Effect of the September 1987 floods on the road infrastructure in Natal

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Synopsis
The excessive rains that fell over much of Natal at the end of September 1987 resulted in damage estimated at R96 million to rural roads and bridges. Damage was caused at more than 400 places and included 26 bridge structures, 130 bridge approaches and 40 causeways. No modern bridge structures were damaged, although some of the approaches were washed away. The damaged structures were mostly between 26 and 42 years old.

Samenvatting
Die uitsonderlike reën wat teen die einde van September 1987 oor die grootste deel van Natal uitgesak het, het skade ten bedrade van R96 miljoen aan plattelandse pasie en brûe veroorsaak. Skade het by meer as 400 plekke voorgekom en het 28 brugstrukture, 130 brugaanlope en 40 laagwaterbrûe ingesluit. Geen moderne brugstrukture is beskadig nie, ofskoon sommige van die aanlope wegespoel het. Die beskadigde strukture was meestens tussen 26 en 42 jaar oud.

Introduction
September is the normal time for the start of the rainy season in Natal, usually with gentle spring showers. In 1987, however, the rains started towards the end of August, followed by four days of continuous rain at the end of September. This caused damage to the road infrastructure more severe than anything previously experienced. Most of the province was affected, except north-western Natal where relatively little damage occurred. Thus the inland portion of the area, which suffered most from cyclone Domino in 1984, escaped relatively lightly.

The damage to the roads and bridges appears to have been caused by very high peak flows. These resulted from the extended duration of the rainfall coupled with the occurrence of the highest intensity of rain at the time when the rivers were already full.

It must be emphasized that, contrary to the view generally held, no modern bridge structures were damaged, although some of the approaches were washed away. The damaged structures were mostly between 26 and 42 years old and were designed before the flood hydrographs currently in use became available.

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Little damage occurred to the modern national road bridges that were less than 20 years old, although several bridges suffered severe erosion around the abutments. These bridges were designed with the benefit of better flood intensity and scour depth prediction data, which had not been available previously. Improved piling equipment has also become available since the early 1960s, making it possible to build foundations capable of meeting modern design criteria.

National roads
The declared national road network consists of the coastal route N2, connecting inland to the Transvaal at Pongola, and the Durban-Johannesburg route N3. Relatively little damage occurred on these main highways. The total cost of R4 million reflects the lesser damage suffered by modern high level bridges, often with additional waterway occasioned by the high geometric standards of freeways. The wide side drains minimized damage to road structures by diverting excessive flows from...
culverts that had overfilled and by retaining slides of topsoil and grass away from the traffic lanes. Only two serious disruptions required traffic to be diverted for several weeks. Some 200 m of the southern approach to the Mvoti River Bridge on the north coast was washed away and a landslide in residual dolerite soil on shale resulted in a 100 m gap in the northbound carriageway of route N3 at McKenzies Hill between Howick and Mooi River. This landslide necessitated the installation of stressed anchor cables to hold the southbound carriageway, which enabled this carriageway to carry all N3 traffic during reconstruction of the failed section. A rock toe was constructed to restrain the slip movement without removing the major portion of the landslide, which was retained as the embankment with the road reconstructed on top.

Provincial bridges Damage to rural roads and bridges occurred at more than 400 points and included 28 bridge structures, 130 bridge approaches and 40 causeways. The four major provincial bridges damaged were located on the coastal routes, either in estuaries or near the coast.

The greatest single disaster was the collapse of the John Ross Bridge over the Tugela River. This 27 year old bridge had a continuous deck and was founded on caissons keyed into the tillite bedrock. The river level was well below the underside of the deck, when the one pier in midstream was displaced from its caisson foundation. The collapse of this pier resulted in a chain reaction that left only the abutments standing.

The traffic was diverted to the 50 year old single lane steel bridge upstream and to the unused half of the rail bridge over the Tugela River. Preliminary tenders to design and construct a replacement bridge have been received and five tenderers have been selected to submit detail designs and tenders. The construction period offered will be a major consideration in the adjudication of tenders, in order to minimize the inconvenience currently being suffered by road users.

Including the replacement of the skid bearings with more robust units. Four spans of the Mpambinyoni River Bridge at Scottburgh collapsed and were replaced by three spans and two piers founded on very much deeper piles than the original ones. The spans that were rebuilt after the 1985 floods were not damaged. During construction, traffic was diverted to a temporary causeway across the estuary.

At Batstones Drift near Port Shepstone the low level causeway over the Mzimkulu River was washed away. This carried mainly cane traffic and was built on timber piles after the 1959 floods. Traffic is using a temporary pontoon bridge erected by the SA Defence Force while a new low level structure founded on concrete piles is being constructed.

Inland the border bridge over the Mlambwane River between Harding and Transkei suffered the loss of its superstructure. A temporary Bailey bridge was also erected by the SA Defence Force to carry the traffic until the superstructure can be rebuilt by the Department of Transport. Further upstream on the Mzimkulu River a 40 year old bridge giving access to the Centocow Mission near Creighton was severely damaged. A temporary crossing has been provided using the second Callander Hamilton emergency bridge.

The approaches to the Josephine Bridge (ref Hailmarks December 1985 issue) over the Mikomasi River between Richmond and Inxopo were washed away. Of particular interest is that the south abutment constructed in 1914 was badly damaged and will have to be replaced, while the adjacent extension built in 1972 withstood the onslaught.

Provincial roads The floods caused widespread scour damage to cut slopes and embankments. Some of these were of sufficient magnitude to threaten the stability of the road, but the treatment of these was relatively straightforward and did not present geotechnical problems.

Two major landslides occurred in slopes of cuttings on provincial roads. In both cases the material involved is a dolerite residual soil
Subsidence on the N3 at McKenzies Hill

containing boulders in a clayey matrix. The first was on R612 between Donnybrook and Bulwer, where 150 m of the roadway was disrupted and lifted by the toe of a slip circle that extended to 70 m above the road edge. The slip was stabilized by installing subdrains and drainage trenches and removing 50 000 m$^3$ of material from the top of the slip circle to restore a balanced condition. A key of compacted rock was built to intersect the slip plane and prevent further movements.

The second landslide was on the old road R103 between Balgowan and Nottingham Road, in a 4 m cutting on a steep hillside. This slip moved 200 m of the roadway 0.1 m laterally and extended from 50 m above the road edge to a toe emerging in natural ground below the road. Stabilization was achieved by loading the toe with material from borrow. Slipped material was removed to spoil and the road realigned for over 500 m in stable material.

Appreciable loss of the wearing course has been experienced on gravel roads. Extensive regraveling will have to be carried out.

Execution and cost of repair work

The repair work on national roads was carried out almost entirely by contract. The total cost was R4 million.

On the damaged provincial roads, departmental maintenance and construction forces were on the scene before the floods had abated. They were very soon reinforced by road construction contractors and hired plant. Extensive use was made of consulting engineers in the planning of repair work and the supervision of its execution. These repair teams worked very long hours under hazardous conditions to get traffic moving on the main roads.

The preliminary estimate of the cost of the repair work on provincial roads is R92 million. More than 90 per cent of this work will be executed by contract.

Remarkable progress was made up to the start of the year-end holiday. Much remains to be done on primary, secondary and tertiary routes and it is unlikely that the work will be substantially complete before early 1989.

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Preliminary hydrological assessment of the Natal flood (continued)

References