

# Asset Management

## State of Good Repair

# *BRIDGES*

## *SGR Bridges & Tunnels Inspection Procedure*

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*This document includes the procedure for the SGR scoring of RTD's  
pedestrian and LRT bridges/tunnels.*

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**Intended Audience:** SGR Inspectors

**Subject:** SGR Bridges & Tunnels Inspection Procedure

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## SGR Master Condition Rating Definitions for RTD

This rating is based on how close an asset or component is to replacement or major overhaul. Scores will not have a greater granularity than a half point. An asset is in a State of Good Repair if the score is greater than (2.5). Refer to individual asset group Inspection Standards Document for confidence in reliability and specific examples. Asset Management believes that Confidence in Reliability and Remaining Useful Life are interchangeable.

|            |   |
|------------|---|
| <b>5.0</b> | New or like new, 95% to 100% confidence in reliability; no visible defects, no damage, cosmetically looks new. *An asset is only new once, after rebuild some old parts are not new and therefore the highest score after rebuild is (4.5).                                 |
| <b>4.5</b> | The inspector is 90% to 95% confident in the reliability of the component / asset.  |
| <b>4.0</b> | The inspector is 80% to 90% confident in the reliability of the component / asset. The asset shows minimal signs of wear, no major defects. Some minor defects with only minimal signs of deterioration. Cosmetic defects/minor wear.                                       |
| <b>3.5</b> | The inspector is 70% to 80% confident in the reliability of the component / asset.  |
| <b>3.0</b> | The inspector is 60% to 70% confident in the reliability of the component / asset. Some moderately defective or deteriorated components; expected maintenance needs. Cosmetically “fair” but all devices are functioning as designed. Small repairs or minor refurbishment. |
| <b>2.5</b> | The inspector is 50% to 60% confident in the reliability of the component / asset. Asset near overhaul or retirement, but in serviceable condition.   |
| <b>2.0</b> | The inspector is 40% to 50% confident in the reliability of the component / asset. Asset has numerous defects or deteriorated component(s). Significant or multiple repairs needed.   |
| <b>1.5</b> | The inspector is 30% to 40% confident in the reliability of the component / asset.  |
| <b>1.0</b> | The inspector is less than 30% confident in the reliability of the component / asset. Critical defects exist that may affect function or safety. Asset is in need of multiple major repairs or refurbishment; numerous defects.   |
| <b>0</b>   | Not safe to use, multiple major repairs or Asset set for disposal/retirement.   |

## Scope

RTD contracts with third party professional structural engineers (PE's) to inspect our freight and commuter rail bridges each year per FRA requirements; LRT and pedestrian bridges every two years. These engineers send RTD very detailed inspection reports. SGR will provide a condition score for bridges and tunnels by referencing the current engineering bridge element inspection reports.

The PE reports, which are accessible on the N: Drive (see section *Bridge Score Calculator* for specific locations), include an inventory page, nationally recognized element scoring convention, recommended maintenance, blueprint drawings, photo images, and comments. SGR scoring will be derived primarily from the engineer's scores with some discretion left to the SGR inspector for qualifying circumstances.

Inspectors should thoroughly review the contents of the PE report on the bridge or tunnel that they are assessing, especially the element notes. The objective is to distill this information into a single condition score per category using primarily, the Bridge Score Calculator.

## Naming Conventions: PE Reports vs. Maximus

The PE report names generally, do not follow the same convention as the equipment ID's in Maximus, though there are hints of similarity by abbreviation. However, both tend to identify the structure by location. So, when in doubt, compare the structure's physical description in the PE report to the equipment description in Maximus.

LRT bridge equipment ID's in Maximus can be found by going to the *Equipment Units* drop-down under the SGR tab and select *Linear Primary Information*. Click on the *Search* button. In the Equipment ID field, type in *BRG* and choose the drop-down. The equipment IDs will generally mimic the location of the structure. Choose the one with the description that resembles the PE report's description.

Pedestrian bridges are considered public facilities and are identified in Maximus under *Stationary Equipment* such as US36BROOMFIELD-BRID, US36McCASLIN-BRID, US36SHERIDANSTA-BRID, and US36TABLEMESA-BRID.

## Engineer's Bridge Scoring System

Element inspection reports use a matrix of all the applicable elements listed vertically along the left and condition states (CS) one through five across the top, with CS1 being good and CS5 - terrible. The PE scores each element as a percentage in one or more condition states, depending upon the severity of the deterioration and how much of the element is affected. SGR is mainly concerned with the columns containing the element codes, descriptions, and the condition state percentages.

| Element Inspection Report |                      |       |           |        |       |        |       |        |      |        |      |        |      |
|---------------------------|----------------------|-------|-----------|--------|-------|--------|-------|--------|------|--------|------|--------|------|
| Elm/En                    | Description          | Units | Total Qty | % in 1 | CS 1  | % in 2 | CS 2  | % in 3 | CS 3 | % in 4 | CS 4 | % in 5 | CS 5 |
| 12/1                      | Bare Concrete Deck   | (SF)  | 4,013     | 0 %    | 0     | 100 %  | 4,013 | 0 %    | 0    | 0 %    | 0    | 0 %    | 0    |
| 121/1                     | P/Stl Thru Truss/Bot | (LF)  | 634       | 79 %   | 500   | 14 %   | 90    | 5 %    | 34   | 2 %    | 10   | 0 %    | 0    |
| 126/1                     | P/Stl Thru Truss/Top | (LF)  | 634       | 79 %   | 500   | 21 %   | 134   | 0 %    | 0    | 0 %    | 0    | 0 %    | 0    |
| 141/1                     | Paint Stl Arch       | (LF)  | 361       | 94 %   | 341   | 6 %    | 20    | 0 %    | 0    | 0 %    | 0    | 0 %    | 0    |
| 152/1                     | Paint Stl Floor Beam | (LF)  | 1,185     | 100 %  | 1,181 | 0 %    | 4     | 0 %    | 0    | 0 %    | 0    | 0 %    | 0    |
| 161/1                     | Paint Stl Pin/Hanger | (EA)  | 20        | 100 %  | 20    | 0 %    | 0     | 0 %    | 0    | 0 %    | 0    | 0 %    | 0    |
| 210/1                     | R/Conc Pier Wall     | (LF)  | 24        | 100 %  | 24    | 0 %    | 0     | 0 %    | 0    | 0 %    | 0    | 0 %    | 0    |
| 234/1                     | R/Conc Cap           | (LF)  | 56        | 71 %   | 40    | 29 %   | 16    | 0 %    | 0    | 0 %    | 0    | 0 %    | 0    |
| 307/1                     | Modular Expansion Jt | (LF)  | 45        | 100 %  | 45    | 0 %    | 0     | 0 %    | 0    | 0 %    | 0    | 0 %    | 0    |
| 310/1                     | Elastomeric Bearing  | (EA)  | 10        | 60 %   | 6     | 40 %   | 4     | 0 %    | 0    | 0 %    | 0    | 0 %    | 0    |
| 333/1                     | Other Bridge Railing | (LF)  | 634       | 100 %  | 634   | 0 %    | 0     | 0 %    | 0    | 0 %    | 0    | 0 %    | 0    |
| 341/1                     | Substr Conc Coating  | (EA)  | 1         | 100 %  | 1     | 0 %    | 0     | 0 %    | 0    | 0 %    | 0    | 0 %    | 0    |
| 358/1                     | Deck Cracking SmFlag | (EA)  | 1         | 100 %  | 1     | 0 %    | 0     | 0 %    | 0    | 0 %    | 0    | 0 %    | 0    |
| 600/1                     | Genl Remarks         | (EA)  | 1         | 100 %  | 1     | 0 %    | 0     | 0 %    | 0    | 0 %    | 0    | 0 %    | 0    |

## SGR Bridge Categories

Below is the chart of 50-plus elements that the engineers have identified and assessed on our bridges and tunnels that have been condensed into ten categories that SGR will score. Not all structures will have all categories. The calculator is programmed to label each engineering element with its corresponding SGR category. Not all categories will apply to all bridges so those will receive “NA” in the Maximus SGR test (see section *Bridge Score Calculator*).

| <b><u>Abutments</u></b>        | <b><u>Arches/Suspension Rods</u></b> | <b><u>Caps</u></b>                | <b><u>Culverts</u></b>              | <b><u>Deck</u></b>     |
|--------------------------------|--------------------------------------|-----------------------------------|-------------------------------------|------------------------|
| R/Conc Abutment                | Paint Steel Arch                     | R/Conc Cap                        | Channel Cond                        | Bare Concrete Deck     |
| Elastomeric Bearing            | Paint Steel Pin/Hanger               | Paint Steel Cap                   | Concrete Culvert                    | Bare Conc Dk w/Brs     |
| Elastomeric Bearing (Teflon)   | Unpainted Steel Arch                 |                                   | ChannProtMatCond                    | Coated Metal Curb/SW   |
| Fixed Bearing                  |                                      |                                   |                                     | Pole Attachment        |
| Disk Bearing                   |                                      |                                   |                                     | Conc Curbs/SW          |
| Moveable Bearing               |                                      |                                   |                                     | RR Deck                |
| Pot bearing                    |                                      |                                   |                                     |                        |
| <b><u>Expansion Joints</u></b> | <b><u>Girders/Beams</u></b>          | <b><u>Headwalls/Wingwalls</u></b> | <b><u>Pillars/Piers/Columns</u></b> | <b><u>Railings</u></b> |
| Compression Joint Seal         | Open Girder                          | Wingwalls                         | R/Conc Pier Wall                    | Railing (Concrete)     |
| Construction Non-Exp Joint     | P/Stl Thru Truss/Bottom              | Bank Condition                    | Paint Steel Column                  | Metal Rail Coated      |
| Open Expansion Joint           | P/Stl Thru Truss/Top                 | Culvert Headwalls                 | Paint Concrete Column               | Other Bridge Railing   |
| Modular Expansion Joint        | Paint Steel Floor Beam               | Culvert Wingwalls                 | Concrete Pile Cap/Ftg               |                        |
| Pourable Joint Seal            | Paint Steel Stringer                 | Slope Prot/Berms                  | Substr Conc Coating                 |                        |
| Strip Seal Expansion Joint     | Paint Steel Open Girder              |                                   | R/Conc column                       |                        |
|                                | Unpainted Steel Floor Beam           |                                   |                                     |                        |
|                                | P/S Conc Open Girder                 |                                   |                                     |                        |
|                                | Superstr Cnc Coating                 |                                   |                                     |                        |
|                                | P/S Conc Box Girder                  |                                   |                                     |                        |

Conversely, some structures may have several elements with differing scores that fall under a single category. In this case, the lowest score within that category is the only one that will be used in the calculation of an SGR score. This is in accordance with the idea that a bridge is only as strong as its weakest structural component.

Freight rail bridges along the southwest corridor are inspected by the third party engineer group as part of RTD’s agreement with the freight carriers for the use of their right of way. Since the bridges that the freight trains run on are not considered to be RTD owned assets, SGR will not be entering test results on these. However, the bridges that the LRV’s use adjacent to the freight bridges are RTD owned and should be scored.

# Bridge Score Calculator

The bridge score calculator and engineering reports are accessed in floating locations. The calculator is designed to print to file to whatever folder that it originates from, depending on bridge type and year of inspection.

For example, if one is scoring a pedestrian bridge in the year 2017, open the calculator located in folder *N:\SS&F\Asset Management\ (N)In-Progress\Bridges\Reference\_Material\Pedestrian Bridges Score Calculators\2017*. This is where the calculator data for that pedestrian bridge will be saved as a PDF file along with its engineering report.

If one is scoring an LRT bridge in the year 2018, open the calculator located in folder

*N:\SS&F\Asset Management\ (N)In-Progress\Bridges\Reference\_Material\LRT Bridges Score Calculators\2018*. This is where the calculator data for that LRT bridge will be saved as a PDF file along with its engineering report.

When the bridge calculator is opened it is time stamped in cell A1 with the current date. Enter the equipment ID as it appears in Maximus in cell B1. The bridge score calculator uses the element code from the engineer report to uniquely identify each element and assign it to its proper SGR category. As these codes are entered in column C, columns A & B will auto-populate. Condition state percentage values for each element are manually entered from the engineer report into the calculator grid. The total percentage values for each element need to add up to 100% in each row of column H, which will turn off the red flag for that corresponding cell. Once all values are entered, raw SGR scores for each element will auto-populate columns I & J. Click on the *CALCULATE SCORE* button. The calculator selects the lowest value in each SGR category and uses that value as the SGR score, which appears in columns K & L. These are the values to be entered as a decimal number into the SGR-BRIDGES test in Maximus. SGR categories that do not auto-populate do not apply and get an SGR score of *NA* entered in the test.

The image on the following page shows element codes and condition state values entered from an engineer report for the pedestrian bridge over I-25 at Arapahoe Station, after the *CALCULATE SCORE* button was clicked.

The *PRINT* button allows the inspector to save the current view calculator image as a PDF file in its default location where the calculator was opened.

The *RESET FORM* button clears the field of all data to prepare the calculator for scoring the next bridge on the list.

| A                     | B                              | C           | D          | E          | F          | G          | H              | I            | J                | K                     | L                   | M               |
|-----------------------|--------------------------------|-------------|------------|------------|------------|------------|----------------|--------------|------------------|-----------------------|---------------------|-----------------|
| 3/14/2016             |                                |             |            |            |            | #N/A       |                |              |                  |                       |                     |                 |
| <b>SGR Categories</b> | <b>Engineering Description</b> | <b>EL #</b> | <b>CS1</b> | <b>CS2</b> | <b>CS3</b> | <b>CS4</b> | <b>Total %</b> | <b>score</b> | <b>SGR Score</b> | <b>SGR Categories</b> | <b>Bridge Score</b> |                 |
| #N/A                  | #N/A                           |             |            |            |            |            | 0              | 0            | 0                | #N/A                  | 0                   | Calculate Score |
|                       |                                |             |            |            |            |            |                |              |                  |                       |                     | Print           |
|                       |                                |             |            |            |            |            |                |              |                  |                       |                     | Reset Form      |

**Example of calculator prior to data input**

2/23/2016

**ARAPAHOE-BRID**

**RTD-PED25ARAP**

| SGR Categories         | Engineering Description                            | EL # | CS1 | CS2 | CS3 | CS4 | Total % | score | SGR Score | SGR Categories         | Bridge Score |
|------------------------|--|------|-----|-----|-----|-----|---------|-------|-----------|------------------------|--------------|
| Deck                   | Concrete Deck Bare                                 | 12   |     | 100 |     |     | 100     | 3     | 3         |                        | 0 4          |
| Girders/Beams          | Steel Bottom chord Through Truss Painted           | 121  | 79  | 14  | 5   | 2   | 100     | 3.7   | 3.7       | Abutments              | 3.6          |
| Girders/Beams          | Steel Through Truss excluding Bottom Chord Painted | 126  | 79  | 21  |     |     | 100     | 3.79  | 3.7       | Arches/Suspension Rods | 3.9          |
| Arches/Suspension Rods | Steel Arch Painted                                 | 141  | 94  | 6   |     |     | 100     | 3.94  | 3.9       | Cap                    | 3.7          |
| Girders/Beams          | Steel Floor Beam Painted                           | 152  | 100 |     |     |     | 100     | 4     | 4         | Deck                   | 3            |
| Arches/Suspension Rods | Steel Pin and Hanger Assembly Painted              | 161  | 100 |     |     |     | 100     | 4     | 4         | Expansion Joints       | 4            |
| Pillars/Piers/Columns  | Concrete Pier Wall                                 | 210  | 100 |     |     |     | 100     | 4     | 4         | Girders/Beams          | 3.7          |
| Cap                    | Concrete Cap                                       | 234  | 71  | 29  |     |     | 100     | 3.71  | 3.7       | Pillars/Piers/Columns  | 4            |
| Expansion Joints       | Modular Expansion Joint                            | 307  | 100 |     |     |     | 100     | 4     | 4         | Railings               | 4            |
| Abutments              | Elastomeric Bearing                                | 310  | 60  | 40  |     |     | 100     | 3.6   | 3.6       |                        |              |
| Railings               | Miscellaneous Bridge Railing                       | 333  | 100 |     |     |     | 100     | 4     | 4         |                        |              |
| Pillars/Piers/Columns  | Concrete Coating (Substructure)                    | 341  | 100 |     |     |     | 100     | 4     | 4         |                        |              |
| 0                      | Deck Surface Cracking                              | 358  | 100 |     |     |     | 100     | 4     | 4         |                        |              |

**Example of calculator after data has been input**

# SGR-BRIDGES Test

The scores entered into the SGR test in Maximus from the above results would look much like this:

| Basic Info  |                 | SAMPLE                   |  |                                  |  |        |                |  |  |  |  |           |  |
|---|-----------------|--------------------------|--|----------------------------------|--|--------|----------------|--|--|--|--|-----------|--|
| Equipment ID  | ARAPAHOE-BRID   |                          |  | 2006-- -- PEDESTRIAN BRIDGE      |  | Status | PENDING        |  |  |  |  |           |  |
| Test type ID  | SGR-BRIDGES     |                          |  | SGR TEST- BRIDGES                |  |        | IN PROGRESS    |  |  |  |  |           |  |
|   |                 |                          |  |                                  |  |        | PASS           |  |  |  |  |           |  |
| Meter 1   | 0               |                          |  |                                  |  |        | PASS CORRECTED |  |  |  |  |           |  |
| Meter 2   | 0               |                          |  |                                  |  |        | FAIL           |  |  |  |  |           |  |
|   |                 |                          |  |                                  |  |        | PERFORMED      |  |  |  |  |           |  |
| Date and time of test   | 5/15/2015 13:39 |                          |  |                                  |  |        |                |  |  |  |  |           |  |
| Date and time due   | 5/15/2015 13:39 |                          |  |                                  |  |        |                |  |  |  |  |           |  |
| Test location ID  | DSHPF           |                          |  | DISTRICT SHOPS PUBLIC FACILITIES |  |        |                |  |  |  |  |           |  |
| Employee ID   | 6378            |                          |  | MRAK, PAULA.                     |  |        |                |  |  |  |  |           |  |
| Work order ID   |                 |                          |  |                                  |  |        |                |  |  |  |  |           |  |
| <b>Test Results</b>   |                 |                          |  |                                  |  |        |                |  |  |  |  |           |  |
| Row #   | Test element ID | Test element description |  |                                  |  |        |                |  |  |  |  | SGR Score |  |
| 1   | SGR3010         | ABUTMENTS                |  |                                  |  |        |                |  |  |  |  | 3.6       |  |
| 2   | SGR3030         | ARCHES/SUSPENSION        |  |                                  |  |        |                |  |  |  |  | 3.9       |  |
| 3   | SGR3040         | CAPS                     |  |                                  |  |        |                |  |  |  |  | 3.7       |  |
| 4   | SGR3050         | CULVERTS                 |  |                                  |  |        |                |  |  |  |  | N/A       |  |
| 5   | SGR3060         | DECK                     |  |                                  |  |        |                |  |  |  |  | 3.0       |  |
| 6   | SGR3070         | EXPANSION JOINTS         |  |                                  |  |        |                |  |  |  |  | 4.0       |  |
| 7   | SGR3090         | GIRDERS/BEAMS            |  |                                  |  |        |                |  |  |  |  | 3.7       |  |
| 8   | SGR3100         | HEAD/WING WALLS          |  |                                  |  |        |                |  |  |  |  | N/A       |  |
| 9   | SGR3120         | PILLARS/PIERS/COLUMNS    |  |                                  |  |        |                |  |  |  |  | 4.0       |  |
| 10  | SGR3130         | RAILINGS                 |  |                                  |  |        |                |  |  |  |  | 4.0       |  |
| <b>Notes</b>  |                 |                          |  |                                  |  |        |                |  |  |  |  |           |  |
| GIRDERS/BEAMS - R3 RUSTING AND SECTIONAL LOSS ON OPEN GIRDERS |                 |                          |  |                                  |  |        |                |  |  |  |  |           |  |
| <b>Add a new note:</b>  |                 |                          |  |                                  |  |        |                |  |  |  |  |           |  |
|   |                 |                          |  |                                  |  |        |                |  |  |  |  |           |  |

The SGR inspector may add any notes to the test that he feels is pertinent and is encouraged to do so if a category shows a backlog and/or he chooses to deviate from the calculated score. Additionally, if the inspector wants clarification or must make a judgment call, he is at liberty to visit the site on location to gather more information.<sup>1</sup>

<sup>1</sup> Any physical inspection that requires fouling the alignment must be done only by qualified personnel and arrangements made prior with Maintenance-of-Way.

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