CONCRETE BLOCK PAVING CONDITION SURVEY AND RATING PROCEDURES

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ABSTRACT

A FUNCTIONAL EVALUATION OF CONCRETE BLOCK PAVEMENT (CBP) WAS NOT POSSIBLE SINCE THERE WAS NO AVAILABLE SURVEY SYSTEM FOR CBP. THEREFOR ITS DEVELOPMENT WAS BASED ON EXISTING SYSTEMS (PAVER) WHICH ARE USED FOR ASPHALT CONCRETE (AC) AND CEMENT CONCRETE (PCC) PAVEMENTS, ADJUSTED TO CBP.
HERE I PROPOSE A PAVER SYSTEM FOR CBP. CONSISTING OF DAMAGES AND DEDUCTED VALUE CURVES OF THE PAVER SYSTEM, BOTH FOR ACP AND PCCP, ADJUSTED FOR CBP.
THIS IS A PRIMARY SUGGESTION NOT YET BASED ON A FULL SCALE RESEARCH.

THE PRINCIPLE OF THE SUGGESTED SYSTEM

THE SUGGESTED SYSTEM IS BASED ON THE DEDUCTED VALUES OF THE PAVER SYSTEM. THE ONLY DIFFERENCES ARE IN THE TYPE OF DAMAGES, DEGREES OF SEVERITY AND THE DENSITY CALCULATION METHOD. THE DIVISION INTO SAMPLE UNITS AND THE DETERMINATION OF SAMPLE SIZES ARE CARRIED OUT AS IN THE CONVENTIONAL PAVER PROCEDURE.

DAMAGE ADJUSTMENT FROM ACP/PCCP TO CBP'S

IN ORDER TO CONDUCT A CBP CONDITION SURVEY AND A RATING SYSTEM, AN ATTEMPT WAS MADE TO FIND TYPICAL DAMAGES IN ACP/PCCP WHICH SIMILAR TO CBP.
TABLE 1 IS A LIST OF ALL DAMAGES IN PCCP AND ACP AND THEIR CBP EQUIVALENT.

TABLE 1: LIST OF ALL DAMAGES IN PCCP AND ACP AND THE CBP EQUIVALENT

ACP	CBP	PCCP	CBP
ALLIGATOR CRACKING	BEARING CAPACITY	BLOW-UP BUCKLING/SHATTERING	----------
BLEEDING	----------	CORNER BREAK	----------
BLOCK CRACKING	OPEN JOINT	DIVIDED SLAB	----------
BUMPS AND SAGES	----------	DURABILITY ("D") CRACKING	----------
CORRUGATION	CORRUGATION	FAULTING	FAULTING
DEPRESSION	DEPRESSION	JOINT SEAL DAMAGE	JOINT SEAL DAMAGE
EDGE CRACKING	EDGE CRACKING	LANE/SOLDER DROP OFF	----------
JET REFLECTION CRACKING	----------	LINEAR CRACKING	----------
LANE/SOLDER DROP OFF	----------	PATCHING, LARGE & UTIL CUTS	----------
LONG & TRANS CRACKING	----------	PATCHING, SMALL	----------
PATCHING & UTIL CUT PATCHING	PATCHING & UTIL CUT PATCHING	POLISHED AGGREGATE	----------
POLISHED AGGREGATE	POLISHED AGGREGATE	POPOUTS	----------
POTHOLES	POTHOLES	PUMPING	----------
RAILROAD CROSSING	----------	PUNCH OUT	----------
RUTTING		RAILROAD CROSSING	----------
SHOVING	----------	SCALING/MAP CRACKING/CRAZING	----------
SLIPPAGE CRACKING	----------	SHRINKAGE, CRACKS	----------
SWELL	SWELL	SPALLING, CORNER	----------
WEATHERING AND RAVELING	WEATHERING AND RAVELING	SPALLING, U JOINT	SPALLING BLOCKS

DAMAGE DEFINITIONS

WHEREVER THE CBP DAMAGE DESCRIPTION IS IDENTICAL TO THE ACP/PCCP DAMAGE, THE EVALUATING METHOD AND THE DEDUCTED VALUE CURVES WERE ADAPTED (CORRUGATION, DEPRESSION, POLISHING, POTHOLES, SWELLING) TO THIS SYSTEM.
ALL OTHER DAMAGES WHERE REDEFINED AND THE DEGREE OF SEVERITY WHERE ADJUSTED ACCORDING TO CBP.
THE DEDUCTED VALUE CURVES WERE ADAPTED WITHOUT ANY CHANGES.

GUIDE TO CBP CONDITION SYSTEM - DISTRESS IDENTIFICATION

1) THE DISTRESS: CORRUGATION
DESCRIPTION: SMALL AND LOCAL SERIES OF CLOSELY SPACED RIDGES AND VALLEYS. THIS TYPE OF DISTRESS IS USUALLY CAUSED BY :
A) BLOW-UP OF A CONCRETE BLOCK
B) SWELLING CAUSED BY FROST

C) SWELLING OF MATERIALS INSIDE THE CRACKS , WITH THE ADDITION OF TRAFFIC LOADS.
IF BUMPS OCCUR IN A LARGE AREA, THE DISTRESS IS CONSIDERED AS SWELLING.

SEVERITY LEVELS: L - CORRUGATION PRODUCES LOW-SEVERITY RIDE QUALITY.
M - CORRUGATION PRODUCES MEDIUM-SEVERITY RIDE QUALITY.
H - CORRUGATION PRODUCES HIGH-SEVERITY RIDE QUALITY.

MEASUREMENT: THE CORRUGATION IS MEASURED IN LINEAR METERS.
DISTRESS DENSITY IS CALCULATE BY:

$$100\% * \frac{0.3 * \text{LENGTH}}{\text{AREA}}$$

2) THE DISTRESS: DEPRESSION.

DESCRIPTION: LOCALIZED AREAS WITH ELEVATIONS SLIGHTLY LOWER THAN THOSE OF THE SURROUNDING PAVEMENT. IN MANY INSTANCES, LIGHT DEPRESSIONS ARE NOT NOTICEABLE UNTIL AFTER RAIN FALL.
DEPRESSIONS ARE CAUSED BY SETTLEMENT OF THE FOUNDATION SOIL OR AS A RESULT OF IMPROPER CONSTRUCTION.

SEVERITY LEVELS: L - 1.2 - 2.5 CM (1/2 - 1")
M - 2.5 - 5.0 CM (1 - 2")
H - MORE THAN 5.0 CM (2")

MEASUREMENT: IN SQUARE METERS.

3) THE DISTRESS: EDGE CRACKING

DESCRIPTION: EDGE CRACKS ARE PARALLEL TO AND USUALLY WITHIN 50 CM OF THE OUTER EDGE OF THE PAVEMENT. THIS DISTRESS IS ACCELERATED BY TRAFFIC LOAD AND CAN BE CAUSED BY WEATHER-AFFLICTED BASE OR SUBGRADE NEAR THE EDGE OF THE PAVEMENT OR DUE TO THE LACK OF LIMITING ELEMENTS OR THEIR HYPOFUCTION.

SEVERITY LEVELS: THE TOTAL OPENING BETWEEN THEIR BLOCKS:
L - 7.0 - 8.5 MM
M - 8.5 - 10.0 MM
H - MORE THEN 10.0 MM

MEASUREMENT: IN SQUARE METERS.
IN CASES WHERE EDGE CRACKING OCCURS WITH FAULTING , ONLY THE FAULTING IS MEASURED

4) THE DISTRESS: PATCHING

DESCRIPTION: A PATCH IS AN AREA OF PAVEMENT WHERE THE BLOCKS HAVE BEEN REPLACED OR RECYCLED. A PATCH IS CONSIDERED A DEFECT NO MATTER HOW WELL IT IS FUNCTIONING. (A PATCHED AREA IS USUALLY NOT FUNCTIONING AS WELL AS THE ORIGINAL PAVEMENT SECTION). A PATCH CAN BE NOTICED BY ITS DIFFERENT COLOR, WIDE SURROUNDING JOINTS, PARTIAL BLOCKS IN THE CORNERS OR A DIFFERENCE IN ELEVATION BETWEEN THE PATCH AND THE ADJACENT AREA.

SEVERITY LEVELS: L - THE PATCH IS IN GOOD CONDITION AND SATISFACTORY. THE RIDE QUALITY IS RATED GOOD OR LOW SEVERITY. THE BLOCKS ARE STABLE WITH NO OPEN JOINTS.

M - MODERATELY DETERIORATED PATCHES AND/OR RIDE QUALITY RATED AS MEDIUM SEVERITY. SOME BLOCKS ARE UNSTABLE WITH OPEN JOINT

H - BADLY DETERIORATED PATCHES AND/OR RIDE QUALITY RATED AS HIGH SEVERITY. THE BLOCKS ARE UNSTABLE AND PARTLY BROKEN OR CONCEALED. THE JOINTS ARE WIDE AND THE SURFACE OF PAVEMENT IS NON-UNIFORM.

MEASUREMENT: IN SQUARE METERS.

IN A SINGLE PATCH WITH DIFFERENT DEGREES OF SEVERITY, THE AREAS SHOULD BE MEASURED AND RECORDED SEPARATELY. NO OTHER DISTRESSES ARE RECORDED WITHIN THE PATCH.

IF A LARGE AMOUNT OF PAVEMENT HAS BEEN REPLACED, IT SHOULD BE CONSIDERED AS A NEW PAVEMENT.

5) THE DISTRESS: POLISHING

DESCRIPTION: THIS DISTRESS IS CAUSED BY REPEATED TRAFFIC APPLICATIONS. WHEN THE BLOCK SURFACE BECOMES SMOOTH TO TOUCH, ADHESION WITH VEHICLE TIRES IS CONSIDERABLY REDUCED. THIS TYPE OF DISTRESS IS INDICATED WHEN THE SKID RESISTANCE TEST SHOWS LOW RESULT OR A SIGNIFICANT DROP COMPARED TO PREVIOUS TESTS.

SEVERITY LEVELS: NO DEGREES OF SEVERITY HAVE BEEN DEFINED. HOWEVER, THE POLISHING DEGREE MUST BE SIGNIFICANT BEFORE IT IS INCLUDED IN THE CONDITION SURVEY AND RATED AS A DEFECT.

MEASUREMENT: IN SQUARE METERS.

6) THE DISTRESS: POTHOLES
DESCRIPTION: POTHOLES ARE SMALL (USUAL LESS THAN 50 CM DIAMETER). POTHOLES ARE PRODUCED WHEN BLOCK SHIFT. THEIR GROWTH IS ACCELERATED BY LACK OF SUPPORT FROM THE SURROUNDING BLOCKS.
SEVERITY LEVELS: A NUMBER OF MISSING BLOCK.
L - 1
M - MORE THAN 1
MEASUREMENT: COUNTING THE POTHOLES ACCORDING TO SEVERITY.

7) THE DISTRESS: RUTTING
DESCRIPTION: A RUT IS A SURFACE DEPRESSION IN THE WHEEL PATH. PAVEMENT UPLIFTING MAY OCCUR ALONG THE SIDES OF THE RUT. RUTTING STEMS FROM A PERMANENT DEFORMATION IN ANY OF THE PAVEMENT LAYERS OR SUBGRADE' USUALLY CAUSED BY CONSOLIDATED OR LATERAL MOVEMENT OF THE MATERIALS DUE TO TRAFFIC LOADS. SIGNIFICANT RUTTING CAN LEAD TO MAJOR STRUCTURAL FAILURE OF THE PAVEMENT.
SEVERITY LEVELS: MEAN RUT DEPTH
L - 1.2 - 2.5 CM (1/2 - 1")
M - 2.5 - 5.0 CM (1 - 2")
H - MORE THAN 5.0 CM (2")
MEASUREMENT: IN SQUARE METERS.

8) THE DISTRESS: SWELL
DESCRIPTION: SWELL IS CHARACTERIZED BY AN UPWARD BULGE IN THE PAVEMENT'S SURFACE. A LONG, GRADUAL WAVE OF MORE THAN 3 M LONG. THIS DISTRESS IS USUALLY CAUSED BY FROST IN THE SUBGRADE OR BY SWELLING OF THE SOIL.
SEVERITY LEVELS: L - SWELLING CAUSES LOW SEVERITY RIDE QUALITY. IT IS NOT ALWAYS EASY TO DETECT, BUT IT CAN BE DETECTED BY DRIVING AT THE MAX. SPEED LIMIT OVER THE PAVEMENT SECTION. ACCELERATION WILL OCCUR AT THE SWELLING IN THIS CASE.
M - SWELLING CAUSES MEDIUM SEVERITY RIDE QUALITY
H - SWELLING CAUSES HIGH SEVERITY RIDE QUALITY.
MEASUREMENT: IN SQUARE METERS.

9) THE DISTRESS: FAULTING

DESCRIPTION: A DIFFERENCE IN ELEVATION BETWEEN THE BLOCKS. THE CAUSES OF FAULTING ARE:
A) CONSOLIDATION
B) SETTLEMENT BECAUSE OF SOFT FOUNDATION
C) PUMPING OR ERODING OF MATERIAL FROM UNDER THE BLOCKS.

SEVERITY LEVELS: THEY ARE DEFINED BY THE DIFFERENCE IN ELEVATION ACROSS THE BLOCKS
L - 3 - 10.0 MM (1/8 - 3/8")
M - 10.0 - 19.0 MM (3/8 - 3/4")
H - MORE THAN 19.0 MM (3/4")

MEASUREMENT: COUNTING THE NUMBER OF BLOCKS ACCORDING TO THE SEVERITY.
DISTRESS DENSITY:

$$100\% * \frac{A * N}{AREA}$$

WHERE : N - NUMBER OF BLOCK
A - AREA OF A BLOCK
AREA - SAMPLE UNIT AREA

10) THE DISTRESS: JOINT SEALING DAMAGE

DESCRIPTION: JOINT SEAL DAMAGE IS ANY CONDITION WHICH ENABLES SOIL OR ROCKS TO ACCUMULATE IN THE JOINTS OR WHICH ALLOWS SIGNIFICANT WATER INFILTRATION.
WELL COMPACTED FILLING MATERIAL ENABLES THE BLOCKS TO ACT AS AN ELASTIC LAYER, AND PREVENT THE SAND TO BE PUMP OUT.

SEVERITY LEVELS: L - JOINT SEAL IS IN GENERAL CONSIDERED A GOOD CONDITION, WITH ONLY MINOR DAMAGE.
M - LACK OF JOINT SEALING ON ONE BLOCK JOINT.
H - LACK OF JOINT SEALING ON TWO OR MORE BLOCK JOINTS AND THE BLOCK ITSELF BEEN UNSTABLE.

MEASUREMENT: JOINT SEAL DAMAGE IS NOT COUNTED ON A BLOCK-BY-BLOCK BASIS, BUT RATED ACCORDED TO THE OVERALL CONDITION OF THE SEALANT OVER THE ENTIRE AREA.
DIFFERENTIATION SHOULD BE MADE BETWEEN JOINT SEAL DAMAGE AND JOINT OPENING

11) THE DISTRESS: PIT, LOCAL SPOIL AND BROKEN BLOCKS.

DESCRIPTION: THE BLOCK ITSELF OR ITS EDGE ARE BROKEN DUE TO TRAFFIC LOAD AND MECHANICAL DAMAGE

SEVERITY LEVELS: NO DEGREES OF SEVERITY ARE DEFINED. HOWEVER, THE DEGREE SHOULD BE SIGNIFICANT BEFORE IT

CAN BE INCLUDED IN THE CONDITION SURVEY AND RATED AS A DAMAGE.

MEASUREMENT: COUNTING THE NUMBER OF ACCORDING TO THE SEVERITY.

DISTRESS DENSITY:

$$100\% * \frac{A * N}{AREA}$$

WHERE : N - NUMBER OF BLOCK
A - AREA OF A BLOCK
AREA - SAMPLE UNIT AREA

12) THE DISTRESS: JOINT OPENING

DESCRIPTION: WIDE JOINTS WITH NO FULL SUPPORT BETWEEN THE BLOCK'S.

SEVERITY LEVELS: JOINT WIDTH:
L - 7.0 - 8.5 MM
M - 8.5 - 10.0 MM
H - MORE THAN 10.0 MM

MEASUREMENT: JOINT OPENING IS MEASURED IN LINEAR METERS.

DISTRESS DENSITY:

$$100\% * \frac{L * 2B}{AREA}$$

WHERE: L - THE OPEN JOINT LENGTH
B - WIDTH OF A BLOCK
AREA - SAMPLE UNIT AREA

13) THE DISTRESS: ABRASION

DESCRIPTION: ABRASION IS CAUSED BY CATERPILLAR VEHICLE MOVEMENT ON PAVEMENT. THE CATERPILLARS GRIND THE BLOCK TO DUST AND REDUCE THE THICKNESS. ABRASION IS OFTEN ACCOMPANIED BY RUPTURE BLOCK UP TO SHAPE DEFORMATION.

SEVERITY LEVELS: L - THE BLOCK SURFACE IS ABREAST, BUT THE BLOCK TEXTURE (AGGREGATE AND CEMENT) CAN STILL BE SEEN. NO SIGNIFICANT REDUCTION IN THICKNESS.
M - TEXTURE DISCRIMINATION CANNOT BE MADE. THERE IS SOME THICKNESS REDUCTION.
H - BLOCK ABRASION WITH CONSIDERABLE THICKNESS REDUCTION.

MEASUREMENT: IN SQUARE METERS.

14) THE DISTRESS: BEARING CAPACITY

DESCRIPTION: FAILURE OF ONE PAVEMENT LAYER OR MORE CAUSED BY A HIGH DEGREE OF STRESS. THIS IS A RESULT OF HIGH SEVERITY ABRASION, BLOCK

BRACING, POPOUT BLOCKS, POTHOLES, JOINT SEALING THAT WERE NOT TREATED ON TIME.

SEVERITY LEVELS: L - JOINT OPENING, DEPRESSION RUTTING AND CORRUGATION. THE BLOCK ORDER IS LIGHTLY DERANGED.

M - BROKEN BLOCKS, WIDE JOINT, RUTTING, DEPRESSION, CORRUGATION POPOUT BLOCKS AND POTHOLES. DERANGED BLOCK ORDER.

H - TOTALLY RUIN OF PAVEMENT. ROCKED BLOCKS, VERY WIDE JOINT, NO BLOCKS ORDER.

MEASUREMENT: IN SQUARE METERS.

ADVANTAGE OF THE PROPOSED CBP CONDITION SYSTEM

THE PROPOSED CBP CONDITION SYSTEM IS A TOOL TO CONDUCT DAMAGES SURVEY. IT IS THE FIRST STEP FOR EVERY MAINTENANCE MANAGEMENT SYSTEM. THE GROWING USE OF CONCRETE BLOCKS REQUIRE SUCH A SYSTEM IN ORDER TO DECIDE WHAT TO DO AND WHERE, WILL OBSERVING ECONOMICAL STANDARD.