

## **THE BASICS OF A GOOD ROAD**

We spend a lot of local tax dollars on roads; perhaps more than any single item besides education. Yet, most of us do not realize what makes a good road good and a bad road bad. This Fact Sheet explains what goes into the making of a good road. Whether it's a paved road in town or a gravel-surfaced road in the county, there are certain things that are common to any good road.

### **THE TEN ESSENTIALS FOR GOOD ROADS**

People who build roads best and keep them in top condition abide by the following rules.

1. Get Water Away from the Road
2. Build on a Firm Foundation
3. Use the Best Soils Available
4. Compact Soils Well
5. Design for Winter Maintenance
6. Design for Traffic Loads and Volumes
7. Pave Only Those Roads That Are Ready
8. Build from the Bottom Up
9. Protect Your Investment
10. Keep Good Records

So, here we discuss each of these essentials in more detail.

#### **1. GET WATER AWAY FROM THE ROAD**

Drainage cannot be overemphasized in road construction and maintenance. Water affects the entire serviceability of a road. Too much water in the base materials weakens the road. Water allowed to remain on top of a gravel or blacktopped road weakens the surface and, when combined with traffic, causes potholes, cracking, and rutting. If improperly channeled, water causes soil erosion and breakdown of pavement edges. Whether it's mud in the spring or frost heaves in winter, the presence of water in roads is nothing but trouble. Building and maintaining a good surface drainage system and maintaining it is the best way to lessen water's damaging influence on a road. A proper surface drainage system prevents water from infiltrating the pavement's surface and removes water from the driving lanes in a constant thin sheet to the side ditches which carry the water away from the roadway. Sealing cracks in the pavement surface also helps, but this is of little use if the surface drainage system does not function properly. A surface drainage system has four components: road crown, shoulders, ditches and culverts.

The crown or superelevation of the road surface allows water to run off to the side ditches. Shoulders are an extension of the road surface and allow for the continued flow of water to the ditches. Ditches are used to carry water away from the roadway. They need to be kept clean and protected from erosion. Water left in the ditch can sometimes leak back into the pavement's foundation materials. Water collected and carried in the ditch must be directed away from the roadway at frequent intervals sometimes using a cross-drain culvert, which directs water from one side of the road to the other, helping to control the flow of water and slowing it down to reduce erosion. Road managers are guided by the principles that:

- Water runs down hill,
- Water needs outlets at the bottom of all grades, and
- Puddles mean problems.

If it were not for water a Public Works director or Road Supervisor's job would be easy. But because of water, whether in liquid form or as snow or ice, their work is never done. Except for some moisture that is needed for soil compaction and for dust control, water is the road manager's enemy.

## 2. BUILD ON A FIRM FOUNDATION

All roads wear from the top down, and fail from the bottom up. This is another way of saying that the road base determines the service life of a road. The base supports everything above it including traffic loads. A good road requires a suitable foundation which in turn requires stable material. A road material is stable if it has little or no change in its volume and does not deform under repeated loads whether the material is wet or dry. If adequate support does not exist, the road will rapidly deteriorate.

In soils that are not ideal, stabilizing agents such agents as geogrids, asphalt, chlorides, cements, lime and other products can be used. To select the proper stabilizing agent, an understanding is required of both the soil and agent to be used. The additive must be the correct type and in the correct quantity to produce satisfactory results.

## 3. USE THE BEST SOILS AVAILABLE

In some areas of Montana, natural good-quality gravel is getting to be in short supply. Blended or crushed gravels are more expensive alternatives. The quality of soils used by a public road agency will often depend on local availability and budget. In deciding what is affordable, agencies should consider the long-term consequences of using lower quality material. By putting down a good base in the beginning using quality materials, an agency can correct the few weak spots in the roads over a period of years and be assured of a sound base upon which eventually to apply a permanent hard surface. Using inferior base materials may require excessive maintenance during the road's life and perhaps costly rehabilitation before paving. The adage "pay me now or pay me later" applies to road building. Written guides exist to help road commissioners classify the usefulness of soil types for road foundations and bases. The guides give information on potential frost action, compressibility, and drainage characteristics.

## 4. COMPACT SOILS WELL

The denser the materials are, the stronger the base is. When soil is improperly compacted, future traffic loads or changes in moisture content can cause settlement and failure of the roadway. Compaction is achieved by pressing soil particles together using rollers, tampers, or vibrators, expelling the air from the mass, filling the spaces between the particles, and making the material denser. Well-graded soils having a fairly even distribution of particle sizes will compact more easily than poorly-graded soils having mostly one particle size. Jagged or semi-jagged particles will compact to a more stable configuration than rounded particles of similar size. A certain amount of moisture is necessary for good solid compaction.

## 5. DESIGN FOR WINTER MAINTENANCE

If an agency designs its roads for winter maintenance, they would be adequate for the remainder of the year. Consider the following: A one-way plow cuts a nine-foot-wide swath. If the road is wide enough to allow the plow and a school bus to meet, it is wide enough during the remaining seasons of the year. If ditches and roadside areas are wide enough to store snow, chances are they will accommodate spring thaws and heavy water flows. In general, you will not be sorry for having a wide road, but you may regret building a narrow one. Grades should be a minimum of one percent for drainage purposes in asphalt and 4% for aggregate surfaces. All roads should not have grades greater than 10% if at all possible. If the road is steeper than that, it is difficult for heavy equipment to maneuver especially in wintertime. Sight distance should be considered in designing a road. For safety's sake a driver should be able to see 75 to 100 feet up the road for every 10 miles of speed. This rule of thumb may be helpful when issuing permits for driveways onto a public road. Specific sight distance requirements are in the AASHTO Green Book.

#### 6. BUILD FOR TRAFFIC LOADS AND TRAFFIC VOLUMES

Ice on a pond will support a young skater, but it will crack under the weight of an automobile or even break apart. Similarly, a road built to serve residential traffic will break down when it starts carrying a number of large trucks. Due to disparity in vehicle weight, it takes approximately 9,600 cars to equal the effect on a road of the passage of one 80,000 pound truck. Road commissioners know that roads, like bridges, should be designed with the expected traffic type and volume in mind. A rule of thumb is to design a road to accommodate the largest vehicle that will use the road under normal operations. Designing the road for the largest piece of equipment that maintains it in all kinds of weather may suffice. There are procedures to design roadway thicknesses, including the base course and surfacing, both for paved roads and gravel roads. As a rule of thumb, common guide is to put in  $\frac{3}{4}$ -inch to one inch of gravel for every foot of traveled way width. For example, a 20-foot-wide roadway should have a 15- to 20- inch gravel base. When considering the type and thickness of pavement mixes to apply on a gravel road, it is wise to seek some advice. Generally speaking, a low-volume road (<300 vehicles per day) having some truck traffic may provide good service with a "chip seal." The main function of such a seal is to eliminate the need to replace and reshape gravel, eliminate dust and to prevent raveling of soils. As traffic volumes and weights increase, the type and thickness of pavement should increase to a point where the pavement itself shares the load stress. Heavy-duty interstate highways, for example, often have a foot or more of asphalt or Portland Cement concrete below the riding surface.

#### 7. PAVE ONLY THOSE ROADS THAT ARE READY

In haste to put a smooth surface on a gravel road, some counties and towns make the mistake of paving a road that is not properly prepared. The result may be a complete waste of money. Unless the base of the road is first built with the proper thickness for the traffic it must bear and the gravel is compacted to a proper density with the ability to drain well, any pavement put on it will fail. Experienced road commissioners make sure a gravel road works well before paving. The cost of reconstructing a failed road is much higher than doing it right the first time.

#### 8. BUILD FROM THE BOTTOM-UP

A road that has a poor base and poor drainage cannot be adequately improved with a top dressing of gravel or new pavement. It may be necessary in some cases to dig out the old road, put in new material and build up the road in layers. Before doing anything to correct a road surface problem, road managers

take into consideration what is causing the problem underneath. Improper drainage, insufficient depth of base or poor-quality gravel may be the culprits. These should be corrected before spending money on the surface.

## 9. PROTECT YOUR INVESTMENT

If worn roof shingles are not replaced and if the outside is not painted occasionally, a house will deteriorate and lose value. Roads and bridges also need regular maintenance to keep them from deteriorating. The increased weight and frequency of traffic on Montana's roads combined with our adverse weather conditions, means an increased rate of road and street deterioration. Regular road and bridge maintenance preserves our road investment and prevents costly major rehabilitation later on. Maintenance activities include: Roadway Surfaces - blading and shaping, patching, resurfacing; dust control; snow and ice removal; Drainage - cleaning and repairing culverts and ditches; Roadside - cutting brush, trees and grass; repair and prevention of roadside erosion; Bridges - channel clearing; repair of rails, decks and structure; cleaning and painting; Traffic Services - sign maintenance; Special Projects - restoration or improvements; emergency work such as removing slides, and repairing retaining walls.

## 11. KEEP GOOD RECORDS

Road commissioners know their roads like the backs of their hands. Most of them are a walking history book when it comes to the roads they manage every day. This knowledge is of little use, however, when the road commissioner is laid up or retires. Good record keeping makes roadwork much easier for everybody. It's easier to draw up budgets and to show citizens plans for roadwork. Recording what type of work was done on a road or bridge, when, and what materials were used can help a lot in decision-making later on. Roadway agencies can start by inventorying all roads and bridges, listing length, width, surface types, culverts, problem areas and other items. Putting these items on a map helps. Next comes listing and prioritizing needed improvements, putting a price tag on them and knocking off a few problems each year. Good record keeping of road and bridge work and equipment is good business. There are several software applications available to use.

## REFERENCES FOR FURTHER INFORMATION

There are many resources available to learn about building and maintaining local roads. Perhaps the greatest source of help is the people in the business.

Road Foremen and Supervisors meetings provide settings to exchange ideas. In Montana, this means the Montana Association of County Road Supervisors annual meeting, or the APWA Meetings annually. Professional engineers, colleges and universities, as well as private consulting businesses and even materials and equipment vendors all have information and technical expertise. Finally, the Local Technical Assistance Program (LTAP) at MSU Bozeman has many resources and can put you in touch with the right people, or help you directly.

## Sources:

1. Montana LTAP at Montana State University-Bozeman, PO Box 1739910, Bozeman, MT 59717
2. Vermont Local Roads Program Saint Michael's College One Winooski Park, Box 260 Colchester, VT 05439

3. Steve Monlux, Civil and Materials Engineer at LVR Consultants LLC Missoula, MT, Multiple TRB white papers and LTAP resource classes and discussion notes