Cold **Chon**

Road Maintenance Techniques

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INTRODUCTION

The maintenance of roads involves the co-ordination of a wide range of seemingly unrelated activities. In practice to achieve a good standard of effective maintenance it is essential that different aspects of the work should integrate smoothly. The task facing the Engineer in Road Maintenance is to maintain a network of roads within available budgets. This is made difficult by the amounts of road which are built to inadequate standards and the increase in both the volumes of traffic and in the axle loadings combined with decreasing budgets and the expectation of further cuts in public expenditure. This is noticeable both in rural areas where the intensification and diversification of agricultural production has resulted in minor roads of minimal pavement construction having to accommodate relatively large volumes of traffic and more particularly commercial vehicles which on occasion can barely fit onto the road, and in urban areas where the growth of towns and cities has incorporated areas serviced by minor roads now carrying heavy volumes of traffic.

The Road network in Ireland consists of

National Primary roads	2739 km
National Secondary roads	2676
Regional, County and Urban Roads	89,000 km. (Approximate figure)

Of these the majority of National Primary and some national Secondary roads have been realigned to modern design standards, the remainder are old pre automobile tracks which received an overlay of gravel and surface dressing during the 1950/60's with subsequent granular overlays and Surface Dressing. Due to the dispersed settlement pattern in Ireland we have a proportionately long road network for our population. The maintenance of these roads will continue to be an ongoing problem, resources will not allow for complete structural overlays or realignment of a significant proportion of these roads.

During the past decade and a half funding has been available to allow a higher expenditure on Road Maintenance than was previously available, resulting in significant improvements in the standard of road pavements through the country. The challenge for engineers over the next few years will be to maintain the road network to an acceptable level with less resources than have been previously available.

ROAD PAVEMENT DETERIORATION

In college most engineers will have been introduced to the basics of road pavement design, the structural design of the road pavement is determined by the estimated traffic volume over the design life of the pavement and the ground conditions, giving a depth of layered construction to provide for a 20 year life, road pavements designed and constructed in the last 30 years have been designed and constructed according to this approach. Pavement overlays are designed on the basis of strength testing and the relevant depth of construction is added to the road structure

Last winter (2009-2010), with heavy rainfall during November and December, followed by severe frost in January resulted in severe damage to many sections of roads throughout the country, noticeably on old portions of road, not on newly constructed, strengthened or Surface Dressed roads. Why is this? What can road maintenance engineers do to prevent a similar occurrence in future?

Other lectures in this course will deal with the design of pavements and structural overlays; my intention is to concentrate on basic routine operations which can significantly increase the life of the road pavement.

All our roads are founded on natural soils, which with the exception of organic material such as peat are treated by Geotechnical Engineers as granular materials as are the non bitumen bound layers in the road structure. From second year Soil Mechanics we will have learned that the strength of such materials is at its maximum at optimum moisture content, during construction these materials are tested and checked to ensure that this moisture content is achieved.

Moisture Content Vs. Strength

Granular materials which are saturated with water will lose 90% of their strength resulting in pavement failures. This is what happened during last winter. If this is to be avoided two things are necessary, the road must have adequate drainage, and its surface must be sealed against the ingress of water.

Saturated pavement failed in winter

Drainage

It is a basic fact of road maintenance that providing and maintaining adequate drainage is the most important factor in prolonging the life of the road pavement.

The most effective action that can be taken by a road engineer to maintain the road pavement and prolong its life is to ensure that the pavement is adequately drained and that water does not pool on the road surface. There should be no such thing as a flat road; roads are built to falls, with either camber or super elevation to assist in draining the water to the road edge.

When water has reached the road edge there must be a drainage system in place to remove the water from the pavement. This can be a piped system with gullies in urban areas, stoned drains on large roads and motorways and water cuts, possibly with side drains on rural roads.

Over time silt and grit from the road is washed into these systems, rendering them ineffective unless they are regularly cleaned, a drainage system is useless unless it can accept the water coming to it. There should be a regular system of checking drainage outlets and cleaning them to ensure they function properly. Problem areas can be easily identified by driving the road on a wet day and investigation/remedial works carried out in dry conditions. Localised ponding is often a result of an accumulation of silt and debris in gullies and watercuts which can be easily cleaned, equally the openings of bridges, culverts and pipes passing under the road should be checked for blockages during conditions of low flow.

Water cuts not maintained

WATER CUTS

Water cuts consist of channels at right angles to the road which allow water to flow into adjacent fields. Traditionally these were maintained by gangs of workers manually using shovels. As the labour force available to Road Authorities has fallen over the last twenty years, this work can in general no longer be carried out manually.

A commonly used alternate method is to use a backhoe (JCB) with a wide (1.2 – 1.5m) bucket which can open and clean the watercuts quickly and efficiently, while the machine is parked parallel to the road. Various devices have also been designed for use on agricultural tractors which will perform this task but without the flexibility of a wheeled loader/ backhoe.

ROADSIDE DRAINS

These were in the past cleaned manually but now must be cleaned by machine. This can be a tedious and awkward task, there is no excavator which will comfortably clean narrow drains parallel to the road edge without considerable manoeuvring, leading to low outputs. There is definitely an opening for a machine geared specifically for this purpose.

With increasing traffic on rural roads, problems have arisen with these often narrow drains being closed by the pressure of the wheels of truck and agricultural machinery. In many instances it has proved necessary to replace them with piped drainage systems.

PIPED DRAINAGE SYSTEMS

Piped Drainage Systems can be sealed or open with water entering through gullies or via a permeable medium. In either case, the drain must be capable of taking the flows of water and the water must be able to reach the drain. Piped drainage systems must be regularly checked to ensure that conduits are not blocked and that in the case of French drains the water can soak to the drain.

Recent developments include the use of plastics to replace concrete pipes in French drains and the use of pipes which can be ploughed into place at a lower cost than traditional systems.

Gullies must be cleaned

In general drainage is achieved by the use of a piped drainage system accessed by means of road gullies. Such a system

will only work effectively if pipes are clear and gullies are not blocked with litter or debris. Road sweeping operations should include a check of all road gullies and cleaning of these as a matter of routine while mechanical sweepers are sweeping the road.

It makes very good sense to survey and map all road gullies and their outlets, and set up a routine inspection programme to ensure the drainage system is adequately maintained.

Even new systems need cleaning

Many drainage systems are inadequate to meet the demands at present placed upon them; in many cases substantial resources are necessary to provide new drainage systems. It is part of the function of the Road Maintenance Engineer to identify the necessary modifications or to establish the need for new systems while ensuring that the existing system is capable of operating at its maximum efficiency.

Often in problem areas a thorough investigation will produce simple solutions, in many cases there may well be disused drainage systems which have been abandoned by neglect and with minor modifications can be used to remedy localised drainage problems.

NEW DEVELOPMENT PROPOSALS

When projects are at planning permission stage the possible effects on the drainage system should be established and catered for, existing drainage systems should be protected by condition and any new systems required must be included in the submitted proposals. In light of recent experience developments on or near floodplains should be subject to rigorous scrutiny, similarly downstream drainage systems should be checked for their capacity to accept the accelerated runoff from paved areas. Information on flood risk is available from the Office of Public Works, local knowledge is also very relevant, and if an area has flooded once it will most probably do so again, unless there has been some change in circumstances since the previous flood event.

Sealing the pavement

Having stressed the importance of road drainage it is necessary to consider the importance of providing an impermeable seal across the entire road surface to protect the underlying layers of the pavement.

Surface dressing seals the pavement

On the majority of roads, this is achieved by Surface Dressing. This consists of the application of a layer of Bitumen emulsion to the road surface, followed by a layer of chippings, the bitumen seals the surface, and the chippings provide friction to allow safe passage of traffic. Surface Dressing can be carried out over kilometres of road at a time using conventional plant or over localised sections where the seal of the road has deteriorated using all in one sprayer/gritters, either way the technique represents the most efficient and cost effective method of sealing a road pavement and providing skid resistance as part of normal maintenance.

Surface dressing seals the pavement

Localised repair with surface dressing

Localised repair with surface dressing

Depending on traffic volumes roads should be Surface Dressed on a cycle varying from 7 to 10 years to seal the surface and extend the life of the pavement. This frequency has not been achieved over much of the country during the last 10 years, the focus of many road authorities has been on pavement renewal rather than pavement maintenance. This approach will not be possible in a period of more limited resources, the focus will have to shift to sealing pavements in order to extend their life, engineers will have to become more involved in the Surface Dressing process.

Bond coat is essential to bond layers

When constructing roads paved with layers of Bitumen Macadam/Asphalt the seal of the road is achieved by the use of Bond coats of Bitumen Emulsion between the various layers of pavement, these both seal the road and bind layers together to make a laminated structure, omission of bond coats or inadequate application of bond coat is a cause of pavement failure.

TRENCHES

A controllable source of road surface defects is inadequately restored trenches or excavations. The large majority of road excavations are carried out by the Road Authority, other public undertakers or contractors operating on their behalf. It is unacceptable that the location of underground services is often found by following the telltale depressions in the road surface.

The majority of trenching operations are carried out in a planned environment, the need to have trenching carried out can be anticipated in advance and as an absolute minimum the adequacy of reinstatement should be assured through a system of quality control on the part of the Roads Authority. The standard to which a Local Authority reinstates its own excavations will set a target for other undertakers.

Guidelines for Trench reinstatement have been prepared by The City and County Engineers Association, these have been adopted by the DoT and DoELG, the recommendations in these should be applied to all trench works.

Common problems with Trench reinstatement are:

Unsuitable fill material used in backfilling,

Inadequate compaction of backfill

Failure to seal over and around the edges of the trench surface, resulting in the saturation of the granular material and subsequent pavement failure,

These problems are avoidable if work is properly specified and supervised; equally Road authorities should keep an accurate database of trench works and road cuttings and record inspections and remedial works where necessary.

REPAIR OF ROAD SURFACE DEFECTS

To the road user the immediate evidence of an inadequately maintained road network is the ubiquitous pothole, a cause of genuine concern and a source of much indignation. Potholes are a symptom of underlying deficiencies in the road, inadequate drainage being the most common, a road pavement being badly fatigued through overloading or lack or renewal or as is a common cause roads of minimal construction depth built for light traffic being subjected to repeated heavy axle loadings. It is probably a measure of the effectiveness of road repair techniques that so many roads are still capable of functioning albeit at a low serviceability while carrying loads far in excess of their structural capacity.

The City & County Engineer's Association in conjunction with the Department of the Environment has prepared and distributed a document "Road Surface Repairs", the which is has been adopted by the DoT and the DoELG . This document gives an overview of the techniques, materials and operating methods currently in use in this country. The reader is advised to study this document which offers a comprehensive guide to the topic.

The following points deserve to be highlighted briefly –

1. Repairing road surface defects is an expensive operation, the operating costs of a conventional truck mounted patching unit run to €2500 per day, regardless of the effectiveness of the repairs carried out.

2. Quality control of the materials used is critical – use of incorrect or substandard materials will result in poor quality work which will rapidly disintegrate.

3. There are many different methods of carrying out road surface repairs varying with machinery used and materials employed. The CCEA document sets out an indication of suitable methods for use on different types or road construction, the choice of method depending more construction of the existing road that it's classification into National, Regional or Minor road.

4. Repair of road surface defects is wasted effort unless drainage problems are attended to, repairs to roads which are either waterlogged or may be expected to be so will not last for any length of time.

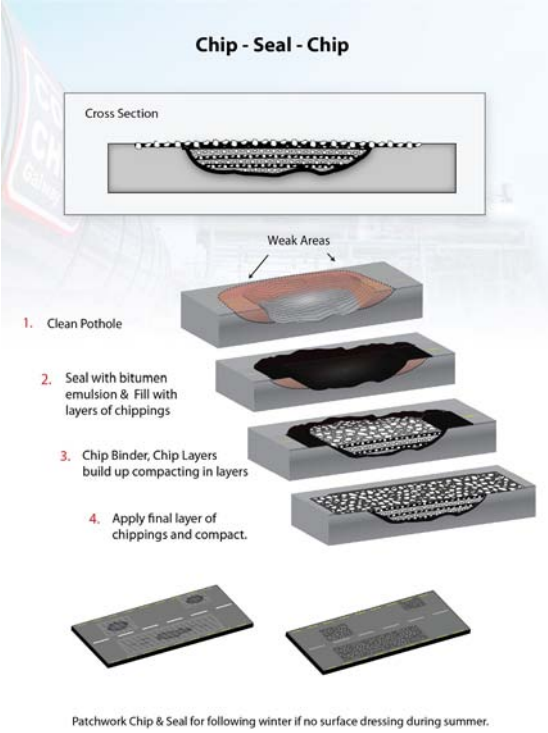
5. Repair crews must be adequately trained and skilled in the techniques they are using, they should understand not only the "hows" but also the "whys" of what they are doing, their efforts should be directed at achieving effective and durable repairs.

6. The two most common causes of repair failure are inadequate compaction and failure to seal the repair surface and perimeter allowing subsequent water penetration and pavement disintegration. All repair techniques depend on the compaction of the repair material – this will not be achieved by the back of a shovel or a lorry wheel – suitable portable compaction equipment is an essential tool in surface repairs, similarly the repaired area and its surrounds must be waterproof.

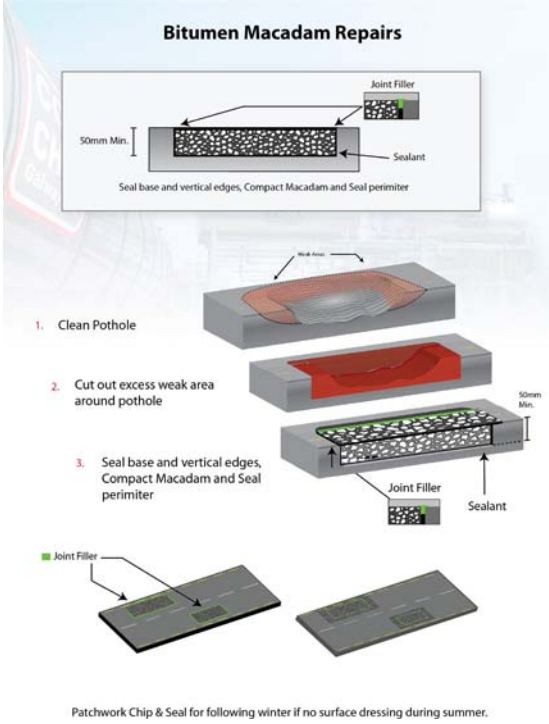
7. Effective repairs will be carried out if the repair crews are directed by engineers with a thorough understanding of the methods, machines and materials being used, and the ability to encourage the crews to develop their skills in a worthwhile manner. Information on methods of repair is available on www.coldchon.ie

Compaction is essential

Macadam repair sealed with surface dressing



Surface repair using emulsion & chip



Surface repair using a hot macadam

FOOTPATHS

One might assume that the maintenance of footpaths for pedestrian use would not present difficult problems to Road Engineers. The high proportion of claims received by Local Authorities arising from trips and falls on footpaths would seem to belie this assumption. The major contributors to footpath defects are:

1. Bad construction
2. Traffic mounting paths
3. Badly reinstated excavations in the path

BAD CONSTRUCTION:

1. Many footpaths lack the strength to perform their function due to inadequate foundations or poor construction methods or materials.
2. The Law prohibits mounting pavements with vehicles, yet many drivers disregard this, the most significant of fenders being drivers or delivery vehicles.
3. Excavations in the path. This should be an avoidable problem but it seems to be a most common difficulty, excavations are carried out routinely but in many cases adequate reinstatement is omitted. At times the Local Authority staff may themselves be part of the problem by excavating footpaths to repair underground services. An important step in footpath maintenance is the preparation of a footpath inventory by the person responsible for maintaining the footpath which will allow an assessment of the relative condition of portions of path, and the estimation of the necessary resources to effect an adequate repair programme. This can be a chastening exer

cise because aside from the problems caused by large areas of exhausted pavements the engineer will repeatedly come across minor defects which can be repaired at low cost but yet represent a threat to pedestrians. These repairs should be effected immediately. Major repairs or renewal should be planned in the same way as other roadworks operations to ensure high quality work and sections should be laid out in a manner to ensure efficient work.

Many footpaths are not accommodating to people affected by physical disability. In preparing a scheme of footpath repair or renewal the engineer should be aware of the needs of disabled people and take advantage of the opportunities to facilitate their mobility, liaison with local disability action groups will prove fruitful in revealing unsuspected barriers to mobility.

REPAIRS

While defective concrete pavements can generally only be usefully repaired by the removal of defective areas and the construction of a new section of pavement, it is possible to renew bituminous paths by using a bituminous slurry seal which will provide a slip resistant and level surface without appreciably raising the profile of the path. This method can also be used on concrete paths suffering from surface ravelling. The unit costs are favourably compared with the cost of removal of the existing path and reconstruction.

ROAD EDGES/CHANNELS

With the increased mechanisation of road sweeping a problem becoming more evident is the ravelling of the road edge at the kerbside. This may be caused in part by inadequate sealing of the area between the kerb and the edge of the road, particularly if the kerb was originally placed after the road was constructed, but the action of mechanical brushes will affect all but well constructed roads. Possible solutions are repairs using patching methods or the application of a slurry seal 3 – 500mm wide at the kerb edge, the latter has been tried and found to provide a satisfactory solution.

RESOURCE USAGE

Given that resources are inadequate, it is imperative that Engineers should target and direct the use of available resources so as to maximise the gain to the road network from the maintenance programme. The emphasis on Local Authority auditing has traditionally been to ensure that moneys are spent in a legal and correct manner. It is inevitable that the question of value for money and the efficient use of resources must be addressed by engineers directing road maintenance operations.

In Ireland the Road Maintenance Engineer can carry out the functions of a number of people involved in construction, projects, he or she may fulfil the duties of surveyor, designer, resident engineer, site agent and certifier, often all within the same morning. It is the flexibility inherent in this arrangement which can allow for the imaginative use of materials and techniques to maximise the return on investment of public funds.

While acknowledging that resources are limited, engineers must ensure that work under their direction is carried out in accordance with the relevant standards. Work badly done will lead to a waste of resources in rectifying defects.

LABOUR RESOURCES

A consequence of the low level of funding for road maintenance and of increasing mechanisation of activities is that the labour force available to Local Authorities has shrunk during the last 10 – 15 years. There is a huge availability of talent and experience in road maintenance available within Local Authorities which must be properly mobilised to achieve efficient work. It is essential that engineers ensure that staff working with them have an appreciation of the tasks to be accomplished and the correct methods of tackling these tasks. This can only be done through training both formal and informal. The formal training should be by means of lectures and seminars geared towards the needs of the particular workers and aimed at improving their knowledge of the methods and techniques being used. More importantly informal training and encouragement should be given on site by the Engineer, Supervisor and Foreman. Road Maintenance staff should be encouraged to develop their skills in the wide range of operations to be achieved.

This should not be a one-way process – while road workers do not have the technical training of engineers in many cases they will have a long experience of the work they are doing and an appreciation of the practicalities of the task which engineers should take heed of.

CONCLUSION

Achieving a high standard of Road Maintenance is a difficult task for Engineers. Good standards will only be achieved if the disparate maintenance operations are integrated together in a practical manner. Limitations on resources will ultimately limit what can be achieved but the task facing Engineers from day to day is to achieve the highest standards within the constraints of available resources. It is hoped that the methods and suggestions outlined in this paper will be of some assistance towards this