6 APPROACHES

6.1 GENERAL

Bridge approaches are an integral part of the structure, and faults in the approaches can be as serious as those in the main structure.

Based on previous research, approximately 5% of New Zealand bridge failures can be attributed to partial or total loss of approach fill.

Defects tend to fall into two categories relating either to traffic safety or to structural deterioration, but of course many have an effect on both of these. Either way, defects are usually very noticeable to the public, and deserve prompt attention.

6.2 INSPECTION AND EVALUATION OF DEFECTS

The aim of inspection is to identify defects and inadequacies in the approaches, and to determine the causes and rates of deterioration. This will allow an evaluation of the significance of each, and an appropriate solution to be arrived at.

Apart from having drawings of the structure and approaches, it is also useful to know:

- Age of the structure;
- Age of the pavement;
- Average annual daily traffic count;
- Percentage of heavy vehicles;
- Size of typical heavy vehicles.

The inspection should include a thorough examination of all the features discussed below.

6.3 DEFECTS AND THEIR CORRECTION

6.3.1 Alignment Geometry

Many bridges have substandard approach geometry. This should be considered a defect if accident records show that it seriously compromises road safety. It usually relates to lack of visibility or to slow-speed curves in a high-speed environment. Extreme vertical curvature can also increase the impact loads on the approach or structure.

Correction of road geometry is a major operation, but shape correction may be acceptable. Measures aimed at reducing speed may be mitigate the effect. These could include improved road marking, marker posts and signs, including advisory speed signs.

6.3.2 Pavement

Pavement defects on bridge approaches are normally considered with maintenance of the rest of the highway. However, because they can affect both impact loading on the bridge and road safety, they need to be addressed as part of the bridge inspection as well. Defects include loss of chip, flushing of excess binder, slicking as well as shear failure resulting in cracking, heaving or rutting.

Guidance will be found in the Austroads Manual: Pavement Design: A Guide to the Structural Design of Road Pavements (1992), and in particular, in the "New Zealand Supplement", Section 10 (TNZ 1997).

Figure 6.1: Settlement of approach caused by lack of fill containment.

6.3.3 Settlement

Settlement usually shows up as a localised depression in the pavement adjacent to the end of the bridge. The amount of settlement necessary before problems develop can be quite small. Depressions in excess of 15-20 mm will be detected by the road user, and when greater than 25 mm will quickly become unacceptable. Apart from the road safety aspect, the effects on the bridge will be increased impact loading and fatigue, with particularly serious consequences for the deck joint nearby. The pavement will suffer the same effects, leading to further accentuation of the depression.

Progressive settlement can often be detected in the approach traffic barrier if the pavement has been corrected by filling over the years without re-levelling the barrier rail.

Settlement may be the result of:

- Plastic deformation of the ground underlying the fill itself if it has not been properly compacted or is of inappropriately graded material;
- Migration of fines from the fill if it is poorly graded with excess fines. This can occur by piping, after high water levels caused by flooding, or by water from defective drains. Seepage from the fill can be a warning sign of this problem;
- Movement of the abutment or wingwalls, which reduces support to the fill;
- Poorly shaped fill around and in front of a spill-through abutment. A horizontal berm should be formed in front of the abutment, allowing the projected fill slope to line up with the road surface immediately behind the abutment, as shown in Figure 6.4. Otherwise material will tend to move through under the abutment and cause settlement.

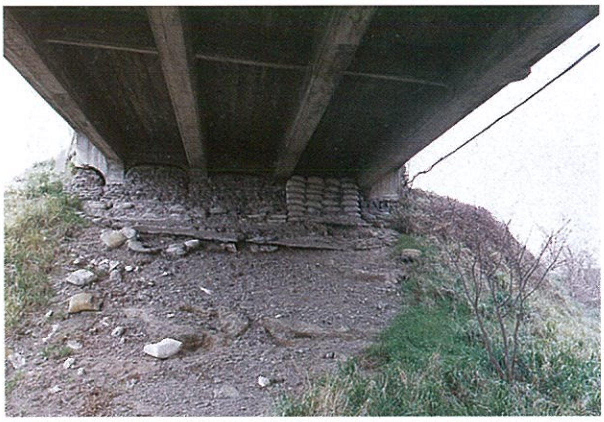

Figure 6.2: Ineffective fill containment.

Figure 6.3: Failure caused by seepage and poor drainage.

Filling the pavement depression is a short-term solution, but it is preferable to determine the cause and correct it.

If settlement is caused by plastic compression in the ground underlying the fill, a possible solution is to remove and replace the fill with lightweight material. Unsuitable fill may be replaced by correctly graded material.

If the cause is migration of fines, it may be sufficient to improve the drainage system by lining channels. Horizontal perforated drains drilled into the fill to remove groundwater may also be beneficial.

If there is insufficient fill in front of a spill-through abutment, as described above, this should be corrected if there is sufficient space to do so. Otherwise, some method of retaining the fill beneath the abutment may be sufficient, such as placing rocks. If there is no settlement slab, construction of one, as required by the Transit New Zealand "Bridge Manual" (SP/M/014) will also improve the situation by preventing a depression forming immediately next to the abutment.

See also Sections 9, 10 and 11.

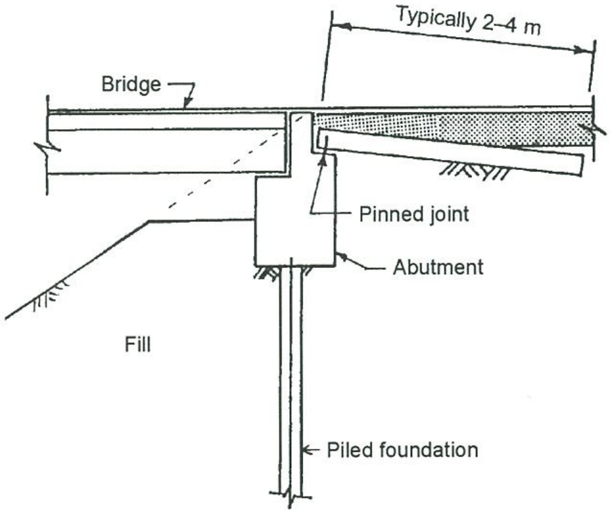

Figure 6.4: Abutment with settlement slab and properly shaped fill.

6.3.4 Erosion, Drainage and Slipping

Erosion of fill may be caused by scour in the waterway, or defective drainage either on the approaches or the bridge. Slipping may occur due to instability in both cuts and fills on the approaches.

If erosion is caused by scour, river protection by gabions or rip-rap may be required, as described in Section 10.

If erosion is due to defective drainage, lining channels is the most effective treatment, and this could include energy dissipation measures where water has to flow down the fill slope. Diversion of water discharging from the bridge may be necessary. Regular cleaning of drains to prevent blockages will also help, and this should include flushing out of soil drains if these are present. Improved vegetation on slopes will also help control the flow. Guidance on drainage systems is provided in the manual: "Highway Surface Drainage – Design Guide for Highways with a Positive Collection System" (NRB 1977).

If slips are a frequent problem, flattening the slopes is an obvious solution, but the drainage improvement described above may be enough to correct the situation by itself.

See also Sections 7 and 10.

6.3.5 Traffic Barriers

Traffic barriers on approaches are most likely to be in the form of non-rigid barriers such as W-section or thrie beam barriers, although rigid concrete or steel barriers may be used in some situations.

The most obvious defects in approach barriers are collision damage. Other faults may include steelwork corrosion, loose joints, and slack cables in breakaway cable terminals. The barrier rail may become misaligned vertically due to fill settlement, or horizontally due to expansion forces if the posts lack sufficient support in the ground. All non-rigid barriers should terminate in an anchorage, sufficient to resist the design force. In older installations this may be a concrete block, with the rail twisted down to meet it at ground level. This terminal does not meet current standards, which are set out in AS/NZS 3845:1999 "Road Safety Barrier Systems". Design office advice should be sought.

A check should be made of non-rigid barriers to see whether the rail is at the correct height to operate as designed. For both W-section and thrie beam barriers mounted on standard blockouts and posts, the height to the centre of the rail from underlying road surface required by AS/NZS 3845:1999 is 530 $\pm$ 20 mm, while the Transit New Zealand "Bridge Manual" (SP/M/014), for W-section guardrail, specifies 550 mm with tolerances of +50 mm, -20 mm.

If the effective height has decreased because the approach has been filled to correct settlement, posts should be reset. See also Section 8.7.

6.3.6 Signs and Roadmarking

State highway bridge approaches, and preferably those on other highways, should comply with the "Manual of Traffic Signs and Markings" (Transit New Zealand). All bridges should have a sign showing the bridge name and route position, and as appropriate may have the following signs:

- Advisory speed;
- Load and/or speed restriction for heavy vehicles;
- Bridge end markers;
- One way bridge;
- Narrow bridge.

The condition of all these items should be checked and rectified as necessary.

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