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DEVELOPMENT OF PROGRAM IN C++ FOR ANALYSIS OF NSV SURVEY DATA BY PCI METHOD FOR FLEXIBLE PAVEMENT

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Abstract

This paper presents the development of software in C++ Language for the determination of Pavement Condition Index (PCI) based on the design procedure mentioned in ASTM D 4433 and future requirement of maintenance of existing road /road network. Presently in India, Manual Pavement Condition survey has been replaced by automated Network Survey Vehicle (NSV). PCI procedure mentioned in ASTM D 4433 which needs uses of several curves and same curves have been converted in regression equations. These equations are used to prepare a Program in C++ Language. This will be useful for Pavement Engineer to determine PCI and maintenance strategy.

Keywords: Pavement condition survey,ASTM D 4433, C++, maintenance strategy,Pavement Maintenance Work

1.0 INTRODUCTION

Pavement Condition Index (PCI), International Roughness Index (IRI) and Present Serviceability Index (PSI) are the major parameters of the pavement performance indices. Overall pavement condition is determined by PCI. Generally functional and structural failure is found during operation period of the pavement. Driver and passenger feel discomfort due to functional failure whereas structural failure loses loading capacity of pavement (Smith et.al 1979) .

Roughness value is the main indicator for function failure whereas rut/shear and fatigue are the main indicators for structural failure (Yoder and Witzak 1975).

Road pavements need routine maintenance, annual maintenance, periodic maintenance and rehabilitation works due to environ¬mental factors and traffic loading.

For the best utilization of limited fund, PCI along with Pavement Management System (PMS) can be used and allow administrators and pavement engineers to allocate funds (Hall et al. 1992).

2.0 LITERATURE REVIEW ON PAVEMENT CONDITION INDEX (PCI)

U.S. Army Corps of Engineers developed Pavement Condition Index (PCI) (Shahin and Walther 1990). Visual observation of each pavement distress along with its extent and severity are used to determine PCI and maintenance strategy can be determined based on PCI as mentioned in Table 1

The PCI method is based on visual examination of the pavement distress type, The PCI provides a measure of the present condition of the pavement based on the distress observed on the surface of the pavement, which also indicates the structural integrity and surface operational condition (roughness and safety). The PCI provides an objective determination of maintenance and repair needs and priorities. Continuous monitoring of the PCI is used to establish the rate of pavement deterioration, which permits early identification of major rehabilitation needs as is shown in Table 1 (ASTM D 4433).

Table 1 Typical Pavement M&R Strategies based upon PCI Value

PCI Range		PCI Rating	Maintenance Strategy
Minimum	Maximum		
85	100	Excellent	Routine Maintenance
70	85	Good	Preventive Maintenance
55	70	Fair	Minor rehabilitation
40	55	Bad	Minor rehabilitation
25	40	Very Bad	Major Rehabilitation
10	25	Serious	Reconstruction
0	10	Failed	Reconstruction

PCI value of 100 presents the very good condition of the existing pavement whereas 0 represents the poorest pavement condition of existing pavement which needs reconstruction immediately. This PCI rating scale is shown in Figure 1.

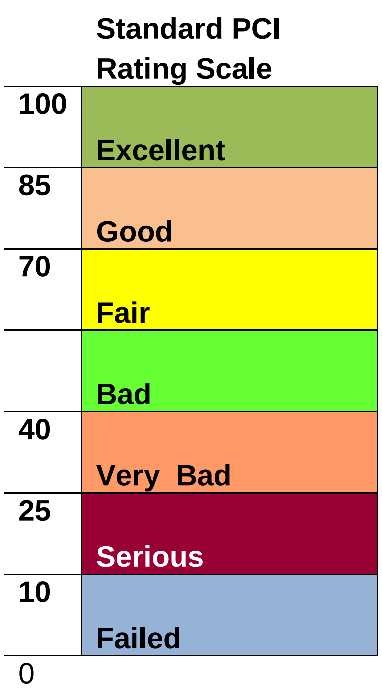

Figure 1 Standard Rating Scale

Field survey field procedure and method of analysis has been presented in ASTM D 4433, 2009.

Usually, PCI is the most unique index in terms of pavement performance rating. It also received a broad application in network-level pavement management and has been adopted as a basis of the pavement management system (Shahin and Walther, 1990).

PCI determines the identification of the need for immediate M-and-R (Galehouse et al. 2003) of roads and it can be used for prioritisation of roads for the case of limited maintenance fund.

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An alternative approach of pavement condition index (PCI) has been developed based on Artificial Neural Networks (ANN) and Genetic Programming (GP) based on visual pavement condition data of more tahn 1250 km road network in Iran and a a computer application was developed based on the results obtained (Habib et. al. 2012).

3.0 LEAD FROM PAST STUDIES AND SCOPE OF PRESENT STUDY

Manual pavement condition survey has been replaced by Network Survey Vehicle and analysis for determination of PCI is carried out manually with combination of Excel. No standard software is available in India. A computer program in C++ has been developed to analyze pavement condition data obtained from NSV and recommend the rehabilitation schedule of the existing pavement.

4.0 PCI DETERMINATION PROCEDURE

Network survey Vehicle has been used to determine pavement distress @ 10 m interval and distress values are converted into per km and these distresses values are used to determine PCI Value. Detail procedure is available in ASTM D 4433 and not reported in this paper, only brief methodology is presented here in.

The condition survey used for determining the PCI rating system as mentioned below:

The deduct values are determined from the deduct value curves for each distress type and severity.

1. Determine each type of pavement distress, it's severity and extend and determine density of each distress.
2. Determine total deduct value (TDV) by adding all individual deduct values.
3. After determination of TDV, determine corrected deduct value (CDV) .
4. Calculate PCI considering following equation: PCI = 100 – CDV
5. Determine maintenance strategy based on PCI and maintenance scheme mentioned in Table 1.

.

These data are collected using network survey vehicle and verified visually.

5.0 PAVEMENT CONDITION SURVEY USING NETWORK SURVEY VEHICLE

Australian Road Research Board (ARRB) Group developed Hawkeye 2000 Professional Network Survey Vehicle (NSV). NSV is equipped with a fully integrated Hawkeye 2000 data collection system. NSV consists of a Multi-Laser Profiler, Digital Imaging System and a Gipsi-Trac unit whose outputs are all linked via a highly accurate distance measuring instrument. Typical photograph is shown in Figure 2.

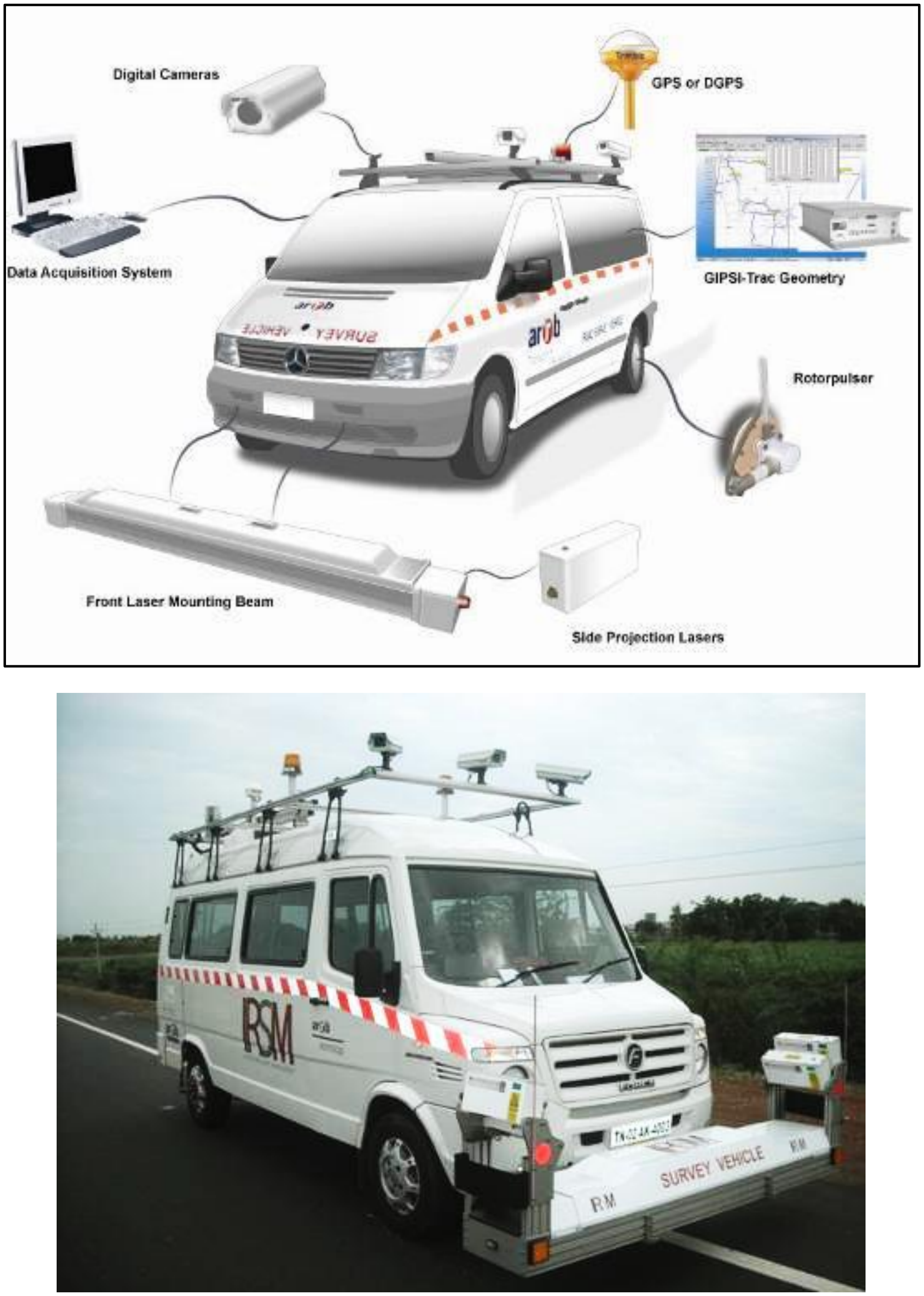

Figure 2 Layout of Network Survey Vehicle
Suggested maintenance procedure for the Study Sections

NSV allows all the data to be collected in a single pass, thus minimizing both the cost and the time needed to complete the survey. Since NSV is completely scalable system which suites to all different types of requirement of data collection and vehicle independent technology. Additionally, each data set is referenced to the road running distance, in accordance with the Council's current reference system, as well as its spatial position using GPS (WGS84). A team of trained and experienced field staff and a driver is utilized during the collection phases of projects. General methodology and modules of NSV for data collection and reporting is presented in the following section.

Integrated into the NSV is a Digital Laser Profiler (DLP) consisting of eleven lasers. This inertial profiler is capable of measuring:

- Roughness
- Rutting
- Micro-texture

6.0 DEVELOPMENT OF COMPUTER PROGRAM FOR ANALYSIS OF NSV RESULT PCI METHOD

PCI has been determined manually based on field results as per design procedure mentioned in ASTM D 6433.It needs lot of labor for the determination of deduct value of each pavement distress type from each curve. Therefore, regression equations are developed for each curve. R2 value for each curve is determined and R2 value is found to be in the range of 0.99 – 1.00 which shows that equations are correlated highly and close to the actual value. Regression equations are developed and presented in Table 2. A Computer Program has been developed using C++ Program the regression equations

Table 2 Parameters of Developed Deduct Value Curve Nonlinear Functions

Distress (severity)	**A_0**	**A_1**	**A_2**	**A_3**	**A_4**	**A_5**	**A_6**	**R^2**
Fatigue cracking (L)	10.749	15.867	7.6012	-1.4052	0	0	0	1
Fatigue cracking (M)	21.39	21.483	5.0615	-1.5665	0.355	0	0	1
Fatigue cracking (H)	30. 188	31.353	7.9737	-10.227	0.2232	3.7003	-1.1542	0.9999
Bleeding (L)	1.8295	-14.933	42.465	-47.127	25.107	-4.5804	0	0.9999
Bleeding (M)	2.7872	5.3875	4.6612	0.3091	-0.6957	0.5096	0	0.9999
Bleeding (H)	5.2119	6.414	7.4293	4.0615	-0.4107	0	0	0.9999
Block cracking (L)	-0.1016	2.3786	8.6496	-3.7548	1.164	0	0	0.9998
Block cracking (M)	2.315	8.9552	5.602	-3.4737	3.32	-0.7577	0	0.9999
Block cracking (H)	6.0091	11.269	10.017	3.4588	-1.5089	0	0	0.9999
Edge cracking (L)	3.1444	2.0074	1.1778	6.222	2.0139	-3.3278	0	0.9995
Edge cracking (M)	8.2677	8.533	6.5905	1.8119	-0.9679	-1.349	0	0.9998
Edge cracking (H)	13.367	13.955	12.973	6.5226	-2.3835	-4.1062	0	0.9996
L&T cracking (L)	1.7349	6.0577	8.563	7.0654	-11.37	4.3642	0	0.9998
L&T cracking (M)	8.4355	14.045	5.2439	3.3775	2.1445	-2.4006	0	0.9999
L&T cracking (H)	17.67	22.303	15.702	11.802	-0.432	-4.7342	0	0.9999
Patching (L)	2.1419	5.324	6.6383	5.2832	-4.5093	1.0189	0	0.9997
Patching (M)	9.5535	12.007	6.5043	2.8351	0.9623	-0.8932	0	0.9999
Patching (H)	19.016	16.806	3.9878	11.342	5.4961	-5.7158	0	0.9992
Rutting (L)	8.0082	14.038	5.0636	-0.0406	1.4484	-0.9035	0	0.9996
Rutting (M)	17.663	19.717	7.8427	0.5225	-1.5932	0	0	0.9998
Rutting (H)	26.761	23.525	9.4589	3.7395	-3.2432	0	0	0.9999
Potholes (L)	21.4	26.626	5.858	0	0	0	0	0.9985
Potholes (M)	33.3	40.96	9.611 1	0	0	0	0	0.9969
Potholes (H)	51	49.395	10.116	0	0	0	0	0.9998
Raveling (L)	1.7828	0.5165	-0.6228	3.191	0.9732	-1.2907	0.2628	0.9993
Raveling (M)	8.4392	3.406	1.3728	5.739	0.667	-2.1711	0.5652	0.9998
Raveling (H)	15.741	9.3802	7.0157	15.47	-0.3931	-7.6863	2.2487	0.9994
Shoving (L)	3.8756	10.363	2.7931	5.7746	-2.6249	0	0	0.9995
Shoving (M)	9.4749	13.999	7.2303	4.1283	2.415	-2.1604	0	0.9997

Distress (severity)	A_0	A_1	A_2	A_3	A_4	A_5	A_6	R^2
Shoving (H)	18.608	16.77	12.338	8.1407	-1.3562	-2.3024	0	0.9993

7.0 DISCUSSION

In this study, pavement condiction has been measured using NSV and check the pavement condition visually for 10 km of a heavy-traffic highway road corridor .

Pavement Distresses are measured using NSV @ 10 m interval and PCI rating has been determined using the methodology mentioned in ASTM D4433 and same has also been verified at site manually. It has been found that the pavement condition of the project road section is varied from 'very good to fair condition', with PCI varying from 48 to 99 with exception at km 33 to km 34Fair section-.

Based on the PCI rating, the suggested maintenance for the pavement section is finalized using maintenance policy mentioned in Table 1. The information mentioned in Table 3 is used as a guidance to select the appropriate maintenance requirement. A computer Program is developed for analysis of PCI and presented in Annexure 1.

Table 3 Pavement Maintenance

From Km	To Km	PCI	Pavement Condition	Pavement Condition as Per IRC:82	Maintenance Treatment
24	25	84	Satisfactory	Fair	Routine
25	26	98	Good	Good	Routine
26	27	96	Good	Good	Routine
27	28	99	Good	Good	Routine
28	29	99	Good	Good	Routine
29	30	60	Fair	Fair	Minor Rehabilitation
30	31	65	Fair	Fair	Minor Rehabilitation
31	32	96	Good	Good	Routine
32	33	96	Good	Good	Routine
33	34	48	Poor	Poor	Minor Rehabilitation

Annexure 1

```
#include<iostream.h>
 #include<math.h>
#include<fstream.h>
#include<conio.h>
int main()
{clrscr();
fstream fout;
fout.open("mat.dat",ios::out|ios::in);
float
fatlow,fatmedium,fathigh,bleedlow,bleedmedium,bleedhigh,bl
ocklow,blockmedium,blockhigh,edgelow,edgemedium,edgehig
h,ltlow,ltmedium,lthigh;
float
patchlow,patchmedium,patchhigh,rutlow,rutmedium,ruthigh,p
otlow,potmedium,pothigh,ravellow,ravelmedium,ravelhigh;
float
fatld,fatmd,fathd,bleedld,bleedmd,bleedhd,blockld,blockmd,bl
ockhd,edgeld,edgemd,edgehd,potholelow,potholemedium,pot
holehigh,potholeld,potholemd,potholehd,shovglow,shovgmedi
um,shovghigh,shovgld,shovgmd,shovghd;
float
tmedium,ltld,lthd,ltmd,patchld,patchmd,patchhd,rutld,rutmd,r
uthd,ravelld,ravelmd,ravelhd,pci,a1,a2;
cout<< "enter values of density of all condition
distresses:"<<endl;
cin>>fatlow>>fatmedium>>fathigh>>bleedlow>>bleedmedium
>>bleedhigh>>blocklow>>blockmedium>>blockhigh>>edgelow
>>edgemedium>>edgehigh>>ltlow>>ltmedium>>lthigh;
cin>>patchlow>>patchmedium>>patchhigh>>rutlow>>rutmedi
um>>ruthigh>>ravellow>>ravelmedium>>ravelhigh>>potholelo
w>>potholemedium>>potholehigh>>shovglow>>shovgmedium
>>shovghigh>>pci;
fout<<fatlow<<fatmedium<<fathigh<<bleedlow<<bleedmediu
m<<bleedhigh<<blocklow<<blockmedium<<blockhigh<<edgelo
w<<edgemedium<<edgehigh<<ltlow<<ltmedium<<lthigh;
fout<<patchlow<<patchmedium<<patchhigh<<rutlow<<rutmed
ium<<ruthigh<<ravellow<<ravelmedium<<ravelhigh<<potholel
ow<<potholemedium<<shovglow<<shovgmedium<<shovghigh
<<potholehigh;
{
 if(fatlow==0.0) {
 fatld=0.0;
    } else
 {
```

```
fatld=10.749+15.867*log10(fatlow)+7.6012*pow(log10(fatlow),
2)-1.4052*pow(log10(fatlow),3);

 fout<<"deduct value for low fatigue cracking is"<< fatld<<endl;
   }
 if(fathigh==0.0) {
 fathd=0.0;     }
 else {

fathd=30.188+31.353*log10(fathigh)+7.9737*pow(log10(fathig
h),2)-
10.227*pow(log10(fathigh),3)+0.2232*pow(log10(fathigh),4)+3
.7003*pow(log10(fathigh),5)-1.1542*pow(log10(fathigh),6);

 fout<<"deduct value for high fatigue cracking is"<<
fathd<<endl;  }
  if(fatmedium==0.0) {
 fatmd=0.0;     }
 else {

fatmd=21.39+21.483*log10(fatmedium)+5.0615*pow(log10(fat
medium),2)-
1.5665*pow(log10(fatmedium),3)+0.355*pow(log10(fatmediu
m),4);

 fout<<"deduct value for medium fatigue cracking is"<<
fatmd<<endl;  }

  if(bleedlow==0.0) {
 bleedld=0.0;      }
 else {
 bleedld=1.8295-
14.933*log10(bleedlow)*0.4342+42.465*pow(log10(bleedlow),
2)-
42.127*pow(log10(bleedlow),3)+25.107*pow(log10(bleedlow),
4)-4.5804*pow(log10(bleedlow),5);

 fout<<"deduct value for low bleeding is"<< bleedld<<endl;  }
 if(bleedhigh==0.0) {
 bleedhd=0.0;     }
 else {

bleedhd=5.2119+6.414*log10(bleedhigh)+7.4293*pow(log10(bl
eedhigh),2)+4.0615*pow(log10(bleedhigh),3)-
0.4107*pow(log10(bleedhigh),4);

 fout<<"deduct value for high bleedingis"<< bleedhd<<endl;  }
  if(bleedmedium==0.0) {
 bleedmd=0.0;     }
 else {

bleedmd=2.7872+5.3875*log10(bleedmedium)+4.6612*pow(lo
g10(bleedmedium),2)+0.3091*pow(log10(bleedmedium),3)-
0.6957*pow(log10(bleedmedium),4)+0.5096*pow(log10(bleed
medium),5);

 fout<<"deduct value for mediumbleeding is"<<
bleedmd<<endl;      }
  if(blocklow==0.0) {
 blockld=0.0;     }
 else {
 blockld=-
0.101+2.3786*log10(blocklow)+8.6496*pow(log10(blocklow),2)
-
3.7548*pow(log10(blocklow),3)+1.164*pow(log10(blocklow),4)
;

 fout<<"deduct value for low block cracking is"<< blockld<<endl;
}
 if(blockhigh==0.0) {
 blockhd=0.0;     }
 else {

blockhd=6.0091+11.29*log10(blockhigh)+10.017*pow(log10(bl
ockhigh),2)+3.4588*pow(log10(blockhigh),3)-
1.5089*pow(log10(blockhigh),4);

 fout<<"deduct value for high block crackingis"<<
blockhd<<endl;  }
  if(blockmedium==0.0) {
 blockmd=0.0;     }
 else {

blockmd=2.315+8.9552*log10(blockmedium)+5.602*pow(log1
0(blockmedium),2)-
3.4737*pow(log10(blockmedium),3)+3.32*pow(log10(blockme
dium),4)-.7577*pow(log10(blockmedium),5);

 fout<<"deduct value for medium block cracking
is"<<blockmd<<endl;  }

   if(edgelow==0.0) {
 edgeld=0.0;     }
 else {

edgeld=3.1444+2.0074*log10(edgelow)+1.1778*pow(log10(ed
gelow),2)+6.222*pow(log10(edgelow),3)+2.1039*pow(log10(ed
gelow),4)-3.3278*pow(log10(edgelow),5);

 fout<<"deduct value for low edge cracking is"<< edgeld<<endl;
}
 if(edgehigh==0.0) {
 edgehd=0.0;     }
 else {

edgehd=13.367+13.955*log10(edgehigh)+12.973*pow(log10(e
dgehigh),2)+6.5226*pow(log10(edgehigh),3)-
2.3835*pow(log10(edgehigh),4)-
4.1062*pow(log10(edgehigh),5);

 fout<<"deduct value for high edge crackingis"<<
edgehd<<endl;  }
  if(edgemedium==0.0) {
 edgemd=0.0;     }
 else {

edgemd=8.2677+8.535*log10(edgemedium)+6.5905*pow(log1
0(edgemedium),2)+1.8119*pow(log10(edgemedium),3)-
0.9679*pow(log10(edgemedium),4)-
1.349*pow(log10(edgemedium),5);

 fout<<"deduct value for mediumb edge cracking is"<<
edgemd<<endl;  }
```

```
    if(ltlow==0.0) {
 ltld=0.0;     }
 else {

ltld=1.7349+6.057*log10(ltlow)+8.563*pow(log10(ltlow),2)+7.0654*pow(log10(ltlow),3)-11.32*pow(log10(ltlow),4)+4.3642*pow(log10(ltlow),5);

  fout<<"deduct value for low ltcracking is"<< ltld<<endl;
    }
 if(lthigh==0.0) {
 lthd=0.0;     }
 else {

lthd=17.67+22.303*log10(lthigh)+15.702*pow(log10(lthigh),2)+11.802*pow(log10(lthigh),3)-0.432*pow(log10(lthigh),4)-4.732*pow(log10(lthigh),5);

  fout<<"deduct value for high lt crackingis"<< lthd<<endl;   }
   if(ltmedium==0.0) {
 ltmd=0.0;     }
 else {

ltmd=8.4355+14.045*log10(ltmedium)+5.2439*pow(log10(ltmedium),2)+3.3773*pow(log10(ltmedium),3)+2.1445*pow(log10(ltmedium),4)-2.4006*pow(log10(ltmedium),5);

  fout<<"deduct value for mediumb lt cracking is"<< ltmd<<endl;}
    if(patchlow==0.0) {
 patchld=0.0;     }
 else {

patchld=2.1419+5.324*log10(patchlow)+6.6383*pow(log10(patchlow),2)+5.2832*log10(pow(patchlow,3))-4.5093*pow(log10(patchlow),4)+1.089*pow(log10(patchlow),5);

  fout<<"deduct value for low patching is"<<patchld<<endl;   }
 if(patchhigh==0.0) {
 patchhd=0.0;     }
 else {

patchhd=19.016+16.806*log10(patchhigh)+3.9878*pow(log10(patchhigh),2)
+11.342*pow(log10(patchhigh),3)+5.496*pow(log10(patchhigh),4)-5.7158*pow(log10(patchhigh),5);

  fout<<"deduct value for high patchingis"<< patchhd<<endl;   }
   if(patchmedium==0.0) {
 patchmd=0.0;}
 else {

patchmd=9.5535+12.007*log10(patchmedium)+6.5043*pow(log10(patchmedium),2)+2.8351*pow(log10(patchmedium),3)+0.9623*pow(log10(patchmedium),4)-0.8932*pow(log10(patchmedium),5);

  fout<<"deduct value for mediumb patching is"<< patchmd<<endl; }

 if(rutlow==0.0) {
 rutld=0.0;     }
 else {
 rutld=8+14.038*log10(rutlow)+5.036*pow(log10(rutlow),2)-0.0406*pow(log10(rutlow),3)+1.4484*pow(log10(rutlow),4)-0.9035*pow(log10(rutlow),5);
  fout<<"deduct value for low rut is"<<rutld<<endl; }

   }
 if(ruthigh==0.0) {
 ruthd=0.0;     }
 else {

ruthd=26.761+23.525*log10(ruthigh)+9.4589*pow(log10(ruthigh),2)+3.7395*pow(log10(ruthigh),3)-3.2432*pow(log10(ruthigh),4);

  fout<<"deduct value for high rut is"<< ruthd<<endl;   }
   if(rutmedium==0.0) {
 rutmd=0.0;
    }
 else {

rutmd=17.663+19.717*log10(rutmedium)+7.8427*pow(log10(rutmedium),2)+0.5225*pow(log10(rutmedium),3)-1.5932*pow(log10(rutmedium),4);

  fout<<"deduct value for mediumb rut is"<< rutmd<<endl; }

  if(potholelow==0.0) {
 potholeld=0.0;     }
 else {

potholeld=21.4+26.626*log10(potholelow)+5.858*pow(log10(potholelow),2);

  fout<<"deduct value for low pothole is"<<potholeld<<endl;   }
 if(potholehigh==0.0) {
 potholehd=0.0;     }
 else {

potholehd=51+49.395*log10(potholehigh)+10.116*pow(log10(potholehigh),2);

  fout<<"deduct value for high pothole is"<< potholehd<<endl;   }
   if(potholemedium==0){
 potholemd=0;     }
 else {

potholemd=33.3+40.96*log10(potholemedium)+9.611*pow(log10(potholemedium),2);
 fout<<"deduct value for mediumb pot is"<< potholemd<<endl;
}

if(ravellow==0.0) {
 ravelld=0.0;     }
 else {
 ravelld=1.7828+0.5165*log10(ravellow)-0.6228*pow(log10(ravellow),2)+3.191*pow(log10(ravellow),3)
+0.9732*pow(log10(ravellow),4)-1.2907*pow(log10(ravellow),5)+0.2628*pow(log10(ravellow),6);
```

```
 fout<<"deduct value for low ravel is"<<ravelld<<endl;   }
 if(ravelhigh==0.0) {
 ravelhd=0.0;    }
 else {

ravelhd=15.741+9.3802*log10(ravelhigh)+7.016*pow(log10(ravelhigh),2)+15.47*pow(log10(ravelhigh),3)-0.3931*pow(log10(ravelhigh),4)-7.6863*pow(log10(ravelhigh),5)+2.2487*pow(log10(ravelhigh),6);

  fout<<"deduct value for high ravel is"<< ravelhd<<endl;   }
  if(ravelmedium==0){
 ravelmd=0;    }
 else {

ravelmd=8.4393+3.406*log10(ravelmedium)+1.3728*pow(log10(ravelmedium),2)+5.739*pow(log10(ravelmedium),3)+0.667*pow(log10(ravelmedium),4)-2.17*pow(log10(ravelmedium),5)+.5652*pow(log10(ravelmedium),6);
 fout<<"deduct value for mediumb ravel is"<< ravelmd<<endl;


 }
if(shovglow==0.0) {
 shovgld=0.0;    }
 else {

shovgld=3.8756+10.363*log10(shovglow)+2.7931*pow(log10(shovglow),2)+5.775*pow(log10(shovglow),3)-2.6249*pow(log10(shovglow),4);

  fout<<"deduct value for low shovging"<<shovgld<<endl;   }
 if(shovghigh==0.0) {
 shovghd=0.0;    }
 else {

shovghd=18.608+16.77*log10(shovghigh)+12.338*pow(log10(shovghigh),2)+8.140*pow(log10(shovghigh),3)-1.36*pow(log10(shovghigh),4)-2.3024*pow(log10(shovghigh),5);

  fout<<"deduct value for high ravel is"<< shovghd<<endl;   }
  if(shovgmedium==0){
 shovgmd=0;    }
 else {
shovgmd=9.4749+13.99*log10(shovgmedium)+7.2303*pow(log10(shovgmedium),2)+4.128*pow(log10(shovgmedium),3)+2.415*pow(log10(shovgmedium),4)-2.16*pow(log10(shovgmedium),5);
fout<<"deduct value for medium shoving"<<shovgmd<<endl;  }

if(pci>85&&pci<=100){
fout<<"pavement condition is very good and needs routine maintenance"<<endl;}
 else
  if(pci>70&&pci<=85) {

 fout<<"pavement condition is satisfactory and needs preventtive maintenance"<<endl;}
 else
  if(pci>55&&pci<=70){

 fout<<"pavement condition is fair and needs pminor rehabilation"<<endl;}
 else
  if(pci>40&&pci<=55)  {

 fout<<"pavement condition is poor and needs monor rehabilatione"<<endl;}
  else
   if(pci>20&&pci<=40){

 fout<<"pavement condition is very poor and needs major rehabilation"<<endl;}
 else
  if(pci>10&&pci<=20) {

 fout<<"pavement condition is serious and needs reconstructione"<<endl;}
  else
    {

 fout<<"pavement is failed and needs reconstruction"<<endl;}
    fout.close();


  getch();

   return 0;
}
```

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