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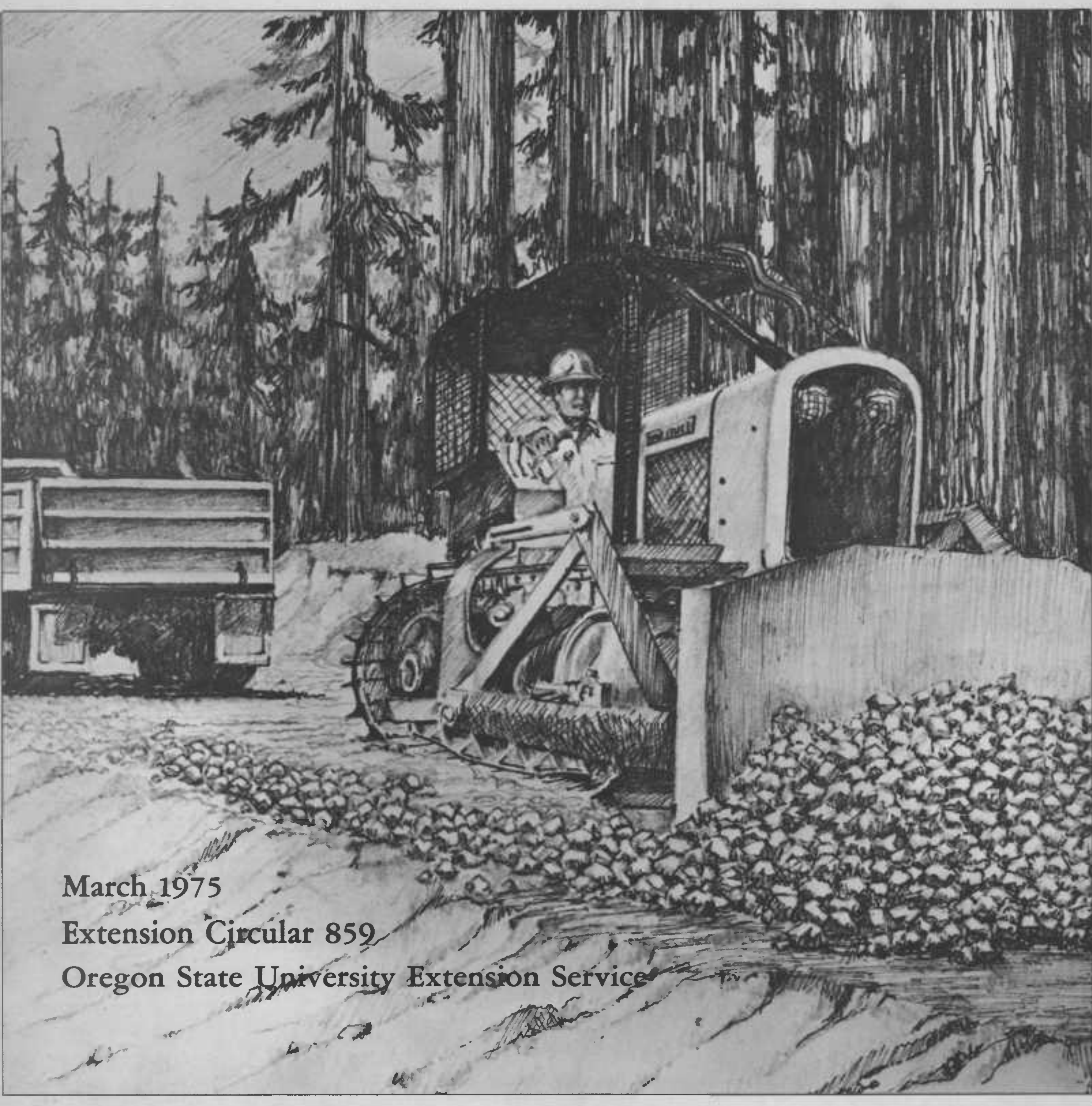
A publication for SMALL WOODLANDS OWNERS
FORESTRY EXTENSION
Oregon State University

Rocking Woodland Roads



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Contents

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Rocking Woodland Roads

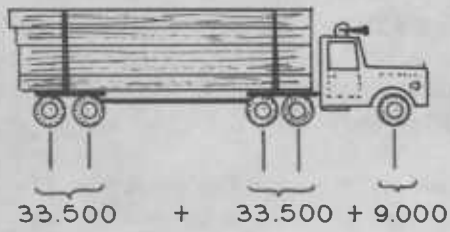
The application of rock to woodland roads provides numerous benefits for you. The efficiency of all forest management operations will be increased; land use for related resource development will be enhanced; and, the firm road surface will provide greater environmental protection.

A Rocked Road's Structure and Function

A rocked road is not a simple ribbon of cleared land in the forest. It is an engineered structure providing a smooth, long-lasting running surface. The layered structure supports trucks by distributing the axle weight over a larger area of soil.

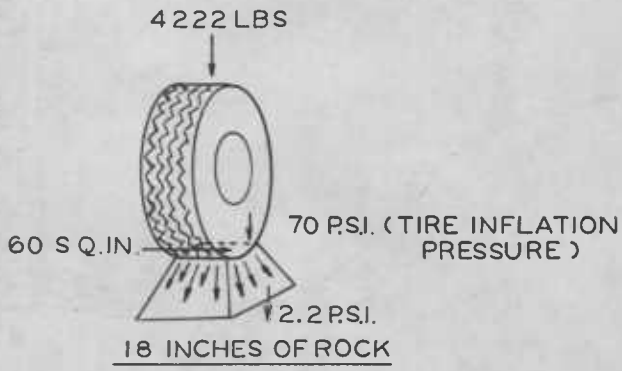
Weight distribution

Some forest roads become rutted when the weight of loaded log trucks is concentrated on the soil surface. This is particularly noticeable on wet soils. On rocked roads, axle road weight is distributed over a large soil surface area by the rock layer. Consequently, the loaded truck will not sink and rut the road. This is why the road remains operable in the wettest weather.



Anticipated truck axles loads should probably be the maximum gross truck weight allowed by Oregon's State statute ORS 483.506. It is 76,000 pounds. The weight distribution on a loaded truck for the front, drive, and trailer axles would be approximately 9,000, 33,500, and 33,500 respectively. Tandem axles on the drive and trailer wheels would yield 16,750 pounds per axle or 4,187.5 pounds per tire.

Prepared by Erwin R. Berglund, Extension Watershed Specialist, Forest Engineering Department, Oregon State University, and Marvin Rowley, Manager, Forest Properties, School of Forestry, Oregon State University.



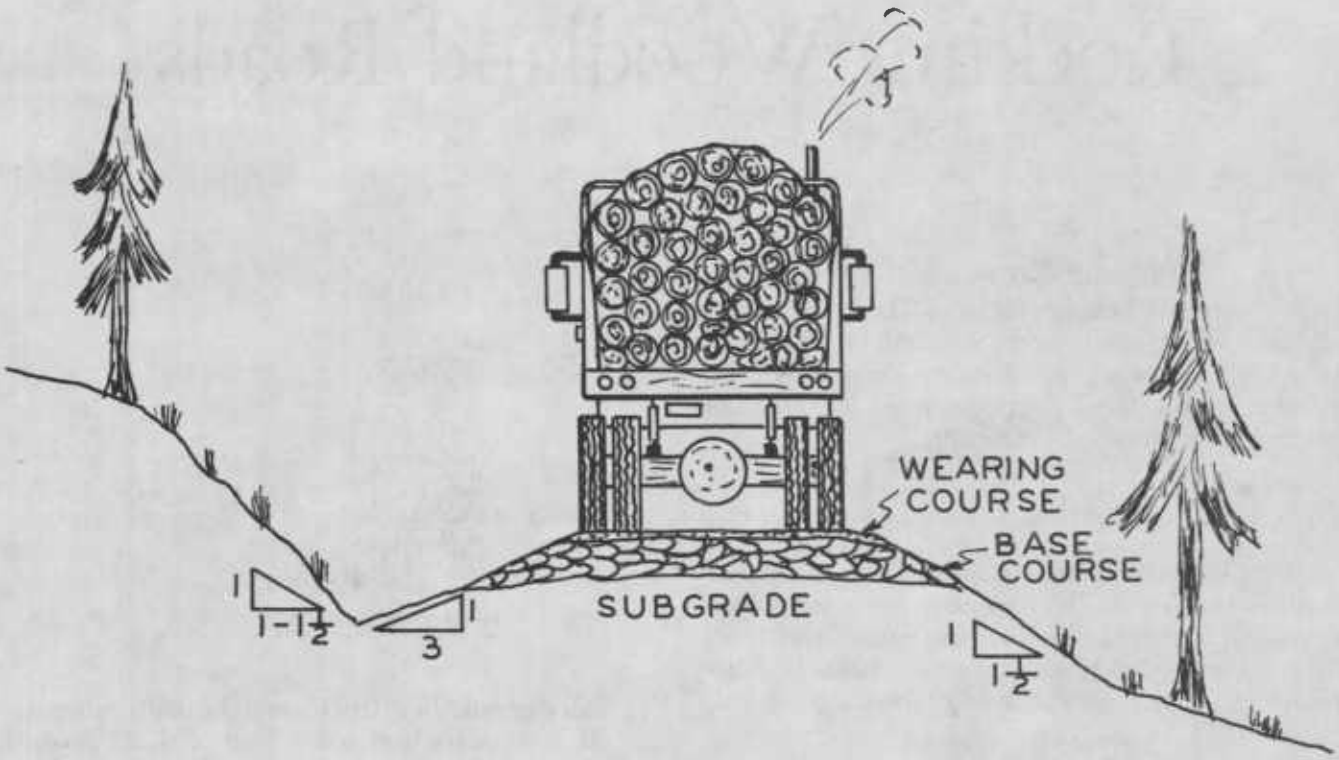
An example of a truck's weight distribution is: If a truck's wheel has a load of 4,222 pounds and a tire contact area of 60 square inches, it applies a force of 70 pound per square inch to the road surface—be it rock or soil (dirt). If the road had an 18-inch layer of rock over the soil, the truck applies a force of 2.2 pounds per square inch to the soil. The truck would exert less force to the soil surface than a 200-pound man standing on soil.

Road Components

The "subgrade" is compacted soil. Compacting the soil presses soil particles closer together and increases the soil density and bearing strength. It is shaped by crowning, insloping, or outsloping to facilitate drainage.

The "base course" is the foundation of coarse rock. It provides the support to the wearing course. This layer will usually range from 6-12 inches thick with individual rocks 3-6 inches in diameter.

The "wearing course" is the fine, surface rock layer. It gives properly rocked roads the characteristic pavement-like surface. Less strain on equipment occurs when wheels roll with minimal resistance. By crowning, insloping, or outsloping this wearing course, you will assure a well-drained road surface. Good surface drainage lessens water reaching the subgrade. Unobstructed ditches can then quickly remove excess water. The overall effects of the wearing course are less water on the road surface and in the subgrade.



Road Preparation

Subgrade construction is the final step in preparing your road for rocking. The subgrade is the road's foundation and it supports your road investment.

Preparing the subgrade

Carefully construct the subgrade in the road's fill sections. Do not allow wood and debris to be buried in the fill. Wood will decay and create maintenance problems. Large, unavoidable material, like stumps, must be buried at least two feet below grade. The desirable subgrade consists of only rock and soil.

Compacting the subgrade

The subgrade must be compacted to achieve greatest benefits. Compaction presses the soil particles together to form a firm foundation for rock. Two benefits are readily recognized. First, less rock is necessary on compacted subgrades. A well-compacted subgrade will need only one-half as much rock. That is, only 6-8 inches of compacted, crushed rock would be necessary to bear maximum highway loads. Second, a compacted subgrade will reduce maintenance. Irregularities created by soft spots will be less frequent on the rocked road surface. A well-compacted subgrade should not have ruts in it. Ruts will only impede surface drainage.

Compaction is best achieved when the soil is neither too dry nor too wet. When the soil is very dry it is stronger and resists compaction and deformation. When the soil is very wet it deforms and moves but it does not compact well. Maximum compaction results at an optimum moisture level between these two extremes. The optimum soil moisture for maximum compaction occurs when it is dry enough to till for agricultural practices. The specific soil moisture will vary from one soil type to another.

Equipment use will compact the subgrade. The preliminary road should be constructed at least one year prior to rocking. Normal use with logging trucks and tractors during the year will compact the surface. Following a different track for each trip of a vehicle will eventually compact the entire subgrade. Soft spots and oversights during fill construction will become evident with use and may then be remedied.

Specialized compaction equipment may be rented if you are rushed and don't have time to compact the subgrade during normal equipment use. Vibrators, sheep-foot rollers, and grid rollers all give greater assurance of maximum compaction over a shorter time period. Watering of the subgrade may be necessary to obtain the optimum soil moisture for compaction.

Quality and Quantity of Rock

What kind of rock can I use? How much rock do I need? These are immediate, fundamental questions. All rock isn't alike. Various properties differ from one type to another. Rock quality and quantity are not independent. Hauling costs may force you to substitute rock quantity for quality where poorer rock is nearby and plentiful and high-quality rock is far away.

Rock quality

The best rock is relatively hard and heavy, sharp edged, and not mottled or stained. Rocks with these characteristics are suitable for the road's wearing surface. Relatively hard and heavy rock implies high density and greater wearing life. Softer, less dense rock will break down more readily and increase maintenance problems. Broken rocks which maintain sharp, defined edges after years of exposure are generally good material for roads. If the edges are rounded or crumble easily, the rock probably weathers too fast. Mottled or stained rocks indicate water movement through rock pores or fractures. Porous rocks, such as sandstones, are not structurally strong and will rapidly break down under road use, although they may be suitable for a base rock where a hard rock is used for the running surface. In general, sedimentary rocks such as sandstone and shale are less suitable for road use. Basalt, on the other hand, is an excellent, long-wearing rock.

Stream gravel deposits are suitable for roads if precautions are observed. Stream rocks bouncing and rolling in water become round and smooth. These rocks are like marbles—they will squirm and move when you drive on them. This squirming makes it difficult to build a hard, firm road surface.

Two approaches are common in using stream gravel. (1) It is best to crush the rock. This produces sharp edges and flat sides. A strong, binding road can be developed. (2) Success can be achieved by using a mixture of all particle sizes. The mixture must have particles ranging from sands to small rocks so that small particles can fill the voids between the rocks. This second method will be the most economical. Do not remove gravel from or adjacent to streams—use only old floodplain deposits unless you have a permit from the appropriate regulatory agency.

Rock quantity

The quantity of rock needed depends on the subgrade characteristics and the anticipated truck axle loads. A six- to eight-inch rock layer would be sufficient to support the truck on a *well developed* subgrade. On a poor subgrade, 20 inches or more of rocks may be needed. On the average, 10-12 inches of rock would be advisable.

A minimal layer of rock of 6 inches may be applied, and the road patched with additional rock when problems arise. A good road surface will result from the minimal use of rock. *Caution:* this minimal rocking technique requires rock hauling and spreading equipment to be available whenever you use the road.

Rock volume estimation

To estimate the total rock volume required for the job, determine the appropriate rock thickness for the base and surface rock layers and the surface area of the road. The estimate should be in cubic yards. The final rock thickness will be approximately two-thirds of the initial thickness[1] because the applied rock will settle and compact with use.

Method 1. This is the basic method for volume determination. Conventional engineering units (feet) are utilized. The formula is:

$$V = \frac{LWT}{18}$$

where:

V = rock volume estimate in cubic yards

L = road length in feet

W = road width in feet[2]

T = rock thickness in feet

18 = the number of cubic feet per cubic yard (27) multiplied by the rock compaction factor (2/3)

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[1] Source: U.S. Department of Interior. Undated. Forest Engineering Handbook. Bureau of Land Management, Oregon State Office, Portland. 220 p.

[2] The edge of the rocked road surface is not vertical. Instead, rock tapers toward either side.. A precise volume estimate must account for this excess. To do so, add one of the two taper widths to your desired road width and then use either these formulas or Tables 1 or 2.

Method 2. This is essentially the same as Method 1 except the common units of miles, feet, and inches are used. The road length, for example, can be estimated from your truck's speedometer. This formula is:

$$V = 24.44\ wlt$$

where:

V = rock volume estimate in cubic yards (same as method 1)
l = road length in miles
w = road width in feet
t = rock thickness in inches
24.44 = conversion constant corrected for the rock compaction factor (2/3)

Example: We wish to rock 4,752 feet (0.9 miles) of road. It averages 12 feet wide. The desired rock thickness is 1.083 feet (13 inches). How much rock must be hauled and applied?

Method 1. By using the conventional units of feet:

L = 4,752 feet

W = 12 feet

T = 1.083 feet

therefore

$$V = \frac{(4{,}752)\ (12)\ (1.083)}{18} = 3{,}431$$

cubic yards

You will need 3,431 cubic yards of rock to complete the construction.

Method 2. l = 0.9 miles

w = 12 feet

t = 13 inches

Thus,

$V = (24.44)\ (0.9)\ (12)\ (13) = 3{,}431$ cubic yards

Methods 1 or 2 will provide identical answers.

Tables 1 and 2 will be helpful in estimating your rock requirements.

Buying Rock

If your property does not have a rock source and/or rock is available nearby, buying rock is often found to be advantageous. Consider the following points when buying rock:

- Check the rock quality. Does it fit the criteria stated previously?
- Consider hauling distance and method. Costs will increase with hauling distance. Large-volume trucks may be less expensive per load.
- Determine the method for measuring rock. Truck volume or weight measures are most common. Your payment depends on the method of measurement.
- Schedule rocking needs. Rock will not always be available when you want it. Your schedule may have to be adjusted to that of seasonal availability.

Locating Rock

A rock pit on your own land may be ideal. You would have rock available and you would reduce hauling costs. Some woodlands have only sandstone and other poor-quality rock—on the other hand, your land may be underlain by hard basalt. If you have good rock on your land, consider it a valuable resource and manage it.

You may have to be a prospector if rock location isn't obvious. Furthermore, bulldozers may be necessary to remove some surface soil. First consider topographic features. Do you have any abnormal land forms that are cliff-like, domed, or knob-like? If so, these areas may be underlain by weather-resistant rock. Weather resistance is one property of an ideal rock. Second, look at the trees and other vegetation. Do you have any droughty areas where the vegetation's vigor and form are different than the surrounding woodlands? If so, the soil may be shallow. Rock may be near the surface. Third, consider your previous operations. Did you have to detour around rocky areas or move surface rock aside? If so, take a second look at these areas. Fourth, don't forget your neighbors. If they have rock pits, are topographic or vegetative characteristics on their land similar to yours? Did they ever fail in an attempt to find rock? If so, where? You can also learn by their attempts.

Having found rock, explore it. Probe around with a bulldozer to determine whether there is sufficient rock present. Vein-like outcrops may not contain enough rock. Investigate the potential rock volume prior to developing the pit.

Table 1. Rock volumes necessary to develop a final rocked surface of given thickness and width, per 100 feet of road. *For example, if an eight-inch-thick final rocked surface was desired and the average road width for a certain section of road was 15 feet, then 56 cubic yards of rock would be needed for each 100 feet. This includes the rock compaction allowance.*

Final rock thickness	Road width (feet)										
	10	11	12	13	14	15	16	17	18	19	20
	Cubic Yards										
4 inches	19	20	22	24	26	28	30	31	33	35	37
5 inches	23	25	28	30	32	35	37	39	42	44	46
6 inches	28	31	33	36	39	42	44	47	50	53	56
7 inches	32	36	39	42	45	49	52	55	58	62	65
8 inches	37	41	44	48	52	56	59	63	67	70	74
9 inches	42	46	50	54	58	63	67	71	75	79	83
10 inches	46	51	56	60	65	69	74	79	83	88	93
11 inches	51	56	61	66	71	76	81	87	92	97	102
12 inches	56	61	67	72	78	83	89	94	100	106	111
13 inches	60	66	72	78	84	90	96	102	108	114	120
14 inches	65	71	78	84	91	97	104	110	117	123	130
15 inches	69	76	83	90	97	104	111	118	125	132	139
16 inches	74	81	89	96	104	111	119	126	133	141	148

Table 2. Rock volumes necessary to develop a final rocked surface of given thickness and width, per one-tenth mile of road.

For example, if an eight-inch-thick final rocked surface was developed and the average road width for a certain section of road was 15 feet, then 293 cubic yards of rock would be needed for each 0.1 miles. This includes the rock compaction allowance.

Final rock thickness (inches)	Road width (feet)										
	10	11	12	13	14	15	16	17	18	19	20
	Cubic Yards										
4 inches	98	108	117	127	137	147	156	166	176	186	196
5 inches	122	134	147	159	171	183	196	208	220	232	244
6 inches	147	161	176	191	205	220	235	249	264	279	293
7 inches	171	188	205	222	240	257	274	291	308	325	342
8 inches	196	215	235	254	274	293	313	332	352	372	391
9 inches	220	242	264	286	308	330	352	374	396	418	440
10 inches	224	269	293	318	342	367	391	416	440	464	489
11 inches	269	296	323	350	376	403	430	457	484	511	538
12 inches	293	323	352	381	411	440	469	499	528	557	587
13 inches	318	350	381	413	445	477	508	540	572	604	636
14 inches	342	376	411	445	479	513	548	582	616	650	684
15 inches	367	403	440	477	513	550	587	623	660	697	733
16 inches	391	430	469	508	548	587	626	665	704	743	782

Developing a Rock Pit

Familiarize yourself with operational and equipment information and local, county, and state regulations prior to developing the rock pit. Booklets such as "Safety Code for Mining, Tunneling, and Quarrying" may be obtained *free of charge* from:

Workmen's Compensation Board
Labor and Industries Building
Salem, Oregon 97310
Telephone: 378-3278 (Technical Services)

Both operational and construction standards are emphasized.

Some aspects of rock pit development should be done only by contractors—such as rock drilling and blasting which require special equipment. Rock crushing utilizes specialized equipment and it will usually be advantageous to hire a rock crushing contractor, too.

Expose the rock source by removing the overburden—soil, stumps, and other material overlying the rock. You should stockpile the overburden so it won't interfere with safe rock pit operations or

adjacent streams. When operations are completed, replace the soil in the rock pit.

Pit-run rock

Pit-run rock—rock not needing to be crushed—may be available. Good rock is often naturally fractured and pit-run rock may be developed with a bulldozer or minimal blasting.

Rock loosened by blasting may be useable as is. The rock formations in many areas fracture from blasting into pieces 6 inches or less (6 inch-minus) in diameter. This pit-run rock would be suitable for the road's base course.

If your pit-run rock size isn't satisfactory, crush it. A 10-12 inch base course is difficult to obtain with rocks in excess of 12 inches in diameter.

Drilling and blasting

Hard rock formations are prepared by drilling and blasting. This should be performed ONLY by a qualified rock drilling contractor. He will have the equipment and expertise to do the job. State and federal explosive regulations are the contractor's concern.

Crushed rock

Rock crushers reduce rock to desired sizes. Irregularities from larger rocks are avoided. Crushers come in many types and sizes. The type of crusher selected depends on your maximum rock size.

A common crusher is the jaw-type. The primary jaws will reduce rock to a 3-4 inch size. Rock mixed with soil will work well in this crusher. Finer rock to help bind together the road surface is produced with a secondary crusher behind the primary jaws. Uniform rock, smaller in diameter than the thickness of the rock layer desired, will facilitate application. The base course can be efficiently constructed with 4 inch-minus rock. This size will be easy to handle and easy to apply. The use of 4 inch-minus rock often results in an adequate running surface. Surfacing rock may not be necessary.

A 3/4 inch-minus rock is excellent for the wearing course. A smooth, hard, well-drained surface develops with use. Rock less than 3/4 inch-minus breaks down too fast.

It may be wise to develop a stockpile of desirable rock sizes. You will save time and money if you plan for unexpected rock requirements while the crusher is operating in the pit. It may be worthwhile to consider commercial development of the rockpit. When your rock needs are satisfied, replace the soil overburden. Fertilization and seeding will rapidly stabilize the soil.

Applying Rock

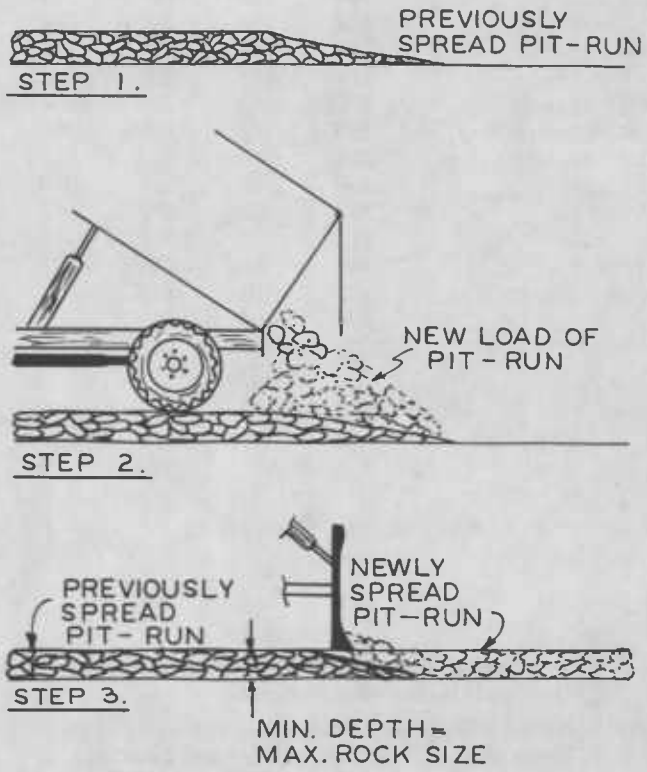
Rock application requires a systematic approach with appropriate equipment. The resulting use of rock will be most efficient.

Equipment

Three types of equipment are generally used to apply rock. A *loader* is needed at the rock pit. At least one *dump truck* is needed to haul rock. More than one dump truck may be needed to keep up with the loader and spreading equipment. *Tractors* or graders can be used to evenly spread the rock on the subgrade. A crawler tractor with a dozer blade is effective with pit-run rock. A grader is more effective with crushed rock.

Applying pit-run rock

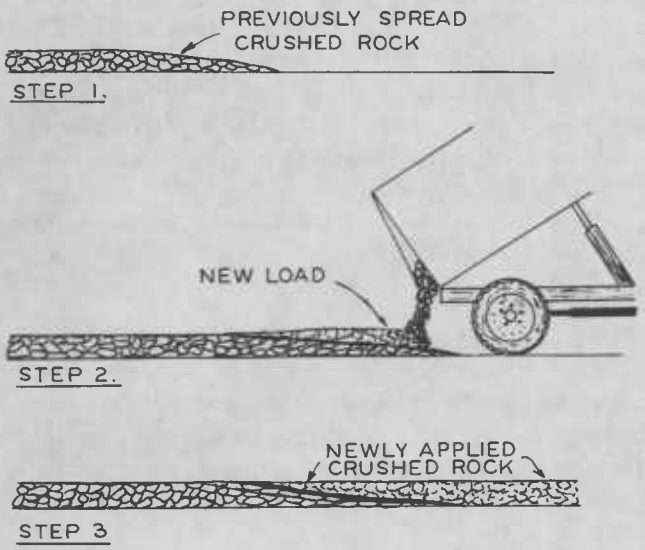
Start rocking your road nearest the rock pit. Repeated trips of the dump truck will compact the rock. Dump each rock load on the newly spread material. By dumping each load on the previously spread rock, a continuous layer will develop—not a patchy, awkward surface. The tractor will spread each load and extend the rocked road. Larger rocks are maneuvered to the subgrade when both truck and tractor operate on the rock. Smaller rocks fill voids between the larger rocks.



Applying crushed rock

Uniform crushed rock is easier to apply. Trucks can spread crushed rock while dumping it. A grader can mix the crushed rock which may be separated by sizes. Proper road width, shape, and drainage are best achieved with the grader.

It is best to first apply half of the rock thickness over the entire road system. After grading the rock to proper road width and shape, apply the second half of the rock overlapping the first and grade again. A uniform rocked surface will result.



Basic Cost Considerations

Analyze your potential road costs. Neighbors can be helpful in regard to road rocking procedures, however their basic costs will not be the same as yours. Many variables influence costs and each job must be analyzed separately.

Seven cost factors to consider are: rock quantity, rock quality, rock pit development, rock crushing, hauling road, application of rock, and season of the year.

Rock quantity

The volume of rock utilized affects all of the cost factors. Contractor costs are based on the amount of work they accomplish. The relative cost of the other factors generally decreases with an increase in rock quantity; that is, the cost per unit of rock (cubic yard or 100 feet of road) becomes less as the job gets bigger. If you foresee future rock needs, you may want to capitalize on lower unit costs and have a stockpile of crushed rock developed.

A stockpile will occupy additional space. Reloading this stockpiled rock into trucks is an extra cost factor.

Rock quality

The amount of rock needed depends on its quality. Rock hardness, necessary sizes, and tolerances for rock/soil mixtures all influence construction costs. Soft rock will require more rock to be applied. Tolerance specifications as to rock size and purity will alter costs. Generally, high-quality hard rock will lower costs.

Rock pit development

The most inexpensive rock pit is a fractured rock outcrop free of topsoil and vegetation. Costs increase if rock is not readily accessible. Opening rock pits by removing topsoil and vegetation can be a major endeavor. It is often worthwhile for you to have a contractor estimate and develop the rock pit.

Rock crushing

Small woodland owners often find it advantageous to hire a contractor. The crushing costs will depend upon the rock type, quantity crushed, and working room available for the machinery. A rock crusher may be purchased if rocking needs are sufficient.

Hauling road

The hauling distance and road conditions from the rock pit to the work area are critical. Minimize the travel time per load of rock. An estimate can be made by driving over the route at a speed comparable to a loaded dump truck. A rock pit in close proximity to the work area is desirable.

The type of haul road is important. A paved highway or well-surfaced gravel road increases hauling efficiency. Hauling time and wear-and-tear on equipment will be less. A dusty, rough haul road will impede the road rocking operation.

The road grade will affect hauling costs. Adverse grades (uphill with a loaded truck) will increase costs. Favorable grades (downhill with a loaded truck) will reduce hauling costs.

Season

Try to schedule contractor's work during their slack time—namely, the wet, winter season. Their rates are often reduced in the winter. Road rocking itself may not be feasible in the winter; but, if the pit is developed in the fall and the rock crushed in the winter, the roads will be ready to rock in the spring or early summer.

Contractor Considerations

Your road is a major undertaking. Both knowledge and equipment are needed for good results. Therefore, many landowners find it advantageous to hire a contractor to rock the road. The following considerations may help you select a contractor.

References

Neighbors or timber companies may recommend a contractor. Ask the contractor for references from previous customers and then contact the references. Was the work of high quality and completed on time? Did any problems arise in dealing with the contractor?

Equipment

Is the contractor's equipment in good repair? Does the equipment show use but not abuse? Does the contractor have all of the necessary equipment? Well-cared-for equipment often implies pride in one's work.

Season

The contractor must be available when you want the work accomplished. Experienced contractors often work in the mountains during the summers. Winter is a slack time. Will the contractor give you a reduced cost if work is performed during the off-season?

Contracts

The contract itemizes the work to be performed. It should encompass unforeseen job conditions. Penalty clauses relative to work accomplishments may or may not be included. A sample contract with disclaimer is included (see page 11).

Your expectations

Specify what you expect the contractor to do. A map should be included as an appendix to the contract. It should indicate the rock source, rock size, crushing and stockpiling sites, roads to be rocked, and hauling distances. A detailed road plan should include rock width and depth, turnouts, turnarounds, curves, and drainage. You may want to include details on the rocking procedure.

Time schedule

Specify the starting and finishing dates.

Payment

Your payments should be based upon a definite unit of measure. This measure is often the volume of rock applied, such as cubic yards, yard-miles, etc. Therefore, specify how the rock is to be measured.

Rock is measured either as a stockpile, as applied on the road, by weight, or by the truckload. The *stockpile* volumes decrease with settling and you and the contractor must have a common understanding. The *applied-on-the-road* method is next. Measurements must be taken at pre-determined intervals. Compute the volume as the road width times depth times length of interval. The *truckload* measure is most difficult. Precise measurements depend on all trucks loaded to a full measure. Some truckloads may also be more loose than others.

Be sure you specify all details no matter which rock measure is utilized.

Non-performance of contract

All contracts should state the action to be taken if non-performance (default) of contract occurs by either party. This protects you and the contractor if contract specifications are not fulfilled. The contractor should be required to furnish a performance bond to cover possible non-performance.

Insurance and protection

Insist that the contractor have sufficient liability and industrial accident insurance. The liability insurance will protect you financially if the contractor has an accident. The industrial accident insurance protects the contractor's employees.

Insist that the contractor obey all Oregon State laws regarding fire and environmental protection.

Are you or the contractor going to obtain necessary work permits? Specify this in the contract, too.

Specific contracts assure a quality road and simplify the contractor's efforts.

Sample Contract

This sample contract was not drafted as a legal document. This only exemplifies the general content common to many contracts.

ROAD ROCKING CONTRACT

This agreement made this ____ day of ____ 19____, by and between ____ hereinafter called the owner, and ____, hereinafter called the contractor.
Witnesseth:
That whereas the owner intends to rock certain roads hereinafter described, and; Whereas the contractor performs rocking of these roads,
Now therefore the owner and contractor agree as follows:

1. *Road location.*
   The road to be rocked is located in Section ____, Township ____, Range ____ Willamette Meridian and is of length ____ with the starting point marked by ____ as shown on map (Exhibit A).

2. *Scope of the work.*
   a. A rock pit will be developed in the place marked on the map (Exhibit A). This work will be done following detailed plans on rock pit development (Exhibit B).
   b. *Rock crushing and rate of payment.*
      1) ____ yd.^{3} crushed to ____ (specified size) and placed on the road (as specified in Exhibit A) to a compacted depth of ____ in. and a width of ____ ft. according to cross section plans (Exhibit C). Curve widening and turnouts are to be rocked as staked on the ground. Compaction method and density will be ____ Bid price ____.
      2) ____ yd.^{3} crushed to ____ (specified size) and stockpiled on the site marked in Exhibit A. Bid price ____.
      3) ____ yd.^{3} crushed to ____ (specified size) and placed on the road (as specified in Exhibit A) to a compacted depth of ____ in. and ____ ft. wide. Bid price ____.
   c. Grading, shaping and compacting the rock on the road (as specified in Exhibit A).

3. *Contract duration.*
   The work to be performed, under this agreement shall begin not later than ____ and shall be completed in its entirety by ____.

4. *Method of payment.*
   The owner agrees to pay the contractor monthly for 90 percent of the contract price for work performed; 10 percent of the contract price is to be paid as final payment when all work is satisfactorily completed.

5. *Measurement of work completed.*
   Measurement will be by taking cross sections of the road profile times length to arrive at the agreed upon compacted cubic yards of applied crushed rock (or other mutually agreeable form of measurement).

6. *Damage.*
   The contractor shall exercise all reasonable precautions to protect the areas outside of the immediate working area. The contractor shall indemnify and hold harmless the owner against all claims and liabilities asserted by third persons resulting directly or indirectly from the contractor's acts or omissions whether negligent or otherwise.

7. *Adherence to laws and regulations.*
   The contractor shall comply with all acts and regulations pertaining to utilizing rock and rocking roads. The contractor shall obtain all necessary permits for the contractual agreement.

8. *Insurance.*
   During the duration of this contract, the contractor shall accept the terms of the Workmen's Compensation Act and shall carry out the operations under the provisions of that law. The contractor shall protect himself and the owner against any and all claims for damages to persons or property, including property of the owner, which may arise out of operations under this agreement by carrying public liability insurance of not less than $ ____ and property damage insurance of not less than $ ____. A copy of the policy or Article of Insurance is to be delivered to the owner prior to commencing operations.

9. *Non-assignment.*
   No part of this agreement may be sold, assigned, or transferred without the written consent of the owner.

(over)

10. *Bonding.*
The contractor shall deliver to the owner a performance bond, cashier's check, negotiable securities, or cash of $ _____. This shall be issued in favor of the owner and shall guarantee complete and faithful performance of all terms of the contract.

11. *Non-performance.*
Should the contractor fail to perform the terms of this contract, the bond shall be forfeited in the amount of the non-performance.

Signatures

_____
Owner

_____
Contractor

_____
Witness (Notary and seal)

Summary

A rocked road provides you with an all-weather, smooth, long-lasting road surface. With rocked roads, the weight of heavily laden trucks is distributed over a large area of soil.

Subgrade preparation is the final step prior to rocking. Use only rock and soil in the subgrade—do not bury wood and debris. Compact the subgrade.

Not all rock is satisfactory for road surfaces. Use rock that is relatively hard and heavy, sharp-edged, not mottled or stained. Stream gravel from old floodplains can be suitable if precautions are taken.

The rock quantity needed is closely related to costs. Applied rock depth depends on the subgrade and anticipated loaded truck weights. A preliminary rock volume estimate can be made.

It is advantageous to locate good rock on your land. To locate rock, consider the land's topography and vegetation, previous operations, and your neighbor's attempts to find rock.

Rock pit development is difficult. The overburden is removed and stockpiled. The soil will be re-used in rehabilitating the rock pit. A contractor must drill and blast the rock if it is necessary. Pit-run rock may be useable as is, or it may be necessary to crush the rock.

Rock application requires at least three pieces of equipment—a loader, dump truck, and tractor. Pit-run rock is successfully applied by blending each truck load with the previous load. Crushed rock can be spread by the truck itself.

Analyze potential road costs. Consider such factors as the rock's quantity, quality, pit development, crushing, hauling road, application, and season of the year.

Many landowners find it advantageous to hire contractors for part or all of the road rocking operation. Look carefully at the contractor's references, equipment, and seasonal availability. Specific contracts assure a quality road and simplify the contractor's efforts.