Rating of Defects

- The STRUMAN BMS is based on the rating of DEFECTS and not the overall condition of the structure
- The inspector is not required to rate the condition of the structure or of inspection items. Only defects are rated
- The BMS uses these ratings of the defects in algorithms to determine the condition of the structure and to prioritise structures for maintenance purposes

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Primary Attributes of a Defect

- D = Degree of defect (Severity)
- E = Extent of defect (Distribution)
- R = Relevancy of defect (How important)
- The BMS uses only these ratings to calculate a Condition Index (CI) for a structure

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Secondary Attributes of a Defect

- Position: Each defect has a position that has to be recorded, e.g. a crack in Pier 1 and a spall on Pier 2.
- Remedial Activity: Each defect must have at least one associated remedial activity & quantity
- Urgency (U): The repair activity must have an urgency associated with it.
- Make Safe (MS): The remedial activity for a defect that poses a high risk to public safety must be marked as Make Safe.
- Monitoring frequency (MF): Some defects may require monitoring with an associated monitoring frequency (MF) – should only be used in exceptional circumstances

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The various Degrees of a Defect

- D may be rated as 1, 2, 3 or 4; or as 0, X or U
- Degree (D) = 0
  - This means no defect or an irrelevant defect
  - If a defect is negligible, such as a small local surface shrinkage crack or minor cracks in a concrete joint nosing, then it should be ignored
  - Don't waste time on the irrelevant
  - If D = 0, enter a 0 on the inspection form and leave E and R blank
  - Do not leave the whole line against the item blank

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Degree (D) = 3

- D = 3 is a "warning" defect (i.e. "the bearings are in a warning condition")
- Bending cracks from 0.3 mm to 0.7 mm in reinforced concrete
- Shear cracks from 0.4 mm to 0.5 mm in reinforced concrete
- Vertical cracks over 10 mm in un-reinforced mass concrete walls
- Larger cracks due to ASR of 1 mm to 2 mm
- Medium size spall due to vehicle collision

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Degree (D) = 4

- D = 4 is a “severe” defect (for example “bearing failure, major spalls or cracks”)
- Bending cracks wider than 0.7 mm in reinforced concrete
- Shear cracks wider than 0.5 mm in reinforced concrete
- Vertical cracks wider than 15 mm in un-reinforced mass concrete walls
- Larger cracks due to ASR > 3 mm
- Large size spall due to vehicle collision

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Degree (D) = X

- This is used to indicate the particular inspection item is not applicable to the structure; for example:
  - Pier items (items 12; 13 & 14) are not applicable to a single span bridge
  - Waterway (item 3) is not applicable to a road-over-road bridge
- If D = X, enter a X on the inspection form and leave E and R blank
- Do not leave the whole line against the item blank

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Degree (D) = U

- This means the inspector is unable (U) to inspect the particular item.
- This should not be used frequently.
- For example, bearings on top of a pier that is 10 m high can be inspected using binoculars.
- For foundations that are below ground level look for tell-tale signs of foundation defects and rate the foundations in this way

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Degree (D) = U (continued)

- In certain instances it may be impossible to inspect bridge decks and bearings at great heights and binoculars may be inadequate.
- In these cases the Under Bridge Inspection Unit (UBIU) should be used.
- The road authority need to identify such bridges where the inspection of specific items have to be done using the UBIU.
- The road authority would normally appoint an inspector to inspect these items only using the UBIU.

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Under Bridge Inspection Unit (UBIU)

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The Extent of a Defect

- E may be rated 1, 2, 3 or 4
- Extent varies from local to general
- Impact damage to deck:
  - in one location E=1
  - in more than one location E=2 or 3
- ASR on whole abutment face E=4

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Relevancy of a Defect

- This is where the most experience is required
- Inspectors must have the required qualifications and experience before inspecting structures.
- The collapse of a structure has major consequences.
- Don't inspect structures if you do not have the required experience – you assume professional risk.
- Most road authorities have a large number of structures and cannot afford inspectors taking a conservative approach due to lack of experience

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The Various Relevancy Ratings of a Defect

- R may be rated as 1, 2, 3 or 4
  - Minimum, Moderate, Major & Critical
- R rating cannot be more than 1 point higher than D rating, but it can be lower
- The inspector is rating the defect and its influence on the item fulfilling its intended function and thus indirectly the structure
- Do not give items perceived as being more important, such as abutments or decks a higher relevancy rating. The BMS has weighting factors that take this into account

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Bridge Inspection Item Weights

Inspection Item	Item Weight
01. Approach Embankment	2
02. Guardrail	1
03. Waterway	2
04. Approach Embankment Protection Works	2
05. Abutment Foundations	5
06. Abutments	5
07. Wing/ Retaining Walls	3
08. Surfacing	1
09. Superstructure Drainage	1
10. Kerbs / Sidewalks	1
11. Parapet	3
12. Pier Protection Works	1
13. Pier Foundations	5
14. Piers, Columns & Arch Springings	5
15. Bearings	3
16. Support Drainage	1
17. Roadway/Rail Deck Expansion Joints	2
18. Longitudinal Members & Cable Groups	5
19. Transverse Members	3
20. Decks, Slabs & Arches	5
21. Miscellaneous Items	0

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Major Culvert Inspection Item Weights

Inspection Item	Item Weight
01. Apron Slabs & Cut Off Walls	3
02. Wing / Ret / Head Walls	3
03. Scour Protection Works	3
04. Embankment/s	2
05. Waterway	5
06. Road Slabs	3
07. Roadway Joints	1
08. Guardrails	1
09. Parapets / Handrails	3
10. Walls	5
11. Top Slab	5
12. Invert Slab/Foundations	5
13. Cell Deformation	5
14. Miscellaneous Items	0

Items Consisting of More than One Sub-item

- All Sub-items of an Item must be rated
- For example, for a bridge with 4 piers, a DER rating must be given to Pier 1, Pier 2, Pier 3 and Pier 4
- The DER Rating may differ for each sub-item

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Remedial Activities

- Where D = 1, 2, 3 or 4 there must be at least one associated remedial activity with the following information:
  - Item No
  - Position of Item
  - Activity
  - Quantity
  - Urgency
  - MS (Make Safe) (if applicable)
  - Remarks in the remarks column
  - Monitoring Frequency (if applicable, when U=0)
  - Photo(s)

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Remedial Activities Pick Lists

- Remedial activity pick lists are available for each structure type
- Only activities on these pick lists must be used
- No activities may be added - choose the nearest item if there is doubt.
- An ad-hoc item has been added to be used where a suitable activity cannot be found on the pick list
- Structure inspections are at a network level and they do not replace detailed project inspections once a structure is identified to be repaired
- However, the estimates of quantities must be as accurate as possible to ensure the budget calculated by the system is reasonable

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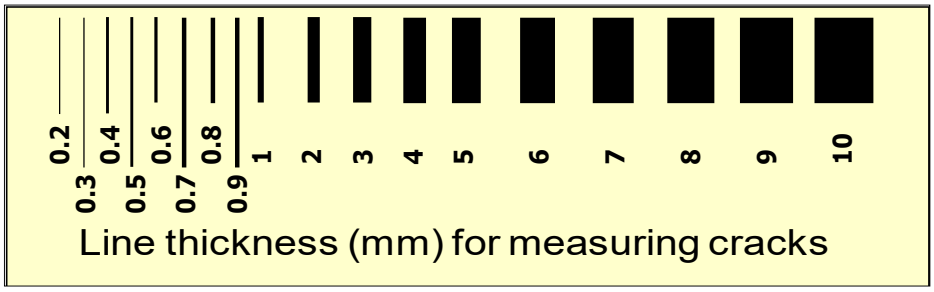
Measuring of Crack Widths



20

Bridge N11_05N_B1213

- Two defects on the deck (Item 20)
- The inspector need to decide which one to rate
- Use the defect with the highest relevancy (Defect 1)

S03 Impact damage

S04 Cracks close to support & sides

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This is an extract of how a single item's associated remedial activities should be captured

SPANS									
	18 Longitudinal Members			19 Transverse Members			20 Decks & Slabs		
	D	E	R	D	E	R	D	E	R
S1	X			X			3	2	3

Item	Pos	Activity	Qty	Unit	U	M S	Remarks	Mon Fr.	Photo No's
20	S1	20.120 Seal Cracks	5	m	2		Cracks at deck seatings		S04
20	S1	20.118. Repair spall (including honeycombing)	20	L	4		Rebar to be repaired as well		S02, S03
20	S1	20.654. Access-using scaffold (< 10 m)	1	No	4				S02, S03
20	S1	20.702. Traffic accommodation-Low (< 10 000 vpd)	1	No	4				S02 S03

Inspectors Assessment of Structure condition and further comments

1. Increase vertical clearance to 5,2m by lowering road
2. Suggest placing of guardrails to protect pedestrians