

Archie-M Standard Loads

CS454 ALLI

1 Document History

- 2025-08-18 PB/HH
 - Corrected axle width for wheel load variants.
 - Reduced min. width to carry for axle loads to 2.1m and for wheel loads to 0.3m (axle width + 0.3m)
- 2025-06-18 HH (circulated with release candidates only)
 - Added wheel load variants to use on narrow available widths.
- 2023-06-14 HH
 - Load file regenerated.
 - Versions without symmetrical loads (for Archie-M 2.6) and with (for 2.5.1) generated.
- 2021-04-18 HH/WJH
 - renamed “Single axle” to “ ≥ 18 tonnes” for clarity
 - Fixed total load for Double Axle ($1.0\text{m} \leq s < 1.3\text{m}$) impact 1.8 cases
 - Fixed axle load for 7.5 tonnes reduced impact
- 2021-03-31 HH/WJH First version distributed, not included in app installer

2 Introduction

Assessment of masonry bridges to CS454 is broadly similar to the approach under BD21.

In this document, we examine the vehicles and rules regarding load factors, and develop an Archie-M load file.

Users of these load definitions should read both CS454 and this document carefully. We have interpreted the rules as written, but it is your responsibility to ensure that the loads used in assessment *both* satisfy the standard *and* reasonably represent the real situation of concern.

If you think there is an error in the loads, or you disagree with the interpretation of the standards given here, please email us at support@obvis.com.

3 Vehicle and available (formerly “bridge”) widths

The distribution model from BD21/CS454 is naive in the extreme, and makes it impossible to deal sensibly with complex bridges or loads.

The standard vehicles have 1.8m axles. The distribution rule of 1.5+h from each wheel means that the wheel distributions will touch with any amount of fill/surfacing from 300mm up. Even on bridges with unusually little fill on the crown, this will be true away from the crown. CS 454 loads therefore assume, as did the BD21 loads before, that wheel loads will merge, and we can assess with axle loads.

Archie-M 2.6 now asks for an *available* width where 2.5 and before referred to a *bridge* width. The latter term caused some confusion, we hope that the new one helps. It is set in the road tab of the ‘edit structure’ wizard. This value should be set to the width of bridge occupied by this load alone. That would normally be the bridge width divided by the number of notional lanes (as described in CS454). If the available width set is narrower than the axle load applied then Archie-M will not allow you apply it; in this case, you will need to use the wheel loads and a suitable smaller available width.

BEWARE that there is currently no warning for applying wheel loads to an available width that is wide enough for the full vehicle.

4 Factors of safety

CS454 approaches factors of safety somewhat differently to BD21.

BD21 bundles impact with γ_{fL} , and states that γ_{fL} is, “3.4 for one of the axles and 1.9 for the others”. The impact factor of $3.4/1.9 = 1.8$ is to be applied to “the critical axle”. Archie has always separated the general γ_{fL} of 1.9 from the impact factor. The impact factor is applied in the load files.

For impact, CS454 takes the same approach as Archie-M, making it a property of the load case, so we no longer have the situation that γ_{fL} appears to have a different value on different axles.

Next, CS454 seeks to bring masonry bridges into the same framework used through the rest of the document. That is a fair goal, and the approach taken highlights that masonry bridge assessment involves both normal factors on live load (γ_{fL}), and load effects (γ_{f3}) *and also an additional factor* (Cl.7.2) “that corresponds to the loads frequently reaching levels that could result in further distress and reduce the life of the arch”.

The different handling of this additional factor in BD21 and CS454 is interesting. On the one hand, it is given a name in CS454: C_{min} , and the makeup of the values of C_{min} are clear. On the other, CS454 has dropped the background information present in BD21 that gave some clues as to what was going on. That material was not easy to follow, but it was important.

CS454 sets up the masonry assessment problem as follows.

1. Factor your assessment loads using the same ULS factors as used for other bridge types.
2. Find the additional multiplicative factor C that can be applied to those (already factored) loads without causing collapse.
3. Check whether $C \geq C_{min}$

We don’t actually need to follow this route exactly: we only need to show that a bridge achieves C_{min} to show that it passes.

But what is C_{min} ? CS454 gives a very brief explanation, and a rigorous looking formula:

$$C_{min} = \frac{\psi \gamma_{fL,SLS}}{K \gamma_{f3} \gamma_{fL,ULS}}$$

Now, that may look rigorous, but

4 Factors of safety

- ψ is “the proportion of the SLS traffic load that would be frequently experienced, taken as = 0.75 for normal or restricted traffic”, and 1.0 for abnormal traffic “to align with previous practice”.
- K is “the proportion of the ULS resistance where further distress could occur, assumed here to be $K = 0.5$ ”.

It should be obvious that ψ cannot be the same for all bridges with normal traffic, and the fact that this is exactly 3/4 suggests that the number was selected for its effect.

If frequency is relevant, it seems odd that we should assume that full abnormal loading is *frequently* experienced (value of 1.0) wherever we assess for it; this amounts to a hidden extra factor imposed on abnormal traffic. That extra factor may be justified, but it would be better if it were explicit. We aren’t dealing here with abnormal loads, however.

The value of K is of even more concern. First, the idea here is that there is a direct, linear relationship between the load that will cause collapse (ULS) and that which will cause cumulative damage. This is simply wrong, there is no necessary link between ULS and service load damage. Second, the actual value comes from the 1980s tests, but these tests were flawed in execution and interpretation.

It is important to understand, then, that the values for C_{min} in CS454 are rather arbitrary, however many components they are split up into.

The last point to be aware of is that with γ_{fL} of 1.5 and C_{min} of 1.2 for normal traffic, the combined factor is 1.8. This compares with the value of γ_{fL} in BD21 of 1.9. This change is deemed acceptable because of status of many inputs as rule of thumb values, which is perhaps fair enough, but the result is that **CS454 will result in a 5% increase in apparent capacity vs BD21.**

Given that we know bridges suffer cumulative damage at loads assessed as within capacity using BD21 and NR/CIV/025 (which also uses a 1.9 load factor), we have chosen to leave the load factor Archie-M at 1.9, so users must make a conscious decision to reduce it for each new bridge.

5 Load Factors

5.1 Impact (Cl.5.9)

Impact is to be applied to “the most critical axle”. This is handled in Archie-M by providing separate load cases with impact applied to each axle in a bogie. Archie-M (from version 2.6) will auto-run asymmetrical loads in both directions.

Two values for the impact factor are given. Poor road surface requires a 1.8 factor. Good road surface allows a factor of 1.62 (3 significant figures?!). Consider whether it is reasonable to assume that a road surface will remain good.

We provide two sets of impact loads, one for each factor.

5.2 Traffic flow factor (Cl.5.9)

The traffic flow factor applies to all axles equally. If you need to use this, adjust the main load factor or use the γ_{f3} input which is otherwise normally set to 1.0.

5.3 Lane factor (Cl.5.9)

Lane factors are not relevant to masonry bridge assessment, where the effective strip model means we can only assess for a single lane anyway.

5.4 Lift-off (Cl. 7.3.1-7.3.3)

The issue of liftoff is an interesting one. Modern vehicles are so well articulated that lift-off is very rare. The geometry of the process is illustrated in Figure 5.1. The minimum requirements are a long stiff body, a long bogie and a relatively steep rise and fall such that the other end of the vehicle is on a noticeably different vertical alignment from the bogie. Figure 5.1 shows the most common form, though it can also happen if there is a long steep rise and fall from a crest so that the tractor in this layout is heading down one slope while the trailer is still rising on the other side.

5 Load Factors

This sketch should also clarify what is meant by a bogie: a set of axles with shared suspension, that under normal circumstances would carry equal load.

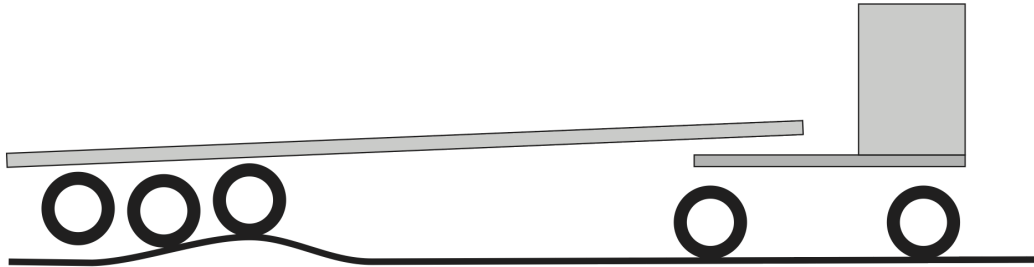


Figure 5.1: The geometry of lift-off

The lift-off rules in CS454 involve shifting load between the outer axles of a 2- or 3-axle bogie. The axle to which weight is shifted is increased by a factor of 1.5, that from which it is taken is decreased by 0.5. Implied in these numbers, and in the concept of a bogie, is that the axles share weight equally in the normal condition, so the bogie weight does not change.

Cl. 7.3.2 states that the conditions for lift-off are:

- 1) a vertical road alignment with significant changes from positive to negative gradient over a short distance (e.g. a humped back bridge);
- 2) arch located at the bottom of a hill or on a straight length of road where approach speeds are likely to be high;
- 3) irregularities in road surface on the arch.

Note that item 2 suggests that there is a speed component to lift-off, which is odd. Is this situation not handled by impact?

As with impact, lift-off can generate symmetrical pairs of loads (e.g. lift-off applied to axle 2 of a 2-axle bogie is the mirror image of the lift-off on axle 1 case). From Archie-M 2.6, asymmetrical loads are run both ways, so the standard loads only include one load from each symmetrical pair.

5.5 Combining factors

It has traditionally been assumed that *either* lift-off *or* impact would be applied in a given situation, and certainly that it is not necessary to apply both in a single load case. CS454 is not explicit on this matter. We maintain the tradition in the new load file.

6 Vehicles

The complete set of assessment loads is given in table 7.3.1a.

The general format of an entry in the load file is described in the online guide to defining new loadcases.

The load file content is as follows.

```
%FAMILY: CS 454, axle loads, no lift-off or impact

%GROUP: Single axles, no lift-off or impact, axle loads

>= 18 tonnes GVW - axle load - no lift-off or impact, 11.50, 1, 1, 11.50, 1, 1.800; 2.100
Fire engines group 1 - axle load - no lift-off or impact, 10.00, 1, 1, 10.00, 1, 1.800; 2.100
13 tonnes GVW - axle load - no lift-off or impact, 9.00, 1, 1, 9.00, 1, 1.800; 2.100
10 tonnes GVW - axle load - no lift-off or impact, 7.00, 1, 1, 7.00, 1, 1.800; 2.100
7.5 tonnes GVW - axle load - no lift-off or impact, 5.50, 1, 1, 5.50, 1, 1.800; 2.100
Fire engines group 2 - axle load - no lift-off or impact, 5.00, 1, 1, 5.00, 1, 1.800; 2.100
3 tonnes GVW - axle load - no lift-off or impact, 2.00, 1, 1, 2.00, 1, 1.800; 2.100

%GROUP: Double axle bogies, no lift-off or impact, axle loads

Double Axle (1.0m <= s < 1.3m) - axle load - no lift-off or impact, 16.00, 2, 1, 8.00,
  ⇨ 1.000, 8.00, 1, 1.800; 2.100
Double Axle (1.3m <= s < 1.8m) - axle load - no lift-off or impact, 19.00, 2, 1, 9.50,
  ⇨ 1.300, 9.50, 1, 1.800; 2.100
Double Axle (s >= 1.8m) - axle load - no lift-off or impact, 20.00, 2, 1, 10.00, 1.800,
  ⇨ 10.00, 1, 1.800; 2.100

%GROUP: Triple axle bogies, no lift-off or impact, axle loads

Triple Axle (1.0m <= s < 1.3m) - axle load - no lift-off or impact, 21.00, 3, 1, 7.00,
  ⇨ 1.000, 7.00, 1.000, 7.00, 1, 1.800; 2.100
Triple Axle (s >= 1.3m) - axle load - no lift-off or impact, 24.00, 3, 1, 8.00, 1.300,
  ⇨ 8.00, 1.300, 8.00, 1, 1.800; 2.100
```

6 Vehicles

```
%FAMILY: CS 454, axle loads, with lift-off

%GROUP: Double axle bogies, with lift-off, axle loads

Double Axle (1.0m <= s < 1.3m) - axle load - lift-off on 1, 16.00, 2, 1, 12.00, 1.000, 4.00,
  ⇨ 1, 1.800; 2.100
Double Axle (1.3m <= s < 1.8m) - axle load - lift-off on 1, 19.00, 2, 1, 14.25, 1.300, 4.75,
  ⇨ 1, 1.800; 2.100
Double Axle (s >= 1.8m) - axle load - lift-off on 1, 20.00, 2, 1, 15.00, 1.800, 5.00, 1,
  ⇨ 1.800; 2.100

%GROUP: Triple axle bogies, with lift-off, axle loads

Triple Axle (1.0m <= s < 1.3m) - axle load - lift-off on 1, 21.00, 3, 1, 10.50, 1.000, 7.00,
  ⇨ 1.000, 3.50, 1, 1.800; 2.100
Triple Axle (s >= 1.3m) - axle load - lift-off on 1, 24.00, 3, 1, 12.00, 1.300, 8.00,
  ⇨ 1.300, 4.00, 1, 1.800; 2.100

%FAMILY: CS 454, axle loads, with impact 1.8

%GROUP: Single axles, with impact 1.8, axle loads

>= 18 tonnes GVW - axle load - 1.8 impact on 1, 20.70, 1, 1, 20.70, 1, 1.800; 2.100
Fire engines group 1 - axle load - 1.8 impact on 1, 18.00, 1, 1, 18.00, 1, 1.800; 2.100
13 tonnes GVW - axle load - 1.8 impact on 1, 16.20, 1, 1, 16.20, 1, 1.800; 2.100
10 tonnes GVW - axle load - 1.8 impact on 1, 12.60, 1, 1, 12.60, 1, 1.800; 2.100
7.5 tonnes GVW - axle load - 1.8 impact on 1, 9.90, 1, 1, 9.90, 1, 1.800; 2.100
Fire engines group 2 - axle load - 1.8 impact on 1, 9.00, 1, 1, 9.00, 1, 1.800; 2.100
3 tonnes GVW - axle load - 1.8 impact on 1, 3.60, 1, 1, 3.60, 1, 1.800; 2.100

%GROUP: Double axle bogies, with impact 1.8, axle loads

Double Axle (1.0m <= s < 1.3m) - axle load - 1.8 impact on 1, 22.40, 2, 1, 14.40, 1.000,
  ⇨ 8.00, 1, 1.800; 2.100
Double Axle (1.3m <= s < 1.8m) - axle load - 1.8 impact on 1, 26.60, 2, 1, 17.10, 1.300,
  ⇨ 9.50, 1, 1.800; 2.100
Double Axle (s >= 1.8m) - axle load - 1.8 impact on 1, 28.00, 2, 1, 18.00, 1.800, 10.00, 1,
  ⇨ 1.800; 2.100
```

6 Vehicles

```
%GROUP: Triple axle bogies, with impact 1.8, axle loads

Triple Axle (1.0m <= s < 1.3m) - axle load - 1.8 impact on 1, 26.60, 3, 1, 12.60, 1.000,
  ⇨ 7.00, 1.000, 7.00, 1, 1.800; 2.100
Triple Axle (1.0m <= s < 1.3m) - axle load - 1.8 impact on 2, 26.60, 3, 1, 7.00, 1.000,
  ⇨ 12.60, 1.000, 7.00, 1, 1.800; 2.100
Triple Axle (s >= 1.3m) - axle load - 1.8 impact on 1, 30.40, 3, 1, 14.40, 1.300, 8.00,
  ⇨ 1.300, 8.00, 1, 1.800; 2.100
Triple Axle (s >= 1.3m) - axle load - 1.8 impact on 2, 30.40, 3, 1, 8.00, 1.300, 14.40,
  ⇨ 1.300, 8.00, 1, 1.800; 2.100

%FAMILY: CS 454, axle loads, reduced impact 1.62

%GROUP: Single axles, reduced impact 1.62, axle loads

>= 18 tonnes GVW - axle load - 1.62 impact on 1, 18.63, 1, 1, 18.63, 1, 1.800; 2.100
Fire engines group 1 - axle load - 1.62 impact on 1, 16.20, 1, 1, 16.20, 1, 1.800; 2.100
13 tonnes GVW - axle load - 1.62 impact on 1, 14.58, 1, 1, 14.58, 1, 1.800; 2.100
10 tonnes GVW - axle load - 1.62 impact on 1, 11.34, 1, 1, 11.34, 1, 1.800; 2.100
7.5 tonnes GVW - axle load - 1.62 impact on 1, 8.91, 1, 1, 8.91, 1, 1.800; 2.100
Fire engines group 2 - axle load - 1.62 impact on 1, 8.10, 1, 1, 8.10, 1, 1.800; 2.100
3 tonnes GVW - axle load - 1.62 impact on 1, 3.24, 1, 1, 3.24, 1, 1.800; 2.100

%GROUP: Double axle bogies, reduced impact 1.62, axle loads

Double Axle (1.0m <= s < 1.3m) - axle load - 1.62 impact on 1, 20.96, 2, 1, 12.96, 1.000,
  ⇨ 8.00, 1, 1.800; 2.100
Double Axle (1.3m <= s < 1.8m) - axle load - 1.62 impact on 1, 24.89, 2, 1, 15.39, 1.300,
  ⇨ 9.50, 1, 1.800; 2.100
Double Axle (s >= 1.8m) - axle load - 1.62 impact on 1, 26.20, 2, 1, 16.20, 1.800, 10.00, 1,
  ⇨ 1.800; 2.100

%GROUP: Triple axle bogies, reduced impact 1.62, axle loads

Triple Axle (1.0m <= s < 1.3m) - axle load - 1.62 impact on 1, 25.34, 3, 1, 11.34, 1.000,
  ⇨ 7.00, 1.000, 7.00, 1, 1.800; 2.100
Triple Axle (1.0m <= s < 1.3m) - axle load - 1.62 impact on 2, 25.34, 3, 1, 7.00, 1.000,
  ⇨ 11.34, 1.000, 7.00, 1, 1.800; 2.100
Triple Axle (s >= 1.3m) - axle load - 1.62 impact on 1, 28.96, 3, 1, 12.96, 1.300, 8.00,
  ⇨ 1.300, 8.00, 1, 1.800; 2.100
Triple Axle (s >= 1.3m) - axle load - 1.62 impact on 2, 28.96, 3, 1, 8.00, 1.300, 12.96,
  ⇨ 1.300, 8.00, 1, 1.800; 2.100
```

6 Vehicles

```
%FAMILY: CS 454, wheel loads, no lift-off or impact

%GROUP: Single axles, no lift-off or impact, wheel loads

>= 18 tonnes GVW - wheel load - no lift-off or impact, 5.75, 1, 1, 5.75, 1, 0.000; 0.300
Fire engines group 1 - wheel load - no lift-off or impact, 5.00, 1, 1, 5.00, 1, 0.000; 0.300
13 tonnes GVW - wheel load - no lift-off or impact, 4.50, 1, 1, 4.50, 1, 0.000; 0.300
10 tonnes GVW - wheel load - no lift-off or impact, 3.50, 1, 1, 3.50, 1, 0.000; 0.300
7.5 tonnes GVW - wheel load - no lift-off or impact, 2.75, 1, 1, 2.75, 1, 0.000; 0.300
Fire engines group 2 - wheel load - no lift-off or impact, 2.50, 1, 1, 2.50, 1, 0.000; 0.300
3 tonnes GVW - wheel load - no lift-off or impact, 1.00, 1, 1, 1.00, 1, 0.000; 0.300

%GROUP: Double axle bogies, no lift-off or impact, wheel loads

Double Axle (1.0m <= s < 1.3m) - wheel load - no lift-off or impact, 8.00, 2, 1, 4.00,
↪ 1.000, 4.00, 1, 0.000; 0.300
Double Axle (1.3m <= s < 1.8m) - wheel load - no lift-off or impact, 9.50, 2, 1, 4.75,
↪ 1.300, 4.75, 1, 0.000; 0.300
Double Axle (s >= 1.8m) - wheel load - no lift-off or impact, 10.00, 2, 1, 5.00, 1.800,
↪ 5.00, 1, 0.000; 0.300

%GROUP: Triple axle bogies, no lift-off or impact, wheel loads

Triple Axle (1.0m <= s < 1.3m) - wheel load - no lift-off or impact, 10.50, 3, 1, 3.50,
↪ 1.000, 3.50, 1.000, 3.50, 1, 0.000; 0.300
Triple Axle (s >= 1.3m) - wheel load - no lift-off or impact, 12.00, 3, 1, 4.00, 1.300,
↪ 4.00, 1.300, 4.00, 1, 0.000; 0.300

%FAMILY: CS 454, wheel loads, with lift-off

%GROUP: Double axle bogies, with lift-off, wheel loads

Double Axle (1.0m <= s < 1.3m) - wheel load - lift-off on 1, 8.00, 2, 1, 6.00, 1.000, 2.00,
↪ 1, 0.000; 0.300
Double Axle (1.3m <= s < 1.8m) - wheel load - lift-off on 1, 9.50, 2, 1, 7.12, 1.300, 2.38,
↪ 1, 0.000; 0.300
Double Axle (s >= 1.8m) - wheel load - lift-off on 1, 10.00, 2, 1, 7.50, 1.800, 2.50, 1,
↪ 0.000; 0.300
```

6 Vehicles

```
%GROUP: Triple axle bogies, with lift-off, wheel loads

Triple Axle (1.0m <= s < 1.3m) - wheel load - lift-off on 1, 10.50, 3, 1, 5.25, 1.000, 3.50,
  ⇨ 1.000, 1.75, 1, 0.000; 0.300
Triple Axle (s >= 1.3m) - wheel load - lift-off on 1, 12.00, 3, 1, 6.00, 1.300, 4.00,
  ⇨ 1.300, 2.00, 1, 0.000; 0.300

%FAMILY: CS 454, wheel loads, with impact 1.8

%GROUP: Single axles, with impact 1.8, wheel loads

>= 18 tonnes GVW - wheel load - 1.8 impact on 1, 10.35, 1, 1, 10.35, 1, 0.000; 0.300
Fire engines group 1 - wheel load - 1.8 impact on 1, 9.00, 1, 1, 9.00, 1, 0.000; 0.300
13 tonnes GVW - wheel load - 1.8 impact on 1, 8.10, 1, 1, 8.10, 1, 0.000; 0.300
10 tonnes GVW - wheel load - 1.8 impact on 1, 6.30, 1, 1, 6.30, 1, 0.000; 0.300
7.5 tonnes GVW - wheel load - 1.8 impact on 1, 4.95, 1, 1, 4.95, 1, 0.000; 0.300
Fire engines group 2 - wheel load - 1.8 impact on 1, 4.50, 1, 1, 4.50, 1, 0.000; 0.300
3 tonnes GVW - wheel load - 1.8 impact on 1, 1.80, 1, 1, 1.80, 1, 0.000; 0.300

%GROUP: Double axle bogies, with impact 1.8, wheel loads

Double Axle (1.0m <= s < 1.3m) - wheel load - 1.8 impact on 1, 11.20, 2, 1, 7.20, 1.000,
  ⇨ 4.00, 1, 0.000; 0.300
Double Axle (1.3m <= s < 1.8m) - wheel load - 1.8 impact on 1, 13.30, 2, 1, 8.55, 1.300,
  ⇨ 4.75, 1, 0.000; 0.300
Double Axle (s >= 1.8m) - wheel load - 1.8 impact on 1, 14.00, 2, 1, 9.00, 1.800, 5.00, 1,
  ⇨ 0.000; 0.300

%GROUP: Triple axle bogies, with impact 1.8, wheel loads

Triple Axle (1.0m <= s < 1.3m) - wheel load - 1.8 impact on 1, 13.30, 3, 1, 6.30, 1.000,
  ⇨ 3.50, 1.000, 3.50, 1, 0.000; 0.300
Triple Axle (1.0m <= s < 1.3m) - wheel load - 1.8 impact on 2, 13.30, 3, 1, 3.50, 1.000,
  ⇨ 6.30, 1.000, 3.50, 1, 0.000; 0.300
Triple Axle (s >= 1.3m) - wheel load - 1.8 impact on 1, 15.20, 3, 1, 7.20, 1.300, 4.00,
  ⇨ 1.300, 4.00, 1, 0.000; 0.300
Triple Axle (s >= 1.3m) - wheel load - 1.8 impact on 2, 15.20, 3, 1, 4.00, 1.300, 7.20,
  ⇨ 1.300, 4.00, 1, 0.000; 0.300

%FAMILY: CS 454, wheel loads, reduced impact 1.62
```

6 Vehicles

```
%GROUP: Single axles, reduced impact 1.62, wheel loads

>= 18 tonnes GVW - wheel load - 1.62 impact on 1, 9.32, 1, 1, 9.32, 1, 0.000; 0.300
Fire engines group 1 - wheel load - 1.62 impact on 1, 8.10, 1, 1, 8.10, 1, 0.000; 0.300
13 tonnes GVW - wheel load - 1.62 impact on 1, 7.29, 1, 1, 7.29, 1, 0.000; 0.300
10 tonnes GVW - wheel load - 1.62 impact on 1, 5.67, 1, 1, 5.67, 1, 0.000; 0.300
7.5 tonnes GVW - wheel load - 1.62 impact on 1, 4.46, 1, 1, 4.46, 1, 0.000; 0.300
Fire engines group 2 - wheel load - 1.62 impact on 1, 4.05, 1, 1, 4.05, 1, 0.000; 0.300
3 tonnes GVW - wheel load - 1.62 impact on 1, 1.62, 1, 1, 1.62, 1, 0.000; 0.300

%GROUP: Double axle bogies, reduced impact 1.62, wheel loads

Double Axle (1.0m <= s < 1.3m) - wheel load - 1.62 impact on 1, 10.48, 2, 1, 6.48, 1.000,
↪ 4.00, 1, 0.000; 0.300
Double Axle (1.3m <= s < 1.8m) - wheel load - 1.62 impact on 1, 12.45, 2, 1, 7.70, 1.300,
↪ 4.75, 1, 0.000; 0.300
Double Axle (s >= 1.8m) - wheel load - 1.62 impact on 1, 13.10, 2, 1, 8.10, 1.800, 5.00, 1,
↪ 0.000; 0.300

%GROUP: Triple axle bogies, reduced impact 1.62, wheel loads

Triple Axle (1.0m <= s < 1.3m) - wheel load - 1.62 impact on 1, 12.67, 3, 1, 5.67, 1.000,
↪ 3.50, 1.000, 3.50, 1, 0.000; 0.300
Triple Axle (1.0m <= s < 1.3m) - wheel load - 1.62 impact on 2, 12.67, 3, 1, 3.50, 1.000,
↪ 5.67, 1.000, 3.50, 1, 0.000; 0.300
Triple Axle (s >= 1.3m) - wheel load - 1.62 impact on 1, 14.48, 3, 1, 6.48, 1.300, 4.00,
↪ 1.300, 4.00, 1, 0.000; 0.300
Triple Axle (s >= 1.3m) - wheel load - 1.62 impact on 2, 14.48, 3, 1, 4.00, 1.300, 6.48,
↪ 1.300, 4.00, 1, 0.000; 0.300
```

7 Load file

The complete set of loads is assembled in the file `CS454_chapter7_loads.ldf`. This file is included in the Archie-M distribution, so the various families should appear in the standard load list.