UNIVERSITÀ DEGLI STUDI FIRENZE

Corso di Laurea in: SCIENZE E TECNOLOGIE DEI SISTEMI FORESTALI
Curriculum: PRODUZIONI LEGNOSE

Pianificazione ed organizzazione tecnologica

Manutenzione strade forestali

UNIVERSITÀ DEGLI STUDI FIRENZE
DAGRI
DIPARTIMENTO DI SCIENZE E TECNOLOGIE AGRARIE, ALIMENTARI, AMBIENTALI E FORESTALI

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Road maintenance, repair and upgrade

- **Road Repair** is concerned with the reinstatement of road facilities to a former condition after major damages. Usually associated with harvesting, as harvesting and timber haulage operations are the principal cause of road damage. Most repairs are carried out during and immediately after harvesting.
- **Road Maintenance** is concerned with keeping roads in a usable condition. It may be carried out on an ongoing or as required basis and particular attention should be given to the maintenance of drains and culverts.
- **Road Upgrade** has the aim of bringing a currently substandard road up to full standard or to change the standard to those of an upper road category. Expensive!

Road upgrade

- **Recognising the need for road upgrade.**
  - The most common deficiencies occurring in forest roads can be grouped under two main headings: **Structural** and **Geometric**.

Structural deficiencies

	Deficiency	Results	Indicative signs
1	Lack or inadequate camber.	No surface water run-off. Water ponding on road surface.	Severe rutting when subjected to traffic during wet weather. Erosion of road surface along sloping roads after heavy rainfall.
2	Lack of or inadequate roadside drains.	High water table during wet weather. Lowering of bearing and shear strength of sub-grade.	Severe rutting when subjected to traffic during wet weather.
3	Inadequate culverting	Erosion of road edges and possibly erosion of road surface	Scouring of road sides and/or road surface.
4	Insufficient thickness of surfacing material	Failure of sub-grade when subjected to heavy loads	Severe rutting when subjected to extraction traffic.
5	Poor quality road surfacing material.	Breakdown of surfacing material from the action of traffic, frost and rain.	Severe rutting of road surface.

Road upgrade

- **Recognising the need for road upgrade.**

Geometric (more costly)

	Deficiency	Results	Indicative signs
1	Inadequate tree clearance.	Road shielded from sunlight and sheltered from drying winds, formation unable to dry out resulting in a reduction in the bearing capacity and shear strength of the sub-grade.	Severe rutting in clay soils and severe rutting and pot-holing in mineral soils when subjected to extraction traffic.
2	Inadequate road width.	Reduced operational efficiency. Safety.	Severe rutting on either side of surfaced carriageway especially at bends and corners.
3	Steep gradients Standards	Excessive road surface wear. Damage from surface water (rill).	Trucks encountering difficulties. Wheel spin. Rutting.
4	Poor alignment/tight bends.	Ravelling of road surface and rutting at road edges. Safety	Truck rear wheels leave road surface and rut limits of formation and banks.

Road Maintenance

- Every road, no matter how well designed and constructed, will deteriorate due to:
  - Traffic loading
  - Weather conditions (rain, snow, freeze-thaw cycles, dry-wet cycles ……)
  - Material properties

- Consequently, regular maintenance is required to provide the desired level of service for each road. Type of roads

Road Maintenance

- Road maintenance allows to:
  - Prolong the **life of the road** (and preserve the capital asset)
  - **Save money** in the long-term rectifying damage before major rehabilitation is required.
  - Increase the **operator safety and comfort**
  - Minimize **environmental impact**.
  - Guarantee the easy **access for emergency** services (i.e. fire brigade/ambulances).
  - Reduce **vehicle operating costs -** efficient use during forest operation (high vehicle speed, lower vehicle maintenance cost) .

Preventative Maintenance

- Aim - prevent any major defects and pavement damage from occurring
- The road is maintained on a scheduled basis.
- This approach prolongs road life and maintains continuous access, but is often expensive. Important roads.

- Preventative maintenance is characterised by:
  - A higher initial cost
  - An increased service life of the road
  - Reduced vehicle costs
  - An increase in health (reduction of whole body vibration exposure) and safety for road users
  - More efficient use of maintenance resources

Preventative Maintenance

- Frequency - should be determined by level of service indicators, e.g.:
  - level of roughness
  - rut depth
  - the time it takes a vehicle to travel over the road

- It depends on the volume of traffic, climatic conditions, materials used.

Corrective Maintenance

- The road is maintained on an ‘as required’ basis as defects arise. Generally low cost, but increases the potential for road failure (major rehabilitation). Lower grade roads.
- Corrective maintenance is characterised by:
  - Reduced overall efficiency of maintenance resources (not where necessary but where it is urgent)
  - Higher vehicle operating costs
  - Accelerated pavement wear
  - Risk of complete pavement failure

Road Inspection

- Regular inspection of roads is required to identify problem areas.
- Inspection can be scheduled regularly based on road use, axle loadings and/or pavement material. Alternatively, inspection can be via a road rating system, where road users report the condition of the road.
- The following features should be reviewed during inspections:
  - Pavement surface and shoulders (crossfall, potholes, soft spots, corrugations, slippery surfaces, rutting, scouring)
  - Drainage features (debris, blockages, scour, vegetation growth)
  - Other (excessive dust, encroaching vegetation)

Defects, Causes, and Corrective and Preventative Procedures

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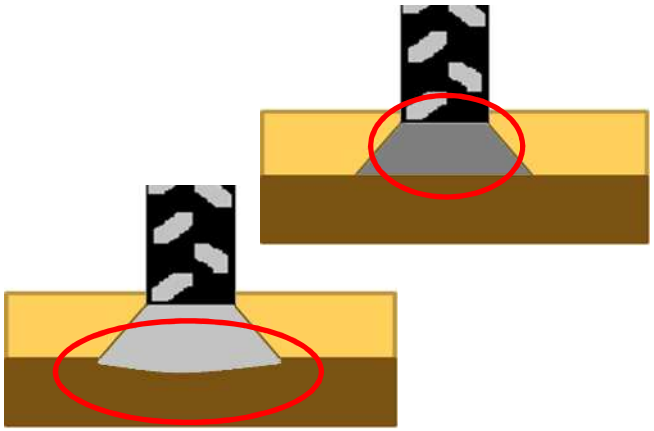
Rutting

- **Description** – longitudinal deformation in the wheel paths caused by the passage of traffic. Dry granular soils that have insufficient fines or wet conditions in water sensitive soils.
- **Cause** – Repeated traffic creates rutting by **compacting material** directly under the wheel. **Material displacement** may also occur (wet condition). This occurs due to failure of the **subgrade, basecourse and/or running surface**. Excessive water, poor grading, poor compaction and inadequate pavement depth are all reasons for subgrade failure.
- **Main consequences** – Increased erosion, risk to the safety, vehicle operating costs.



Rutting

- **Correction** – **grading to the depth of the rutting**, **re-spreading and compacting** is generally sufficient. If subgrade failure is the cause of rutting, then additional aggregate may be required **to increase pavement thickness**.

- **Prevention** – Design and build pavement using **well graded material**. **Compact at optimum moisture content** and maintain the correct **crossfall**. Ensure pavement thickness is sufficient to distribute load onto the underlying subgrade.

Potholes

- **Description** – Round or oblique holes in the upper surface of the pavement.

- **Cause** – Generally caused by **poor drainage due to low crossfall**. **Water lies on the surface, weakening the top layers**. Vehicle movement strips the surface material allowing more water to enter the pavement. **Fines** are suspended in the water and **carried away**. Can also be caused by using overly-large surface aggregate.

- **Main consequences** – Discomfort, risk to the safety, vehicle operating costs.

Potholes

- **Correction** – Grade and re-spread to the depth of the pothole to restore the required crossfall to ensure adequate drainage. New material may need to be imported, mixed and spread to replace lost material.

- **Prevention** – Increase crossfall in problem areas to improve drainage. Use well graded and appropriate sized aggregate for basecourse and running course. Stabilise pavement using moisture retardant in constantly wet and shaded areas.

Corrugations

- **Description** – Material is displaced and arranges itself into parallel ridges that lie at right angles to the road direction.
- **Cause** – Caused by dynamic loads from vehicles travelling over the pavement. Wheels slightly bounce, reducing weight for a moment, then landing a moment later compressing the surface. Corrugations induce greater dynamic load, thus increasing the rate of corrugation damage.
- **Main consequences** – Discomfort, risk to the health and safety, vehicle operating costs.

Corrugations

- **Correction** – grading to the depth of the corrugation, re-spreading and compacting is generally sufficient. Use of high quality aggregate or bitumen seal may be required for trouble spots.

- **Prevention** – maintain a smooth road surface through regular grading, reduce speed.

Surface Scour

- **Description** – Longitudinal or transverse scouring of material from the running surface. Opens the pavement up for further scouring.
- **Cause** – Scouring is caused by the flow of water over the pavement. Susceptible pavements are those that have insufficient compaction, have been excessively or too frequently graded, lack crossfall or have a build-up of debris on the shoulder preventing water drainage.
- **Main consequences** – Discomfort, risk to the health and safety, vehicle operating costs.

Surface Scour

- **Correction** – Cut, grade and compact the affected areas, ensuring that the crossfall is correctly maintained. Clear out water table drains and shoulders to ensure efficient drainage of water from the road surface.

- **Prevention** – Design and maintain appropriate crossfall. Regularly clean water table drains and shoulders. Use high quality and free draining aggregate and/or pavement stabilisation in problem areas.

Soft Surfaces

- **Description** – Movement of material within the pavement causes localised soft spots.

- **Cause** – Material containing a high proportion of fines and which has not been well compacted will move under loading. Another cause is the movement of water into the subgrade, either from the surface or through capillary action.

Soft Surfaces

- **Correction** – Extract and replace the material with correctly graded or stabilised material. Good compaction will help to prevent recurrence of this defect.

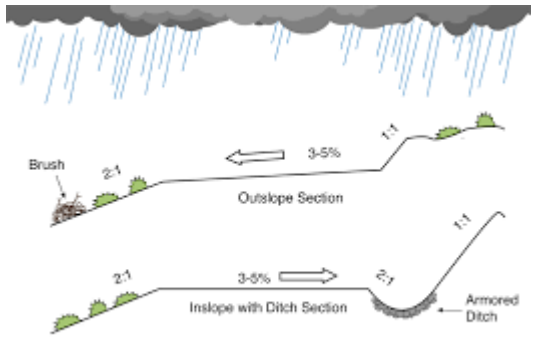
- **Prevention** – Correctly compact well-graded aggregate at the optimum moisture content. Maintain crossfall to limit water ingress from the pavement surface. Keep water table drains clear so that water does not pond and enter the subgrade. subgrade drainage may be required in problem areas.

Drainage System Maintenance

Drainage systems need regular maintenance to prevent major damage to the road

Crossfall

- Effective crossfall is critical for removal of water from the pavement surface.
- However, crossfall must be complemented with an effective drainage system.



Drainage System Maintenance

Water table drains

– Clearing debris and vegetative growth from water table drains

  - Only if and when needed
  - A certain level of vegetation may positively reduce water speed and scouring capacity

Drainage System Maintenance

Culvert cross drains

- Removal of sediments from culvert mouth
- Cleaning the pipe
- Repairing, replacing culverts and their headwall
- Check the spillways and their flumes

Drainage System Maintenance

Sediment trap

- Periodically checked - sediment removal
- Water flow entrance and exit cleaned

Drainage System Maintenance

Cut-offs/lead-out

- Repaired and cleaned regularly

Berms

- Inspecting berms to ensure they are watertight

Shoulder Maintenance

- Shoulder maintenance will help to:
  - Improve safety by providing room for stopping, passing and hazard avoidance
  - Provide additional width to allow for truck off-tracking
  - Provide a pavement drainage area
  - Reduce the risk of pavement edge defects

- Windrows of soil on the edges of the road be regularly breached (inslope, outslope, crown section), except where they have been intentionally constructed for the protection of fills.

Roadside Maintenance

- Roadside maintenance involves controlling roadside vegetation.

- Roadside vegetation must be regularly cleared to:
  - Maintain/improve sight distances
  - Allow room for passing traffic
  - Improve daylighting
  - Remove instable trees
  - All trees which fall onto or across roads are to be removed as soon as possible.

Road Closure

- Road maintenance is expensive and ongoing
- A better option may be to close the road, provided that access is no longer required.
- Road closure involves:
  - Blocking access by using gates or other obstacles
  - Stabilise the road surface by scarification, seeding and mulching to allow revegetation
  - Removal of drainage culverts and stream crossings.
  - Install water bars, berms and ground cover to minimise potential environmental impacts
- This approach is relatively inexpensive and eliminates most environmental impact, whilst retaining the basic road shape. This enables simpler re-establishment of the road if required in the future.