeding followed by the application of mulch, and *schiechteln*® (i.e., seeding combined with the application of a straw cover, and so forth).
- Stabilizing structures (for stabilization and planting on slopes), including interwoven fences consisting of living plants (Figure 2), fascine work, and strips of shrubs (Figure 3).
- Combined types (for use as supporting structures and for slope stabilization), including drywall/blockwork with living plants (Figure 4), Krainer wall made of timber or cast concrete units (Figure 5), hard gabions (Figure 6), and grillage with living plants grown from cuttings (Figure 7).

A second important aspect in this context is the measures integrating the road structure into the surrounding countryside. These may include the following:

- Planting during and after construction work,
- Suitable design of bridges and culverts,
- Wooden railings wherever possible,
- Aesthetic design of fences along roads, and
- Other features, such as provision of parking along scenic routes and at the beginning of footpaths and good integration of crossing paths.

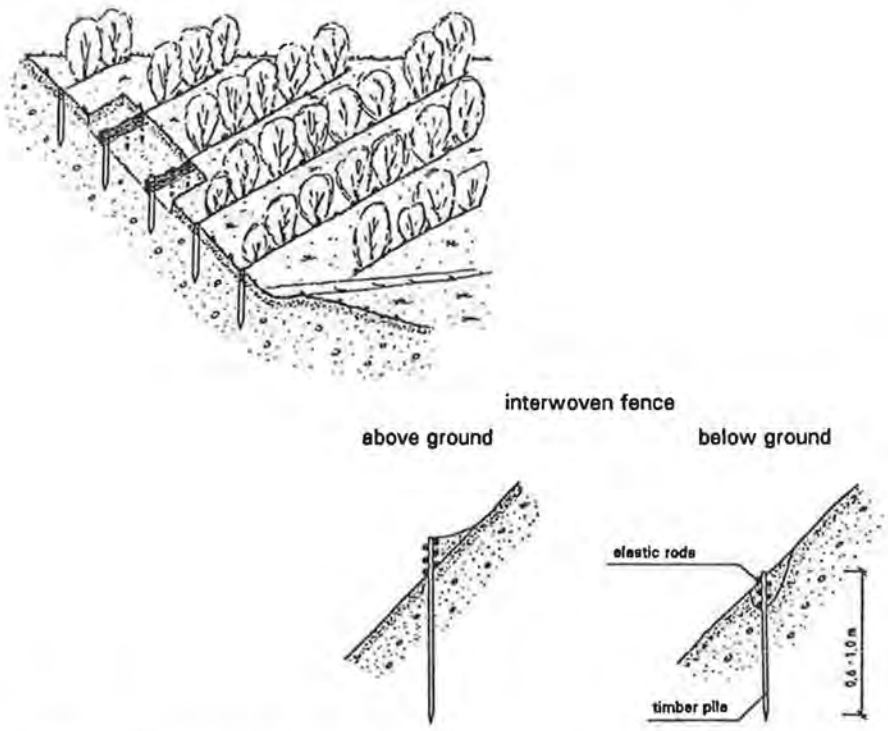

FIGURE 2 Interwoven fence of living plants.

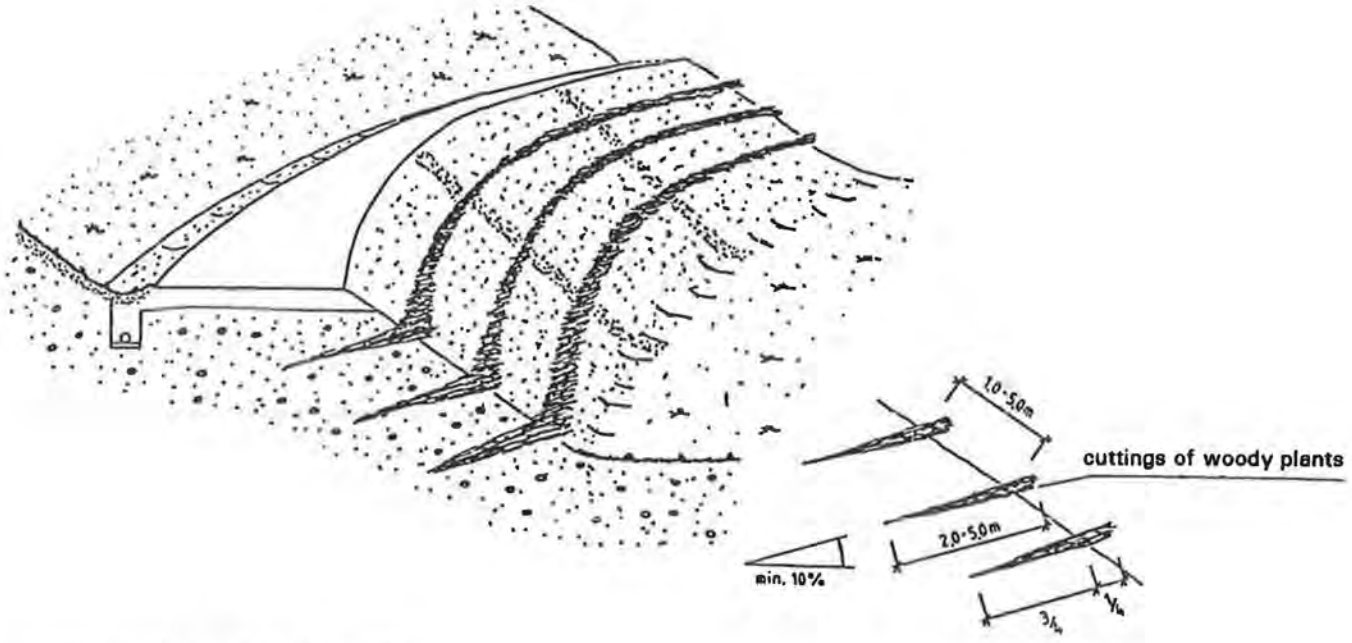

FIGURE 3 Strips of shrubs on fills.

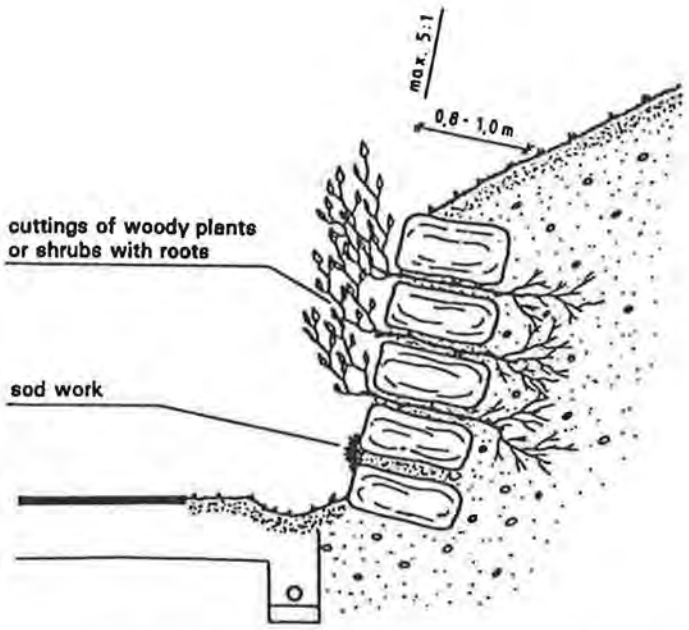

FIGURE 4 Drywall and blockwork with plants: cross section.

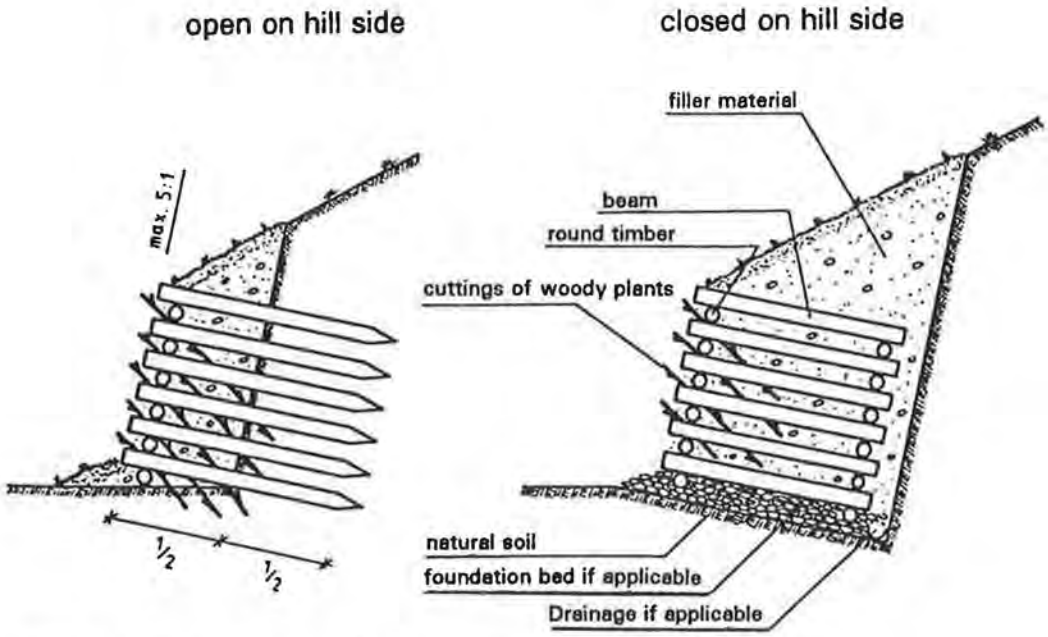

FIGURE 5 Timber Krainer wall: schematic representation.

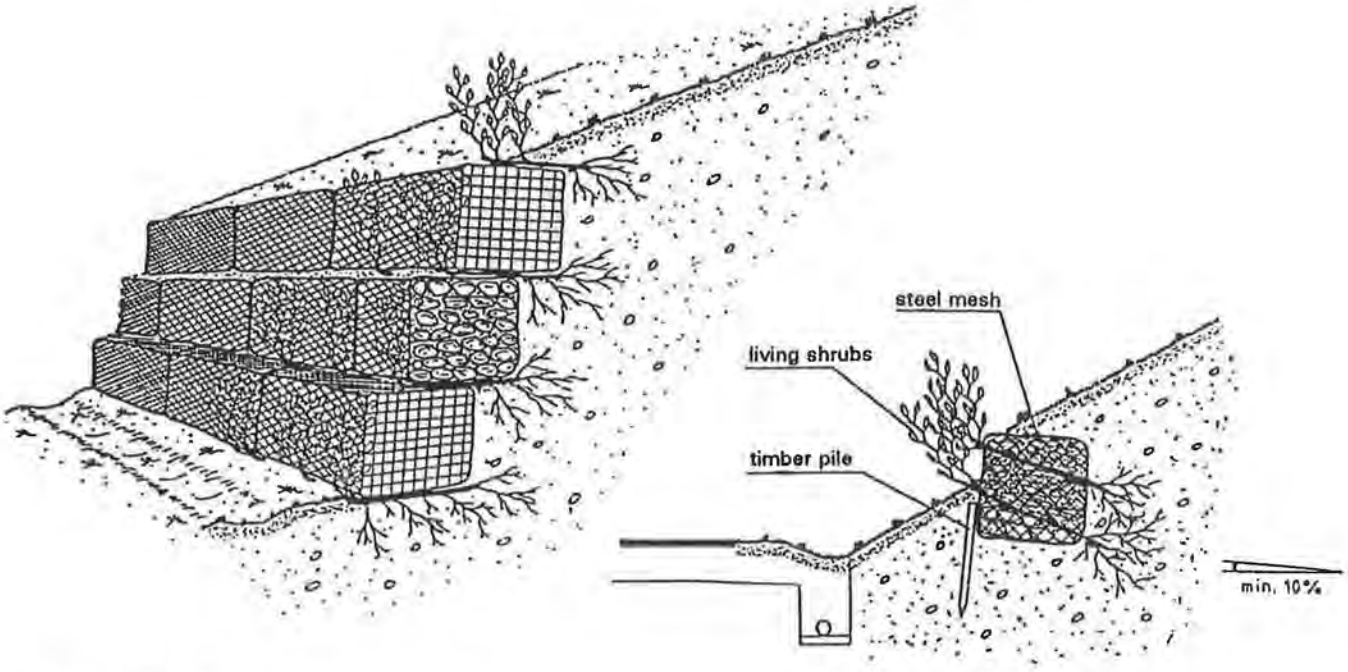

FIGURE 6 Hard gabions with living shrubs.

Final Remarks

These last considerations show that, in rural road construction, requirements go beyond the physical building of a road. To resolve opposition effectively, cooperation of and consensus with experts in wildlife and landscape conservation are needed. Furthermore, their support to find and implement new solutions must be enlisted.

Not only good, serviceable, and durable roads but also aesthetically pleasing roads that bring additional beauty to the landscape must be built. This is a difficult but certainly rewarding task—a challenge that must be

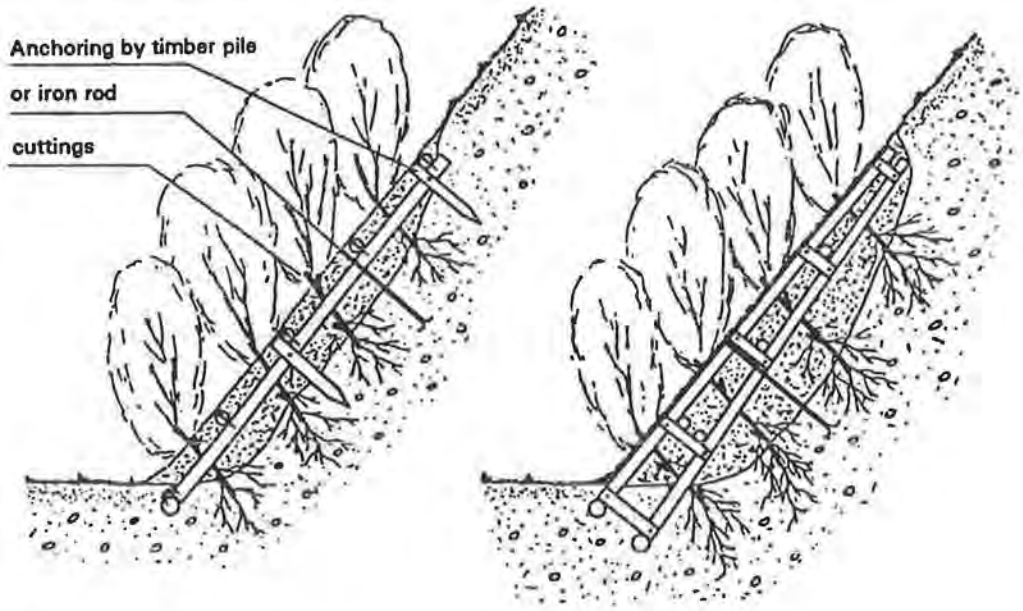

FIGURE 7 Grillage with living plants grown from cuttings.

faced and to which imagination and creativity should be devoted.

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