5 LOAD TESTING

5.1 General

Load testing of bridges has been used in the past in some countries to establish that the structures are capable of supporting service design loads. It typically demonstrates that theoretical capacity ratings are too conservative because in most bridges there exist a reserved residual load capacity. The structural analogy used in theoretical analysis does not always take into account such factors as compound or orthotropic action, contribution of stiffening and architectural member variations in materials properties affecting stress distribution, or boundary constraints such as bearing restraints. The reserved residual strength of a bridge therefore depends on the type of structure, construction materials, and the extent of defects or deterioration.

Although load testing demonstrates whether or not residual strength exists in a bridge, by itself, it does not provide the confidence level to establish a new bridge rating. A complex process of reconciliation would be necessary whereby the theoretical analysis is fine tuned to provide a rational interpretation to the empirical results. Fifteen bridges were load tested in this study, four in the Reference Bridges phase to verify the Load Testing section of the Pilot Project Methodology, and the others in the Remaining Bridges phase where the accepted methodology was applied.

Two types of load tests were conducted in this study, namely behaviour load test and proof load test. Both these load tests are static load tests. No dynamic load testing was carried out in this study. Behaviour load tests are carried out to verify the load distribution in a bridge predicted by analysis and to reveal any unusual structural behaviour not accounted for in the analysis while proof load tests are essentially behaviour load tests carried out with very high static loads for establishing the safe load carrying capacity of a bridge.

5.2 Selection Criteria

The selection of bridges for load testing was made by identifying the bridges according to their specific structural types. A few samples from each group were selected for load testing to understand their behaviour. The selected bridges must have suitable longitudinal road alignment with an adequate sight distance for safety purposes. Another important safety consideration is the traffic condition of the road. Load testing may not be possible if the road is heavily trafficked unless a diversion road exists in the vicinity. If the traffic volume is considerable lower at night, it may be possible to conduct the load test at night although this is not recommended. It must also be possible to access the underside of those bridges for the instrumentation work to be carried out. Another requirement is that there should be sufficient space nearby those bridges for setting up a proper work space to station electronic equipment such as data logger, multiplexor and portable computer. Additionally an area for storing the concrete blocks; for parking the test trucks, mobile crane and other vehicles; and for loading and unloading of those blocks is necessary. Road shoulders can be utilised if the soil bearing capacity is sufficient to support the loads. At one test location, sand was placed and compacted to strengthen the road shoulder. However adequate safety precautions need to be taken to ensure the safety of the road users particularly when the concrete blocks, test trucks or crane encroach upon the roadway due to narrow road shoulders. Power source is required and a portable power generator set could be used to generate the electricity requirements. However such power supply may fluctuate quite considerably and is generally not suitable for instrumentation work. It is preferred that a stable source of electricity from an electricity mains is available near the test location.

Preliminary selection of the load test bridges was made in collaboration with JKR counterpart engineers based on information available in the JKR bridge inventory and from the field inspection and evaluation results. A final decision on the appropriateness of a bridge for load testing was made only after a site visit to the bridge. Fifteen bridges were load tested in this study. These bridges are tabulated in Table 5.1 below.

No	Bridge ID	Bridge Type	District	Test Date
1	FT001+364.7	Slab on Steel Beams	Kajang	5 May 1994
2	FT005+409.2	Steel Beams & Buckle Plate	Kuala Langat	12 May 1994
3	FT005+448.8	Precast R.C. Beams	Kelang	17 May 1994
4	FT001+149.2	2 Span R.C. Frame	Segamat	1 June 1994
5	FT005+500.6	Precast R.C. Beams	Kuala Selangor	30 June 1994
6	FT005+328.5	R.C. Beams & Slab	Port Dickson	14 July 1994
7	FT005+569.0	R.C. Slab	Teluk Intan	28 July 1994
8	FT003+373.5	Slab on Encased Steel Beams	Kuantan	1 Sept 1994
9	FT003+365.5	Slab on Steel Beams	Kuantan	3 Sept 1994
10	FT001+511.7	Triple R.C. Box Culvert	Batang Padang	22 Sept 1994
11	FT001+520.2	Continuous R.C. Beams & Slab	Batang Padang	29 Sept 1994
12	FT005+356.6	Slab on Encased Steel Beams	Sepang	15 Oct 1994
13	FT001+286.8	Steel Beams & Buckle Plate	Rembau	27 Oct 1994
14	FT060+028.5	Precast R.C. Beams	Manjung	24 Nov 1994
15	FT001+425.5	Slab on Prestressed I-Beams	Hulu Selangor	15 Dec 1994

Table 5.1 Load Test Bridges

5.3 Load Testing Team

The bridge load testing team comprises of a load testing advisor or specialist, two or three engineers, one of whom is a counter part engineer from JKR Bridge Unit, and about three technical assistants, one of whom is also from JKR Bridge Unit. The team carry out most of the preliminary and preparatory works including coordination with the relevant Government Agencies, re-evaluation of the bridge with test truck loading, managing the logistical aspects of load testing and supervision of works performed on site. During the test, the team is responsible for the smooth execution of the test, ensuring that safety measures are properly organised, checking measured data during testing, making records of the test with notes, photos and videos, and after the test, performing an analysis on the measured data, and reconciliation and presentation of the test results.

Besides the bridge testing team, an instrumentation team comprising an instrumentation engineer and two technicians are contracted to supply the gauges and transducers, to install the instrumentation and to operate the data logger during the load test. The JKR Workshop provided two drivers for the test trucks, a crane operator for the mobile crane and two assistants. Not limited to driving the trucks during the test, these personnel are responsible for transporting the concrete blocks to the site and back, and operating the crane during loading and unloading of the concrete blocks. For traffic control, two traffic police officers and four flag persons are utilised. In addition, general workers are required to prepare the site under the supervision of the load testing team, providing assistance to the traffic controllers, and to act as watchmen at the worksite. The flag persons and general workers are provided by the local JKR District Office.

5.4 Equipment

The primary equipment required for load testing a bridge are instrumentation and loading equipment. In this study all the bridges load tested were instrumented with resistance wire strain gauges, linear transducers and dial gauges. The readings from wire strain gauges and linear transducers are recorded via connections to a data logger and a 20 channel multiplexor. Method of installation of the gauges and transducers recommended by the manufacturers were adhered to because these devices are delicate and fragile, and hence can be easily damaged. The dial gauges which were used to measure deflections are manually read. The number of strain gauges used on a test vary depending on the structural system of the bridge.

Two Scania trucks with a low bed trailer or "low loader" were used to apply the loads on all the tests. These trucks are loaded with two tonnes concrete blocks such that the maximum load is on the rear tandem axles of the trailer. The maximum number of blocks used on a truck is 25 blocks yielding a gross truck weight of more than 700 kN and the rear tandem axles weight of 460 kN. Loading and unloading of the concrete blocks were done with a mobile crane. The trucks and crane were provided by JKR Workshop.

A canvas covering or a marquee with at least two large desks and some chairs are required as working space as well as providing shelter for the data logger and multiplexor, computer and other equipment. Stable power supply from electricity mains is required for operating the electronic equipment during the load test, for lighting and for using power tools when installing the gauges. The installation usually requires some form of temporary staging since all the bridges selected for load testing span across either rivers or streams. Support type stagings are used and are commonly erected using scaffolding frames or GI pipes and timber planks or boards. Although not encountered in this study, if the river is exceedingly deep or the bridge is too high to obviate the use of such staging, hanger type staging could be used. Measuring tapes, markers, power grinder, sand paper, adhesive tapes and bonding agent and coating for the strain gauges are some other equipment required for installing the instrumentation.

Stationery such as paper, pencils and pens, and clipboards, straight edge, glue and hand calculator, although they may appear trivial, were made readily available. Spray paint is used to mark the loading position on the road surface. Video recorder and camera were used to visually record the load tests. One thirty minute video cassette and two rolls of photographic films with thirty-six exposures were used on most tests. Walkie talkies were utilised for traffic control and for positioning the test truck during a test.

5.5 Safety Measures

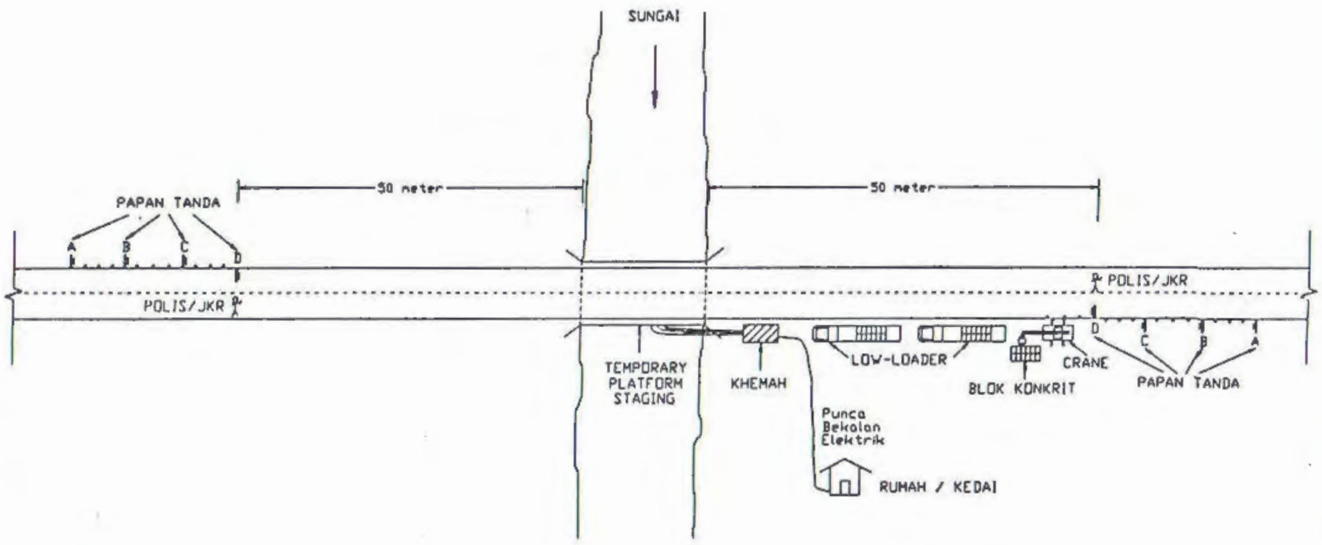
Safety is paramount during bridge load testing. Appropriate safety measures must be planned and carried out with the assistance of, and in close co-ordination with the Government Agencies concerned. These steps are necessary to ensure the smooth execution of the test. Above all the safety issues, traffic control is the primary consideration because road closure is inevitable during load testing. The test location, date and time ought to be broadcasted on local radio stations and daily newspaper to inform the public of the forthcoming load test. Traffic sign boards, flashing beacons and blaze orange traffic cones are placed on both sides of the bridge approaches and at least fifty metres from the test site to warn road users of the load test as soon as the bridge testing team is mobilised on site. During the load test, lane closure sign boards and a stop-go sign pole must be set up at each of these locations and staffed by one traffic police officer and flag persons to regulate the traffic flow. The presence of a traffic police officer is an excellent deterrent to the irate motorist who may otherwise choose to ignore traffic signs. After completing the load test all traffic signings, equipment, etc., should be removed from the site in a safe and orderly manner.

The road is closed to traffic only when test loads are being applied on the bridge to minimise traffic interruption. Positioning of the test trucks at the loading positions must be carried out in a swift and efficient manner to lessen the duration of road closure. Hence, the loading sequence must be carefully studied and planned in advance. In this study the duration of road closure averages about seven minutes per closure. Figure 5.1 shows a typical layout of a load test with the required traffic safety measures.

Other works inherent to load testing such as site preparation, erection of the marquee, installing the instrumentation, loading and unloading of the concrete blocks, etc. should be conducted in a safe manner and abiding with general worksite safety regulations. A proper staging is generally required to install the instrumentation safely. Additional precautions must be taken when working near or above water that may pose a risk of drowning. All personnel on site must be attired with reflectorised safety vest. If load testing has to be carried out at night, additional lighting powerful enough to illuminate the load test area is necessary to ensure safety to both the load testing team and to the public. At least one watchman should be stationed on site during periods of inactivity for security purposes.

5.6 Test Description

After a bridge has been selected for load testing, preparatory work can commence. All available information pertaining to that bridge, for example inspection reports, evaluation reports, JKR bridge inventory data, drawings, previous test reports, etc., are collated and reviewed. The test date, time and duration are fixed and the load testing activities are scheduled. The load test should be scheduled flexibly to allow for contingencies such as poor weather conditions and abnormally heavy traffic. The relevant authorities namely the JKR State Office, local JKR District Office, the JKR Workshop and the traffic police are informed of the forthcoming load test and the nature of assistance that is required from them. A bridge testing team representative should meet with the relevant parties to coordinate and plan the course of action.



LEGEND :

Papan Tanda A :	Ujian Jambatan Sedang Dijalankan	(Telah disediakan oleh Unit Jambatan)
Papan Tanda B :	Awas ! Jalan Ditutup Dihadapan	(Disediakan oleh JKR Daerah)
Papan Tanda C :	Awas ! Kurangkan Laju	(Disediakan oleh JKR Daerah)
Papan Tanda D :	Awas ! Berhenti	(Disediakan oleh JKR Daerah)
. . .	Reflective Cones	(Disediakan oleh JKR Daerah)

NOTA :

1. Lokasi Khemah dan tempat letak kenderaan akan ditentukan daripada lawatan tapak
2. 'Temporary platform staging' diperlukan di bawah jambatan untuk memasang strain gauges.

Figure 5.1 Load Test Layout for Traffic Safety

A re-evaluation of the bridge is performed with the proposed test truck loading based on available data. The loads, loading position and sequence, and locations of strain gauges, linear transducers and dial gauges are determined in parallel with the re-evaluation. The calculated deflections and strains at the corresponding gauges locations are tabulated and plotted for comparison with the measured values later during the load test.

To measure:	Gauge location used:
Positive bending moment effects	At mid-span at girder top flange (or under the slab soffit) and girder bottom flange
Negative bending moment effects	At intermediate support at girder top flange (or under the slab soffit) and girder bottom flange
Restraint effects	At girder ends close to the bearings
Thermal effects	At mid span with zero readings of deflection gauges
Composite action	At mid-span at girder top flange and under the slab soffit

Table 5.2 Typical location of gauges

After the gauging locations are confirmed and the proper staging erected on site, the instrumentation team are mobilised to install the instrumentation. The installation typically takes two full working days for simple bridges but may be much longer if the bridge has a complicated structural system requiring extensive gaugings. However the instrumentation are not installed too early in advance due to the fragile nature of the strain gauges.

Two SCANIA trailers from JKR Workshop were used on the load tests. Each truck is loaded progressively with one or two concrete blocks up until a maximum of 25 blocks depending on the test. Total weight per truck reached 708 kN. Concrete blocks weight approximately 2 tonnes each. About fifty blocks are required on a test. Depending on the site distance from the block storage area, the blocks are transported using the test trucks to the site about 5 days ahead of the test date. Two trips per truck are required for the truck loads to be within the legal limits during transportation. The axle loadings are shown in table 5.3. The test truck axle configuration is shown on figure 5.2 and figure 5.3 shows the two fully loaded SCANIA trucks during load testing.

Load Level	Number of blocks	Axle Weight, kN					Truck Gross Weight, kN
		1	2	3	4	5	
LL1	12	70	88	88	108	108	462
LL2	16	70	88	88	148	148	542
LL3	20	70	90	90	187	187	624
LL4	23	70	90	90	217	217	684
LL5	25	70	90	90	228	230	708

Table 5.3 Measured truck axle weights

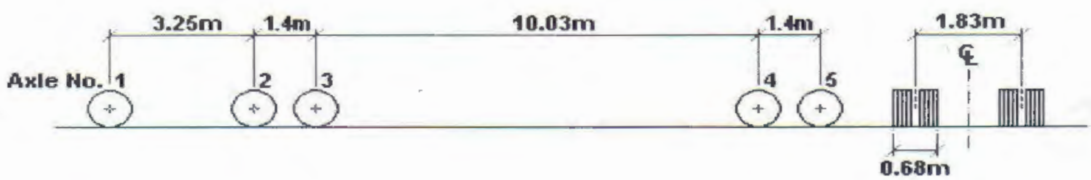


Figure 5.2 Test truck axle spacing

Figure 5.3 Two fully loaded SCANIA trucks during load testing

One day prior to the test day, pre-test check of the site, instrumentation, safety measures, etc., is made to ensure everything is in order. Arrangement for refreshment is also made. Load testing was conducted mostly during the day to avoid unnecessary complications of load testing at night but it may not be feasible on roads that are heavily trafficked in the day time. Arrangements for lighting, additional safety measures, etc. will have to be made for night testing. On the test day, a final check on the traffic signings, the instrumentation and the test trucks are made, and all personnel immediately involved in the test are briefed with regard to their specific tasks. After the road is closed to traffic, the test can commence. One lane is loaded first at the pre-determined load positions followed by the opposite lane, and then with the trucks on both lanes.

Several transverse truck positions as shown in figure 5.4 (bridge FT001+149.2 used as example) were tested to measure the capacity of the deck to distribute the loads laterally. Similarly to locate the maximum positive and negative bending moments, the test trucks were positioned longitudinally as shown in figure 5.5. Theoretical analysis was conducted for these positions prior to the test for comparing the calculated and measured values during the test. All the transverse and longitudinal truck positions are given in the respective load test report in Volume IID.

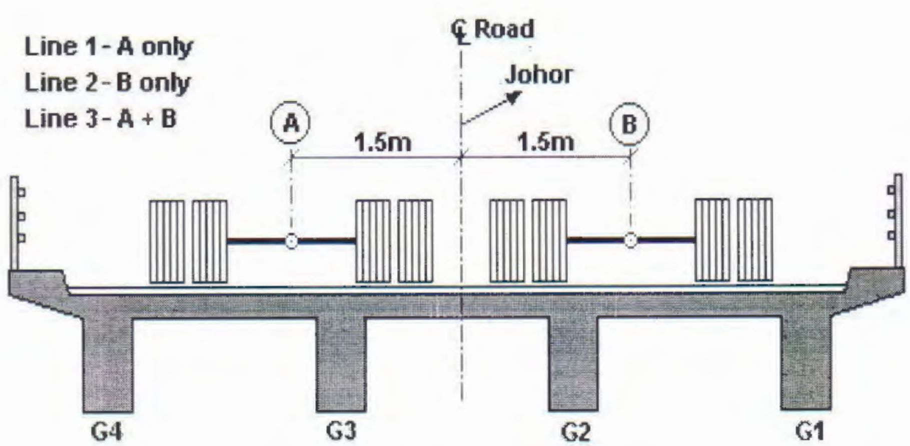


Figure 5.4 Example of transverse position of test truck: Bridge FT001+149.2

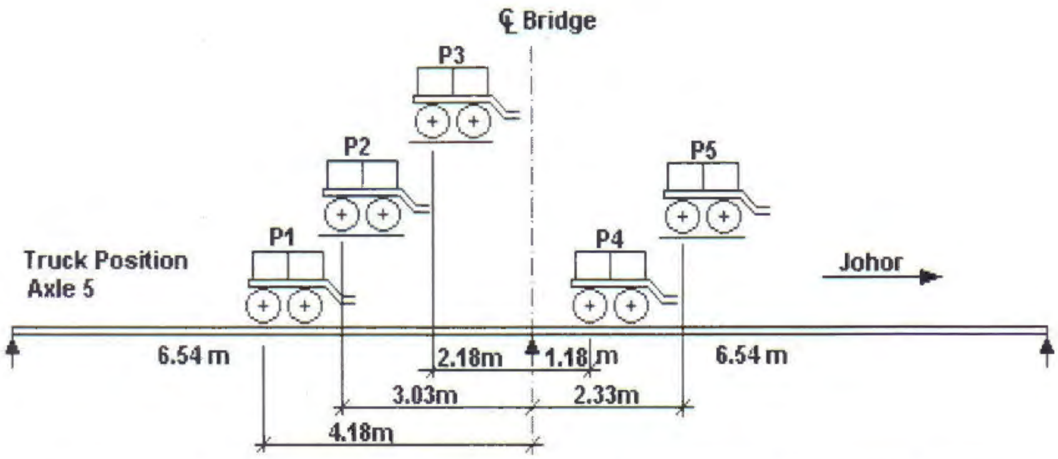


Figure 5.5 Example of longitudinal position of test truck: Bridge FT001+149.2

At each load position the trucks will remain in place long enough (less than one minute) for vibration to dissipate and for the strain and deflection measurements to be made before proceeding to the next load position. After completing one load level, concrete blocks are added to the test trucks and the road is re-opened to traffic. The test loads are applied incrementally over seven load levels, starting from the lowest load level (twelve concrete blocks) to the maximum load level (twenty-five concrete blocks). Each time after the measurements are taken, the measured data are compared to the tabulated and plotted theoretical values. When sufficient data are measured, the data are also checked for linearity to ensure that the testing remained within the elastic range of the structure. Photographs and video recordings are made during the application of the test loads for record. The test is completed with the last measurement taken in the final load level. Site clearing and demobilisation should commence immediately and should be conducted in an orderly manner.

Back in the office the test results are analysed and graphs are plotted to visualise the results and these include:

- determining the lateral distribution of load and checking the increment in strains loads were added by plotting the strains versus the load level.
- computing the theoretical bending moments for analysis due to LTAL, SV, and WRO and the bending moment based on the measured strains for comparison.

- plotting bending moment versus both measured and theoretical strains to show the difference in the girder stiffness.

Letters of appreciation were forwarded to the relevant parties that contributed to the successful execution of the load test. Typically about two weeks is sufficient to prepare for and to complete a bridge load test.

5.7 Load Test Results Summary

A substantial part of this study was devoted to full-scale load tests. The bridges load tested during this study represent most types of bridges encountered in Peninsular Malaysia. Load testing allowed us to confirm the load bearing capacity of the bridges under heavy loadings and comment on the validity of theoretical analysis. The total weight of the vehicle is about 70 Tonnes and is loaded in such a way as to simulate the effects of the Malaysian design load (LTAL). All tests were conducted using a uniform procedure that can be replicated. However, load testing is a complex operation which requires extensive planning, analysis and specialised equipment and incurs a high cost and large manpower utilisation. Most bridges tested showed significant strength reserves.

Two reports called reference reports which contain complete behaviour information were completed for bridges FT001+364.7 and FT005+409.2 for academic purposes. Other reports only highlight specific behaviour and most relevant capacity related information. General description of the bridge behaviour is presented below as well as specific comments on categories of bridges.

The fifteen load tests including the results and interpretation of the measurements are described in detail in Volume II D.

Loadings

JKR workshop SCANIA trucks were used for the load tests in this study. These trucks were selected to simulate as closely as possible the effects of the LTAL. A comparison of bending moments between the truck and LTAL is shown in Figure 5.6 below:

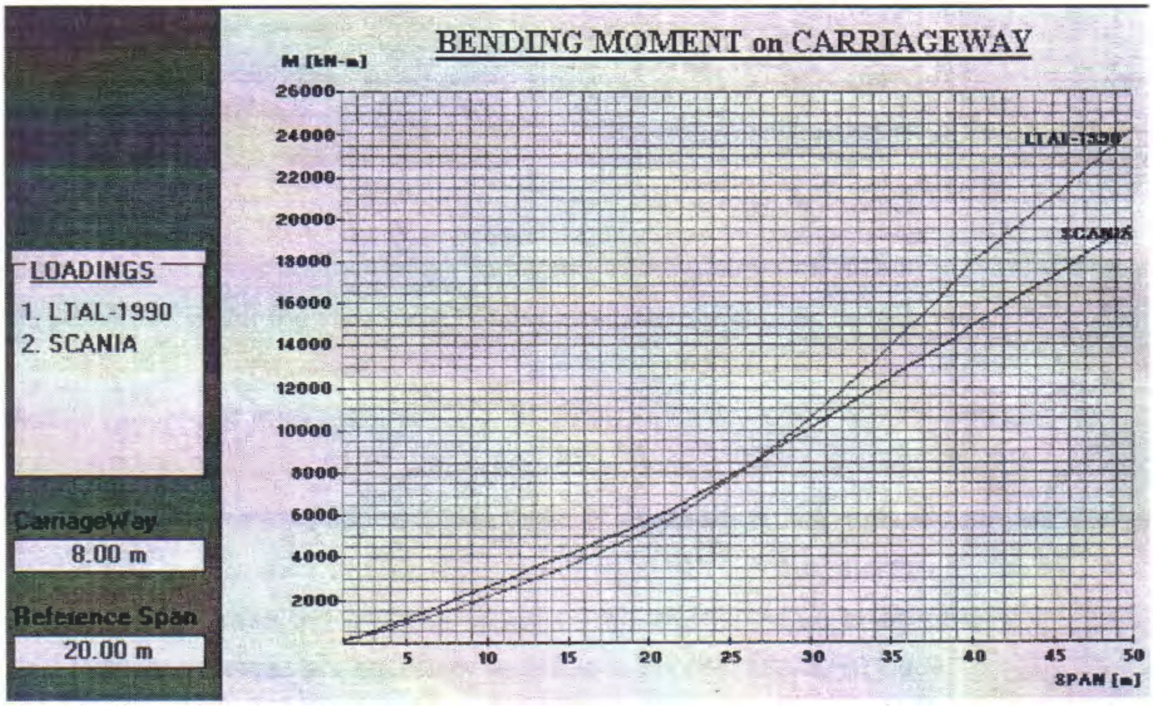


Figure 5.6 Load Effects of SCANIA Truck vs. LTAL

As we can see, the SCANIA trucks simulate adequately LTAL loadings up to spans of about 28 m.

Validity of theoretical model

Transverse (or lateral) distribution observed corresponds generally well to theoretical distribution using grillage analysis meaning that grillage analysis is an adequate model. The only type of girder where poor correlation was obtained are the precast beams installed side by side where there is no structural deck. All bridges showed higher stiffness than models assumed. See following section on High stiffness.

Behaviour

Elastic deformations

All bridges remained under linear elastic behavior under the maximum truck loads. No permanent deformations have occurred. Some elastic strength reserve can be calculated on most bridges except on reinforced, prestressed and slab concrete bridges where the reinforcement is unknown.

Composite action

Effects of composite action can be measured locating strain gauges in the upper part of the beam and under the slab. Most bridges exhibited some composite action.

Elastic reserve of strength

The capacity of the load tested bridge to support more than the statically applied charge can be safely estimated to only a portion of its elastic reserve of strains. The following phenomena increase the stiffness of the bridge and forbid us to assume that unused elastic strains reserves are still totally available to support additional loads:

- Better lateral load distribution capacity than theory predicts
- Longitudinal movement restriction due to bearing rigidity or friction
- Stiffness action due to non structural elements
- Rotational movement restriction due to bearing rigidity
- Arching effect

Plastic redistribution of stresses can be expected before total failure but is of lesser interest since we need to rate the maximum allowable loads without permanent damage to the bridge.

Figure 5.7 shows a typical moment deformation relationship:

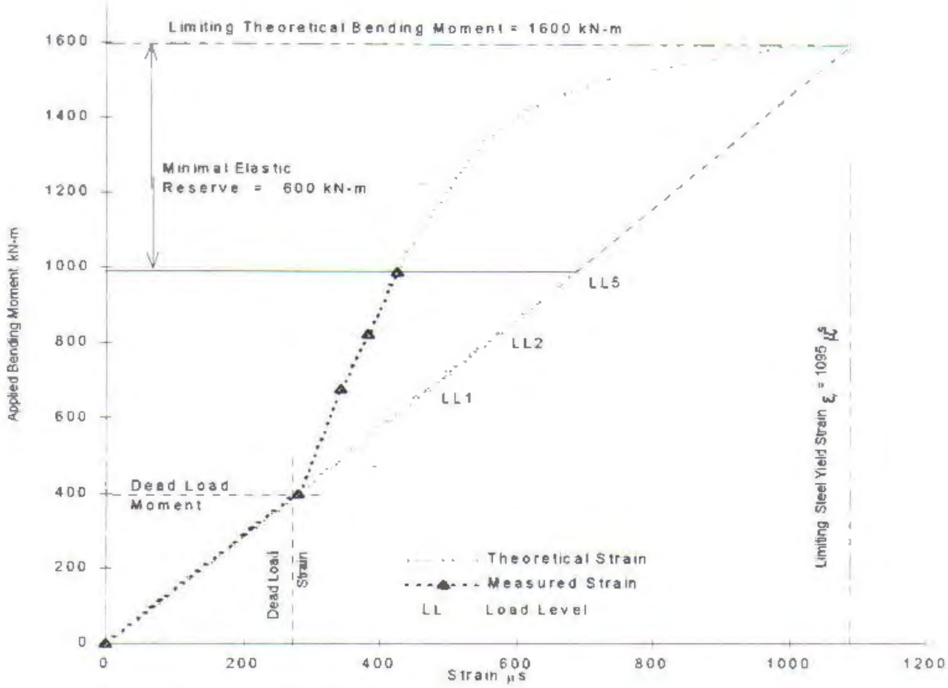


Figure 5.7 <u>Bending Moment of Girder vs. Strain</u>

High stiffness

All bridges showed very high stiffness when compared to the results of the theoretical model used (grillage analysis). We recorded compression strains at bottom flanges near the supports of several girders. Several explanations are formulated below. These are second order phenomena and only become significant when we sum them up. The high stiffness observed can not be taken for granted for evaluation purposes since we can not yet model it properly and have not tested the bridges under dynamic loads which may affect these phenomena.

- **Better lateral load distribution capacity than theory predicts**

  Lateral load distribution is better in reality than in theory due to orthotropic behavior of the bridges. Decks often act as plates which redistribute stresses all over the bridge and trigger the participation of several members away from the applied load. This is only partially simulated using conventional grillage analysis.

- **Longitudinal movement restriction due to bearing rigidity or friction**

Under theoretical analysis, bearings are sliding or rotating freely which is not the case in reality since bearings have a certain stiffness and as they get older they lose their elasticity due to accumulation of dirt, rust or physical deterioration. As they restrain from sliding or rotating, they temporarily induce compressive strains in the girders. This temporary movement restriction cannot be relied on when we design a bridge since bearings are not designed to remain elastic under ultimate loads. Under these loads, bearings will probably fail and substantial movements will inevitably occur. Presently, no techniques to measure actual bearing rigidities are available in the literature.

In several cases, bearings only consisted of two steel plates sliding on each other or a steel plate sliding directly on concrete. Simulation of bearing friction was done on a typical steel girder to verify the magnitude of strains involved. Friction coefficients of 0.3 for steel on steel gave restraints of about 50 μs under LTAL and 100 μs for steel on concrete coefficients of 0.5. This is consistent with our measurements.

- **Rotational movement restriction due to bearing rigidity**

The following figure shows the effect of a typical flat elastomeric bearing pad:

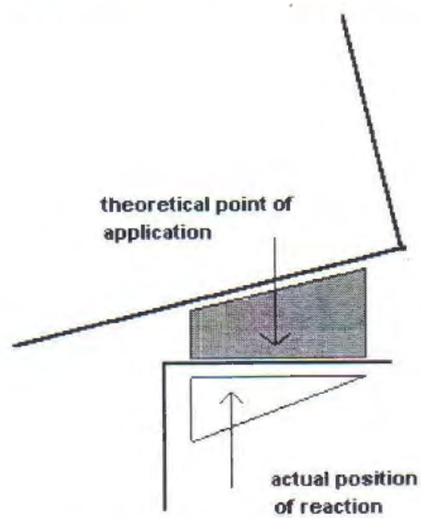


Figure 5.7 Rotational Resistance at Bearings

The triangular stress block induces a slight positive moment in the beam reducing the negative moment measured at mid-span for simply supported bridges. Additionally, exact span length is also reduced, lowering maximum moments.

- **Stiffness action due to non structural elements**

Presence of premix and parapets can significantly increase the bridge rigidity in the elastic range. We cannot however rely on these components for evaluating the behavior of bridges under additional loads since they were not designed as structural components (they can fail at any time) but they surely contribute to increase the measured rigidity under small loads.

- **Arching effect**

Arching effect is a phenomena by which a beam with a high depth / span ratio behaves more like an arch than a slender beam. Arches are much stiffer than ordinary beams. Current theoretical models (slender beam theory where plane sections remain plane) neglect arching effect since bearings are always assumed to move freely. This effect while negligible in laboratory tests increases when bearings show higher than expected stiffness as we suspect happen in most bridges structures.

Steel girders with RC slab bridges

They include: FT001-364.7
FT003-365.5
FT003-373.5 (encased in concrete)
FT005-356.6 (encased in concrete)

Behavior is consistent with our general comments. Important elastic strength reserves varying from two to three times the SCANIA truck load are available for these bridges. Strains results were very stable and consistent for this category.

Buckle plate bridges

They include: FT001-286.8 (Steel beam / Buckle plate & concrete slab)
FT005-409.2 (Steel beam / Buckle plate & gravel)

Two types of buckle plate bridges, with concrete deck and with gravel and premix deck were tested. Deflections monitored were generally higher than those theoretically predicted (using full composite action between steel beams and plates) because it is not possible to properly model unreinforced concrete or gravel decks. A similar buckle plate bridge was previously load tested to failure by JKR at three times the loads applied in this test. Load testing of these bridges allowed us to refine our calculation model. Important elastic strength reserves estimated at twice the SCANIA truck load are still available for these bridges as long as they are maintained in good condition.

RC beams and RC slab bridges

They include: FT001-149.2 (continuous span)
FT001-520.2(continuous span)
FT005-328.5

Behavior is consistent with our general comments. When no reinforcement information is available, no elastic strength reserve can be safely assumed which is the case with our bridges. Some discrepancies in strain readings were observed on concrete girders like FT001-149.2. We have noticed that local concrete spalling may disturb readings and that care must be taken in selecting the gauge locations.

Prestressed concrete bridges

They include: FT001-425.5

No elastic strength reserve can be safely assumed beyond the applied loads since we do not know exactly the reinforcement. Several of these sections have been evaluated assuming that they were reinforced like typical standard sections. However, we know that these bridges are generally in very good condition

RC slab bridges

They include: FT005-569.0

This bridge was load tested very close to its elastic limit as the slope of the moment deformation shows at the highest load level. Gradual loss of inertia and bearing stiffness explain the curved shape of the moment deformation relationship. No elastic strength reserve can be safely assumed beyond the applied loads.

RC box culverts

They include: FT001-511.7 (Triple RC box culvert)

Little significant information can be retrieved from such a short span bridge (3 x 2.5 m). Strains and deformations readings are very small and are distorted by apparatus errors. However, no cracking has been observed and averaged deformation values show that these bridges are much more rigid than theory assume.

Side by side precast girder bridges

They include: FT005-448.8
FT005-500.6
FT060-028.5

Poor distribution of strains is observed under these bridges. The shear keys between the girders behaved irregularly meaning that local slippage is frequent. However, the overall behavior of the bridge appears to be adequate.

Conclusions and Recommendations from Load Testing

All bridges tested showed some strength reserves and did not show any signs of permanent deformation. Transverse or lateral distribution patterns observed generally corresponds well to the theoretical distribution obtained from grillage analysis. This implies that grillage analysis is an adequate but conservative model to represent bridge behaviour and wheel load distribution and this agrees with most current literature that indicate that the theoretical analysis is conservative. Deflections and strains measured cannot be used to predict untested reserves of strength since there are no means to directly measure the second degree factors which were observed in the tests.

Very high stiffness was observed when compared to theoretical results. This additional stiffness may be due to the following second order phenomena that become significant only when combined:

- Better load distribution than theory predicts
- Horizontal movement restriction at bearing
- Stiffness action due to non structural elements (parapet)
- Induced rotational stiffness at hinge bearing
- Arching effect

All bridges load tested were able to support the test truck loads (2 x 70 Tonnes) without cracking or permanent deformation using the proposed methodology and can therefore support truck loads corresponding to actual design loads (LTAL and SV20). No tests have been performed up to ultimate strength limits.

No relationship between the structural capacity rating and the measured results of the load tests was determined due to the wide variations of the results. Statistical methods could not be applied successfully to derive any correlation since the number of bridges involved is very small. Therefore, load testing as a proof test should only be conducted as a temporary measure before rehabilitation or replacement because previous evaluation methods and tests proved inadequate, condition necessitates urgent action and road is classified as strategic (cannot divert the traffic or reduce it to one lane for major repairs).