DEVELOPMENT OF PAVEMENT CONDITION INDEX MODEL FOR FLEXIBLE PAVEMENT IN BAGHDAD CITY

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ABSTRACT

The pavement is one of the basic components of road infrastructure and, therefore, directly influences general levels of transport safety, as well as the quality of transportation services in human and cargo traffic.

Accordingly, the objective of the present study is to develop the prediction model for pavement condition index (PCI) for flexible pavement.

To achieve this objective, (80) selected pavement sections in four sites in the study area and (1100) sample of pavement sections were selected from these sections for the purpose of (PCI) model building. These data include ; longitudinal , transverse, alligator , slippage and block cracking , rutting ,depression , bleeding , polishing , patching and pothole .

The effort to develop a (PCI) model is carried out by using a stepwise regression technique. These statistical processes are carried out with the aid of (STATISTICA – version 5.5) computer package.

The validation process for the developed models shows that, this model is adequate to be used for the prediction of pavement condition for flexible pavements within the range of data.

الخلاصة

التبليط هو أحد المكونات الاساسية لبناء التحتي للطرق ولذا , يؤثرُ على المستويات العامة مباشرة من أمان النقل و بالاضافة الى نوعية خدمات النقل للانسان و شحن المرور.

بناءا على ذلك فأن أهداف الدراسة الحالية هي تطوير النماذج الخاصة بالتنبؤ على دليل حالة التبليط (PCI) المرن .

ولغرض تحقيق هذه الاهداف أُختيرت مقاطع التبليط في أربعة مواقع ضمن منطقة الدراسة , لجمع البيانات المطلوبة لبناء النموذج الخاص بال(PCI) و تم فيه اختيار) عينة من تلك المقاطع لغرض بناء نموذج. أن هذه البيانات تتضمن: التشقق (Cracking) والمتمثلة ب: الطولي (Longitudinal), العرضي (Transverse) , الكلل او التمساحية (Alligator or) Fatigue , الشبكية (Block) والهلالية (Slippage) , التخدد (Rutting) , التخسف (Depression) , النـــــزف (Bleeding) , التلميع(Polishing), الترقيع(Patching) والفجوات(Pothole)

لتطوير نموذج (PCI) فقد تم أستخدام تقنية الانحدار التدريجي (Stepwise Regression) . لقد تم القيام بهذه العمليات الاحصائية بمساعدةبرنامج الحاسوب (STATISTIC V. 5.5).

ان عملية التحقق (Validation) للنماذج المطورة تظهر بأن هذه النماذج ملائمة للاستخدام في التنبؤ عن حالة التبليط المرن ضمن حدود البيانات .

KEY WORDS

Pavement Condition Index, Flexible pavement, ; Longitudinal ,Transverse, Alligator , Slippage and Block cracking , Rutting ,Depression ,Bleeding , Polishing , Patching and Pothole , prediction of pavement condition.

INTROUDECTION

Pavement condition index PCI is one of the most widely used performance measures for pavements, it uses as an indicator of the pavement condition [Susan et. al 2004].

[U.S Army Corps of Engineers 2003] defines the PCI as the default condition index for the PAVER system. A numerical index, ranging from 0 for a failed pavement to 100 for a pavement in perfect condition. Calculation of the PCI is based on the results of a visual condition survey in which distress type, severity, and quantity are identified. It was developed to provide an Index of the pavement structural integrity and surface operation condition.

[Shahin M.Y. (1982)] mentions that, the distress characterization should include three parameters: distress type, severity, and quantity. The lack of any of these parameters will produce an unrepeatable and inconsistent distress characterization.

These points can then be summed and subtracted from some upper limit to give an overall rating of a pavement's structural condition. The equations that describe how to convert from severity and extent of a certain distress type to an index number, or score vary from state to state and can be rather complex [Deighton (1998)] .

STUDY AREA DESCRIPTION

The study area is located on the west of Baghdad in Al-Kharkh side, between latitudes (33 ˚ 22' 7.03"', 33˚ 17' 25.27"), and Longitudes (44˚ 17' 55.36 ", 44˚ 19' 59.25 ") respectively.

This area includes: Al- Huriya, Al-Adel, Al- Kadra'a, and Al-Hamra'a districts. **Figure (1)** shows the location of the selected study area. It is important to mention that all the selected roads in the study area are flexible pavements.

The following items are considered in the selection of the study area:-

1. The selected sites are close to each other to minimize the travel time between sites.
2. The sites are selected are near the residential area in order to minimize the expected effect of congestion or any other effect on this process.
3. Same lengths of sections are selected. This will lead the raters to ride over these sections at desired speed and approximately the same travel time has been used.

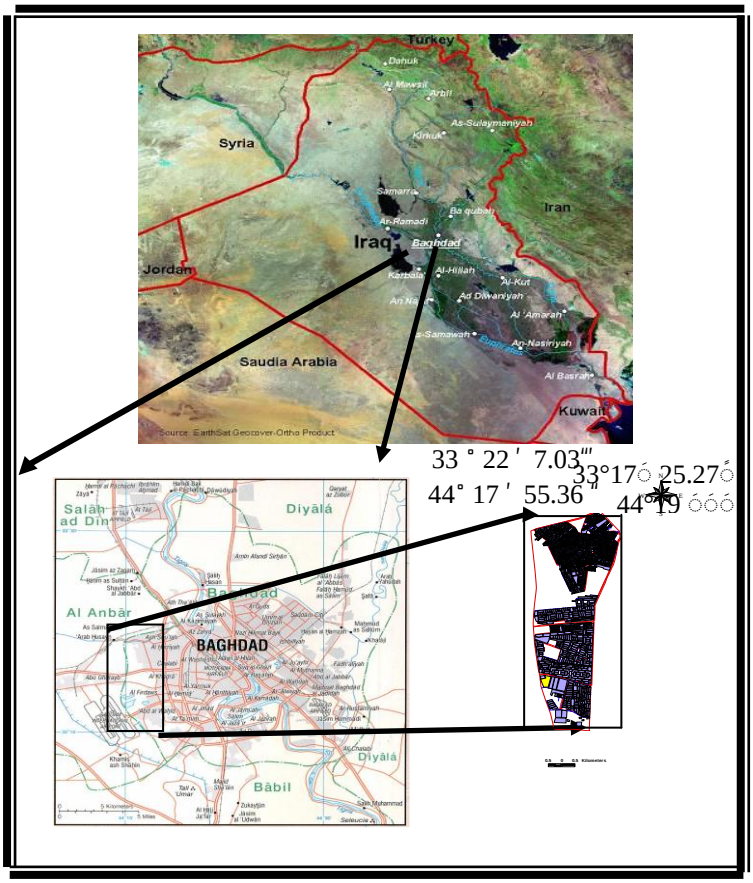

Fig (1) Location of Study Area

DATA COLLECTION PROCESS

The mentioned pavement sections were used to collect the required distresses data for the purpose of model building for the prediction of PCI. The monitoring distresses; types, severity and amount were listed and recorded. The following flexible Pavement distresses were observed in the study area , these distresses includes : Rutting ,alligator, block ,longitude, transverse , slippage cracks, bleeding ,depression ,patching and polishing .

FIELD MEASURMENTS

The field measurement in the present study consists the following flexible pavement distresses:

Alligator Crack

To measure this type of distress, the distress severity it must be determined. This distress is different in level of severity, such as; low, moderate and high. This type of distress is measured manually by use of tape, in area unit (ft²). **Figure (2)** presents the alligator crack in the study area.

Fig (2) Alligator crack at AL- Huirya City

Bleeding

This type of distress is measured manually by use of cloth tape, in area unit (ft^2), it's observed in most of the selected pavement sections.

This distress is different in level of severity. When the severity is "low", the pavement surface creates a shiny; the pavement surface is glass-like and reflecting surface for the" moderate ", and quite sticky for the "high severity ". This type of distress can be obvious in the study area as shown in **Figure (3).**

Fig (3) Bleeding at Al-Hamra'a City

Depression

Depressions are localized in the pavement surface that has elevations slightly lower than those of the surrounding pavement. [ASTM , 2003] starts that the severity level (maximum depth of depression) depends on the range of this depth," low severity" when the range is " 0.5 to 1 inch ", "moderate " when the range is " 1 to 2 inch " and "high severity " when more than " 2 inch ". This failure is measured manually by use of tape and straight edge to determine the severity level and is measured in (ft^2) of surface area. **Figure (4)** shows this type of failure in the study area.

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Fig (4) High Severity Depression at AL- Adel City

Block Cracking

This distress is measured manually by using tape in "ft^2". Block cracks are interconnected cracks that divide the pavement into approximately rectangular pieces. They differ in level of severity, low, moderate and high. **Figure (5)** presents this type of distress in the selected study area.

Fig (5) Block Crack at Al- Huriya City

Longitudinal and Transverse Cracking

These types of distresses are obvious clearly in different severity. Longitudinal cracks are present in parallel to the pavement centerline, and located within the lane (wheel path). This type of crack appears in different severity levels, such as, low, moderate and high level. **Figure (6a)** illustrates this type of failure as appears in the study area.

While the transverse cracks extend perpendicular to the centerline, as shown in **Figure (6b),** transverse crack severity depends on crack width which is caused by shrinkage of asphalt surface due to low temperature or asphalt hardening or result form reflective cracks caused beneath the asphalt surface.

Many types of these cracks are observed in the selected sections, but in different levels of severity. These distresses are measured manually by use of cloth tape in liner "ft".

a - Longitude

b – Transverse

Fig (6) Longitudinal and Transverse Cracks at Al-Hamra'a

Patch/Patch Deterioration

A patch is an area of pavement that has been replaced with new material to repair the existing pavement. These distresses differ in level of severity, Patch is a good condition and satisfactory, or ride quality is rated as low severity or better [ASTM 2003].

Patch is moderately deteriorated, or ride quality is rated as medium severity, or both. Patch is badly deteriorated, or ride quality is rated as high severity, or both; this type needs replacement soon. It is measured manually by tape in "ft^2". **Figure (7)** presents this type of distress as shown in the study area.

Fig (7) Patching at AL-Adel City

Polish Aggregate

This type of failure can be seen in most of the roads in the study area. The polish aggregate is measured manually by use of tape in area unit (ft^2). This distress is caused by repeated traffic applications. This type of distress is indicated when the number on a skid resistance test is low or has dropped significantly from a previous rating [Mike and John, 2002]. **Figure (8)** shows this type of distress as a given in the study area.

Fig (8) Polishing at Al-Hamra'a City

Potholes

Potholes are small usually less than (30 inch) in diameter-bowl-shaped depressions in the pavement surface. These distresses differ in level of severity, and the units measured by number. Potholes are measured by counting different types severity; low, when the depth from 13 to ≤ 25 mm and average diameter100-450mm , medium from 25 to ≤ 50mm, and average diameter200-450mm high is > 50 mm and average diameter450-750mm recording them separately, this type of distress as given by [Mike and John2002**. Figure (9)** shows this type of distress as seen in the study area.

Fig (9) Pavement Potholes at AL-Huriya city

Rutting

A rut is a surface depression in the wheel paths. These distresses differ in level of severity (Mean Rut Depth), low severity is range (¼ to ½in.), moderate severity is range (>½to 1 in.) and high severity is range (>1 in) [AASHTO 1986]. Rutting is measured manually in (inch) depth, and its severity is determined by the mean depth of the rut. The mean rut depth is calculated by laying a straightedge across the rut, measuring its depth, then using mean depth in inch**. Figure (10)** presents this type of distress as it appears in the study area.

Fig (10) Rutting at AL- AL-Huriya City

Slippage Cracking

Slippage cracks are crescent or half-moon shaped cracks, usually transverse to the direction of travel. The severity level of this distress is low when the average crack width is ($< 3/8$ in.), moderate, the average crack width is ($\geq 3/8$ and $<$ 1- ½ in) or the area around the crack is moderately spalled, or surrounded with secondary cracks, high severity if the width crack is (1- ½ in) and area around the crack is broken into easily removed pieces. The area associated with a given slippage crack is measured manually by use of tape in (ft^2), **Figure (11)** shows this distress as it appears in the study area.

Fig (11) Slippage Crack at AL-Huriya City

REQUIRED DATA FOR PCI AND PCR DETERMINATION

Data Collection

The Data obtained from this procedures is the primary basis for determining requirements of the evaluation process. Pavement condition is related to several factors, including structural integrity, structural capacity, roughness skid resistance, and rate of deterioration.

These factors can be assessed by observing and measuring distresses in the pavement. The PCR is based on the PCI, which is a numerical indicator based on a scale of 0 to 100. Its scale and associated ratings are shown in **Figure (12).** The following is a description of the procedure used to assess the condition of the pavement;

PAVER system was used in this study as recommended by many U.S agencies [ASTM 2003 , ALswilimi Saleh , 1995,TECHNICAL MANUAL 1995,] The first step in this method procedure involves the identification of a representative area, before a pavement network is inspected, it must be divided into branches, sections, and sample units. A sample unit for asphalt area is approximate (2500 ft^2) for roads and parking. This area is selected because the networks of roads range from very poor to very good. The number of sample units to be inspected (n) is determined **in Figure (13)** , as a function of the total number of units in the section (N) and the standard deviation of the PCI (α). For the entire section inspections the inspector walks over each section in each sample unit and records the distresses as shown in **Figure (14)** .

The PCI method uses weighted (deduct) values as a function of distress types ,severities and densities of visible distress .This selected procedure is presented by the U.S. Army Corps of engineering " PCI field Manual ". Each of the various types of pavement distresses was identified and measuring "units are liner feet, , square feet and number ". In addition, for each distress, a level of severity was determined into [low (L), Medium (M), High (H)]. In this study there are various kinds of distresses at different density and severity . For the purpose of pavement evaluation, the pavement condition index (Rating Scale) can be used easily as presented in **Figure (12).**

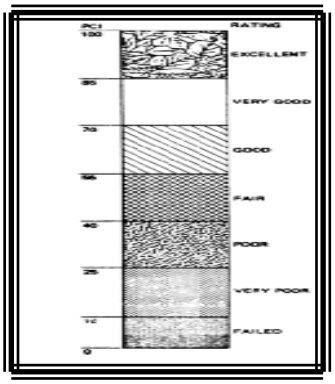


Fig (12) Pavement Condition Index and Rating Scale

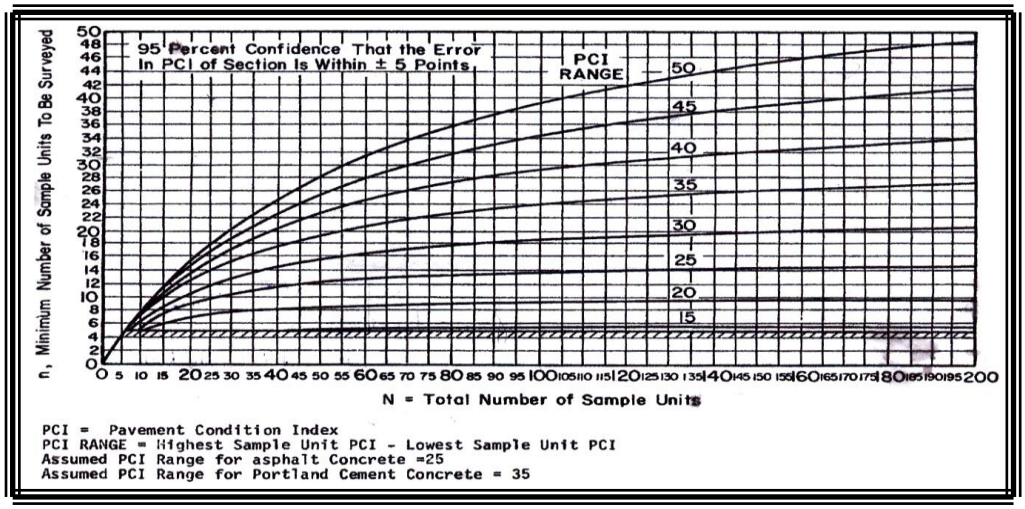


Fig (13) determination of Minimum Number of Sample Units to be Surveyed

Assessment Calculation of PCI

Using the data obtained in the assessment procedure as shown in **Figure (14**), we performed the following calculations to determine the pavement condition index "PCI". All required information about the following calculations are recorded as given in **Table (A1) as per Appendix(A).**

For each of the different types of distresses, for example a distress density is calculated in **Table (A2) as per Appendix (A)** . The formulas from "1 through 3" are used to calculate the distresses density[TECHNICAL MANUAL HEADQUARTERS ,1982]:

$$Density = \frac{Distresses\ amount\ in\ square\ feet}{Sample\ unit\ area\ in\ square\ feet} * 100 \qquad (1)$$

$$Density = \frac{Distresses\ amount\ in\ linear\ feet}{Sample\ unit\ area\ in\ square\ feet} * 100 \qquad (2)$$

$$Density = \frac{Number\ Of\ pothole}{Sample\ unit\ area\ in\ square\ feet} * 100 \qquad (3)$$

The next step is severity estimation, (i.e. L, M, or H) a deduct value for each distress type is determined. The deduct values are determined through the use of the "deduct value curves". These curves are present in **Figures (15 to 23)**, and represent a part of the [U.S. Army Corps of Engineers Technical Manual 1983], then the deduct values for all distresses are summed to produce "deduct total". To calculate the value of the "correct deduct value", the number of deducts greater than (5) is taken as point "q" , from shown in **Figure (24),** it is used to determine a "correction deduct value" (CDV).These Calculations are recorded in **Table (A3)as per Appendix(A)** .

Finally the pavement condition index (PCI) is calculated using the following equ.(4) [TECHNICAL MANUAL HEADQUARTERS ,1982]:

Where **PCI = 100 –CDV** **(4)**

PCI = Pavement Condition Index ,and;
CDV = Correct Deduct Value.

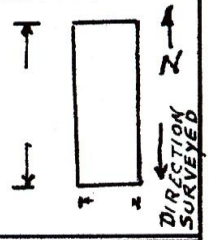
ASPHALT PAVEMENT INSPECTION SHEET
For use of this form, see TM 5-623; the proponent agency is USACE.

BRANCH _____ SECTION _____
DATE _____ SAMPLE UNIT _____
SURVEYED BY _____ AREA OF SAMPLE _____

Distress Types

1. Alligator Cracking
2. Bleeding
3. Block Cracking
*4. Bumps and Sags
5. Corrugation
6. Depression
*7. Edge Cracking
*8. Jt Reflection Cracking
*9. Lane/Shldr Drop Off
*10. Long & Trans Cracking
11. Patching & Util Cut Patching
12. Polished Aggregate
*13. Potholes
14. Railroad Crossing
15. Rutting
16. Shoving
17. Slippage Cracking
18. Swell
19. Weathering and Raveling

SKETCH:



EXISTING DISTRESS TYPE-QUANTITY & SEVERITY

TYPE →						
QUANTITY & SEVERITY						
TOTAL SEVERITY L						
TOTAL SEVERITY M						
TOTAL SEVERITY H						

PCI CALCULATION

DISTRESS TYPE	DENSITY	SEVERITY	DEDUCT VALUE
q=	TOTAL DEDUCT VALUE		
CORRECTED DEDUCT VALUE (CDV)			

PCI = 100 – CDV = _____

RATING = _____

* All Distresses Are Measured In Square Feet Except Distresses 4,7,8,9 and 10 Which Are Measured In Linear Ft; Distress 13 Is Measured In Number of Potholes.

Fig (14) An Sample of a Recorded and Computed of Procedure Data, Asphalt Pavement Inspection Sheet

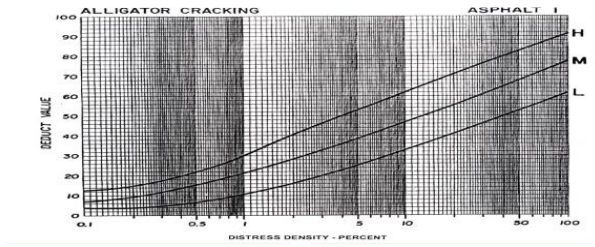


Fig (15) Deduct Value for Alligator Crack

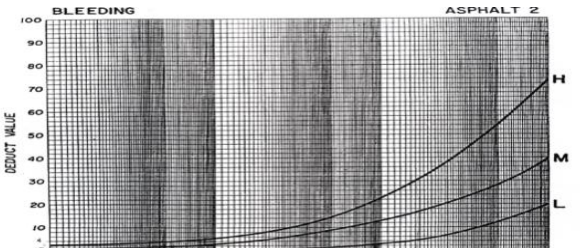


Fig (16) Deduct Value for Bleeding

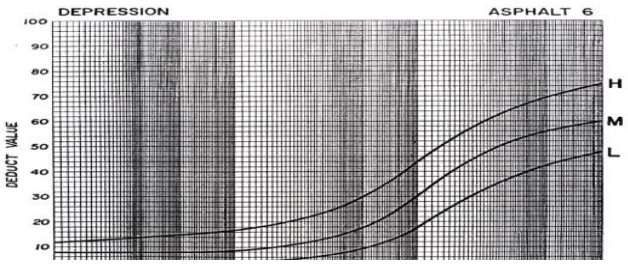


Fig (17) Deduct Value for Depression

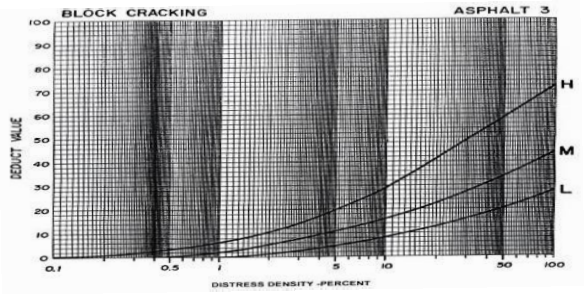


Fig (18) Deduct Value for Block Crack

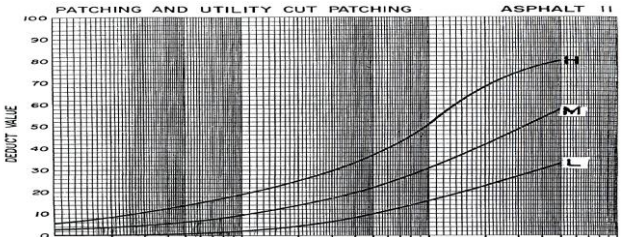


Fig (19) Deduct Value for Patching

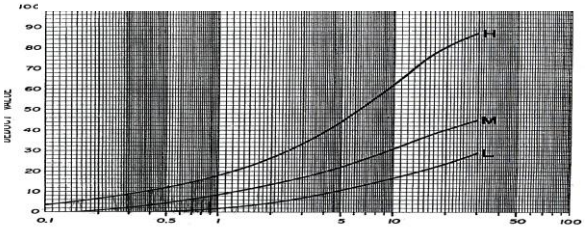


Fig (20) Deduct Value for Long & Tran. Cracking

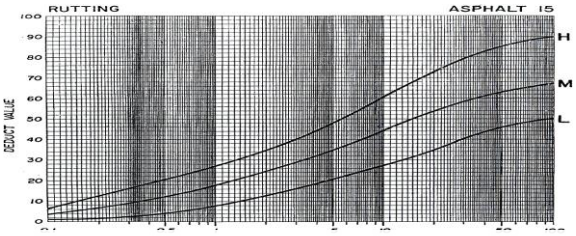


Fig (A-21) Deduct Value for Rutting

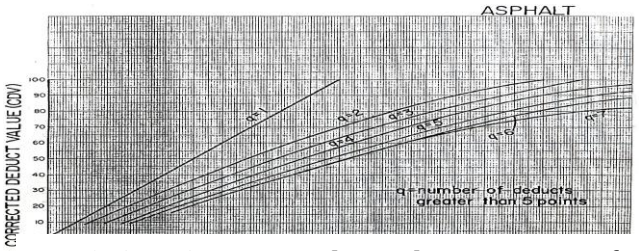


Fig (A-22)Correct Deduct Value Curves for Asphalt – Surfaced Pavements

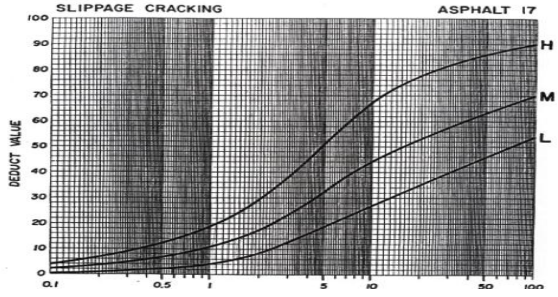


Fig (23) Deduct Value for Slippage Cracking

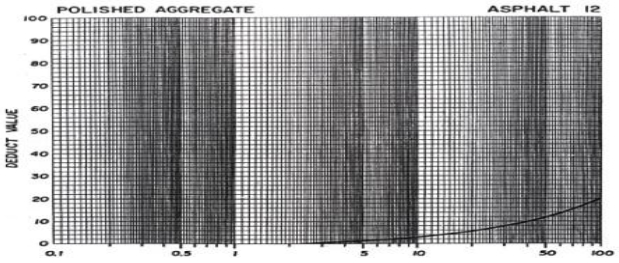


Fig (24) Deduct Value for Polish Aggregate

DEVELOPMENT OF MODEL FOR THE PREDECTION OF PAVEMENT CONDITION INDEX

The statistical techniques used for the models development required for evaluation of the pavement condition indices of the selected roads in the study area.. For the purpose of model development of of the pavement condition, these data include: alligator crack, Bleeding ,depression ,block crack, (longitude and transverse) cracks , patching , pothole , polish , rutting and slippage crack .

OUTLIERS

If one or more of observations is different significantly from all others, it is called "outlier ".The cause of a faulty observation may be a mistake .Outliers and influential observations are checked by using Chauvinist's criterion Kennedy and Neville[1975].The results of this test can be found in**Table (5) .**

Table (5): Results of Chauvenet' Test for Outliers of PCI Database

Variable	Mean	Mini m	Maxim	Standard Deviation (s)	$\lvert xm - \bar{x} \rvert$/s X m = min	$\lvert xm - \bar{x} \rvert$/s X m=maxi
PCI	62.746212	8	94	20.796314	2.6324959	1.5028523
Alligator	20.5383	0.00	98.300	26.34316	0.779643324	2.951869932
Bleed	42.8764	2.7	104.8	20.63454	1.9520009	2.9960135
Depression	21.857875	1.3	53.2	10.73053	1.915830812	2.920836156
Block Crac.	238.9614	0.00	1240.00	364.0559	0.65638656	2.749683771
Lon &Tran	31.6042	0.00	105.3	26.99353	1.1708081	2.7496838
Patch	55.662276	0.00	158.2	45.15347	1.2327354	2.27301267
Polish	454.3457	51.5	1098.5	210.1489	1.9169536	3.065228
Pothole	1.8295455	0.00	6.00	1.649207	1.109325734	2.5287633
Rut	0.038346	0.010	0.158	0.039888	0.7106398	2.9997493
Slippage	38.294712	0.00	132.00	35.48959	1.0790408	2.6403602

Sample Size :264 : $\bar{X}$m = value of outlier . x= sample mean . s = standard deviation .

($\left| xm - \bar{x} \right|$/s)$_{tabulated}$ = 3.08 > all calculated values . Thus the outliers are not rejected

MULTICOLLINEARITY

It is a condition that exists when the independent variables are correlated with another one. By using STATISTICA software the correlation coefficients between all of the variables were calculated and the correlation matrix was setup .This matrix can be seen in **Table (6)** ,the variables having the highest correlation coefficient with the designated dependent variable are selected and calculated, the regression equation is formulated.

Table (6): Correlation Matrix for PCI

STEPWISE REGRESSION PROCEDURE

The procedure begins by computing the simple regression model for each independent variable. STATISTICA software uses the F- statistics and it is usually set at F= 4.0 which is chosen because

Correlations (PCI model .sta- o131.sta)											
	ALIG	BLEED	DEPR	BLOCK	LON_ TRA	PATCH	polish	POTH OLE	RUT	SLIPP	PCI
ALIG	1	-0.054	-0.013	0.201	0.133	0.015	0.007	0.144	0.087	0.196	-0.18
BLEED	-0.054	1	0.0143	0.122	-0.026	-0.003	-0.03	-0.057	0.109	0.034	-0.02
DEPR	-0.013	0.014	1	0.128	-0.004	-0.055	0.03	0.1328	-0.029	0.135	-0.10
BLOCK	0.201	0.122	0.1276	1	0.1588	-0.016	0.061	0.3369	0.095	0.391	-0.39
LO_TRA	0.133	-0.03	-0.0041	0.159	1	0.0193	0.108	0.0425	-0.016	0.118	-0.09
PATCH	0.015	-0	-0.055	-0.016	0.0193	1	0.023	0.0733	0.079	0.015	-0.04
POLISH	0.008	-0.03	0.0298	0.061	0.1084	0.0227	1	0.0650	0.044	-0.002	-0.01
POTHOL	0.144	-0.06	0.1328	0.337	0.0425	0.0733	0.065	1	0.169	0.545	-0.61
RUT	0.087	0.109	-0.0293	0.095	-0.0160	0.0779	0.046	0.1619	1	0.229	-0.27
SLIPPAG	0.196	0.034	0.1351	0.391	0.1177	0.0153	-0.002	0.5449	0.229	1	-0.87
PCI	-0.184	-0.02	-0.1008	-0.38	-0.0864	-0.039	-0.01	-0.607	-0.274	-0.87	1

the significant level is about 5%. The standard is called the F- to – enter for independent variable .

DEVELOPED MODEL

The analysis through the stepwise regression technique is used for the purpose of PCI model development, the following PCI model form results in equ.(5);

$$PCI = 85.3360 - 0.4415*Slip - 2.3254*Poth - 37.2875*RD \quad (5)$$

where:

PCI = *Pavement Condition Index,*

Pot = *Pothole in (number),*

RD = *Rutting in(cm or mm), and;*

Slip = *Slippage Crack in(m^2).*

The regressions summary and stepwise regression, and several possible developed models can be seen in **Tables (7)and (8).**

Table (7): Regression Summary and Summary of Stepwise Regression for PCI Model.

Regression Summary for Dependent Variable: PCI
R=0 .88713146 R^2= 0.78700222 Adjusted R^2=0 .7845445
F(3,260)=320.22 p<0.0000 Std .Error of estimate: 9.6531

	BETA	St. Err. of BETA	B	St. Err. of B	t(260)	p-level
Intercept			85.33596	1.038846	82.14498	0
SLIPPAGE	-0.75337	0.034637	-0.44146	0.020297	-21.7501	0
POTHOLE	-0.18441	0.034169	-2.32537	0.430868	-5.39693	1.53E-07
RUT	-0.07152	0.029433	-37.2875	15.34546	-2.42987	0.015782

Summary of Stepwise Regression; DV: PCI

	Step +in/-out	Multiple (R)	Multiple R-square	R-square change	F - to entr /rem	p-level	Variable included
SLIPPAGE	1	0.87020	0.75726	0.757262	817.3521	0	1
POTHOLE	2	0.88440	0.78216	0.024904	29.83831	1.09E-07	2
RUT	3	0.88713	0.78700	0.004837	5.904277	0.015782	3

Models	R^2	SEE
PCI= 85.3360 - 0.4415 *Slip -2.3254 *Po - 37.2875 *RD	0.80	9.6531
PCI=84.31451- 0.44984*Slipp -2.37313 Po	0.78	9.7433

RESULTS OF THE ANALYSIS

The results of the technique that is used to development process of the pavement condition index model, shows that the slippage crack, pothole and rutting have largely affect the pavement condition index.

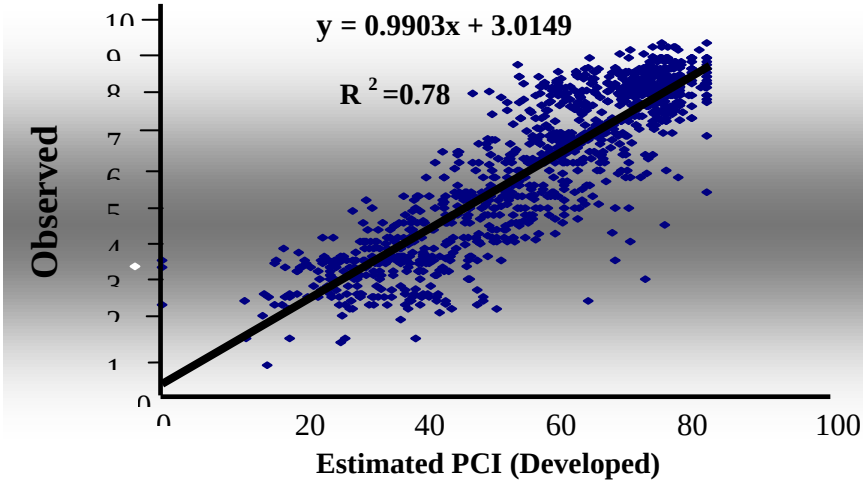


Fig (24) Observed PCI versus New Developed PCI- Model

Pavement condition index can however, be reduced by increasing the distresses in the road pavement. The results show that many variables have little correlation with the PCI and, therefore, little affect PCI, were dropped from the analysis.

It was found that the linear forms of the variables result the best correlation between the independent variables and PCI. The model found shown at previously as a PCI model (equa. 5).

DISCUSSION OF RESULTS

As a result of several different sets of regression models, three variables were found to be common to the general picture of each set to form the PCI model; these are pothole, rutting and slippage crack.

As stated previously the coefficient of determination for PCI model was found to be 0.80, and again that means; 80 percent of the PCI prediction can be explained by this model.

MODEL LIMITATION

As with all regression models, the model is only valid within the ranges of the variables they were developed from .Some additional limitations may be related to the study area. Specific specifications can be listed as follows;

1.A uniform pavement sections of a (1200 ft) each is used for the purpose of PCI model development.

2.Constant pavement areas of a (2500 ft^2) each are used for the purpose of PCI model development.

VALIDATION OF THE DEVELOPED MODEL

The final step in the model building process is validation of the developed models. The objective is to assess the ability of pavement condition index prediction model to accurately predict amount of PCI

in the field. A review of the statistical researches suggested the following methods for validation of a regression model [Ahmed, Namir G 2002].

- check on model predictions and coefficients
- collection new data
- comparison with previously developed Models
- data splitting
- prediction sum of squares

SELECTION OF VALIDATION METHODS

The literature suggests that all available methods of validation could be used. However, in this case, it is not possible to use all the methods of validation .Therefore, the applicability of each method in terms of the validation of the PCI model will be discussed and the most appropriate methods of validation will be selected.

- The fourth method (Data Splitting) recommends that one should not consider data splitting unless N>2P+25, where N is a sample size and P is number of estimated parameters. For the above mentioned discussion and because of the nature of the available data; the fourth method (Data splitting procedure) was selected to assess the predictive ability of the PCI model. It has been

Variable	Mean	St. division	t	t_c
X= observed	67.60567	19.90337	0.073651	1.645
Y= predicted PCI Model	67.73326			

recommended that one may not consider data splitting unless N> 2P+25.

VALIDATION RESULTS

The half of the observed data (those not used in the development process), is used in the validation process of the PCI_ model. The observed PCI values are plotted against those obtained by using of the developed model. This comparison is presented in **Figure (24).**

The relation between observed and estimated PCI can be found in the following form in equ.(6);

(PCI) Observed =0.9903* (Developed PCI) +3.0149 **(6)**

These findings seem to be in good agreement with the relation y= x. The results of checking the goodness of fit for the relation between observed and estimated PCI model by using Chi-square test and t- test, these testing can be seen in the following paragraphs .

Goodness of Fit

To checking the goodness of fit for the predicted models. t – test and Chi- square test were carried out and the following results are expressed;

***t*-test : n= 264, df = 525 confidence level = 95%**

There is no reason to reject the null hypothesis. Thus the difference is not significant.

Variable	x^2 – value	x^2_c – value

X= observed	197.1773	233.993
Y= predicted PCI Model		

X^2 – test : = 264, f = 263, confidence level = 95%

For $x^2 < x^2_c$. Thus is no significant difference between the observed and the predicted values

CONCLUSIONS AND RECOMENDATIONS

The main conclusions that can be drawn from this research are summarized as follows:

1- A stepwise regression technique is used in the development process of the following pavement condition index (PCI) Model in Baghdad city:

PCI = 85.3360-0.4415*Slip -2.3254*Poth -37.2875*RD

2-The developed (PCI) model is adequate to be used for the prediction of pavement condition index for local flexible pavements within the range of the data.

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NOMENELATURE

R^2 = Coefficient of Determination

SEE = Standard Estimation Error

X^2 = Critical chi-square

APPINDEX (A)

Table (A1) Data base Used For the Pavement Condition

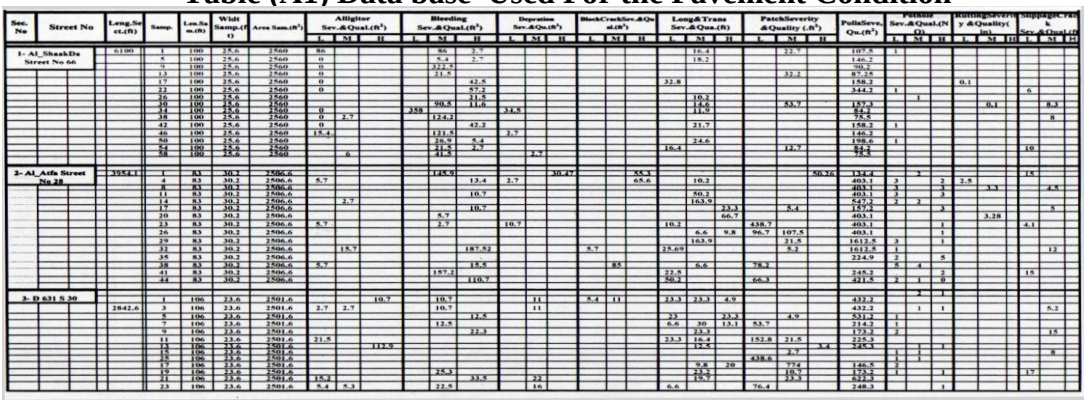

Table (A2) Computed of Density For Distresses in Sample Sections

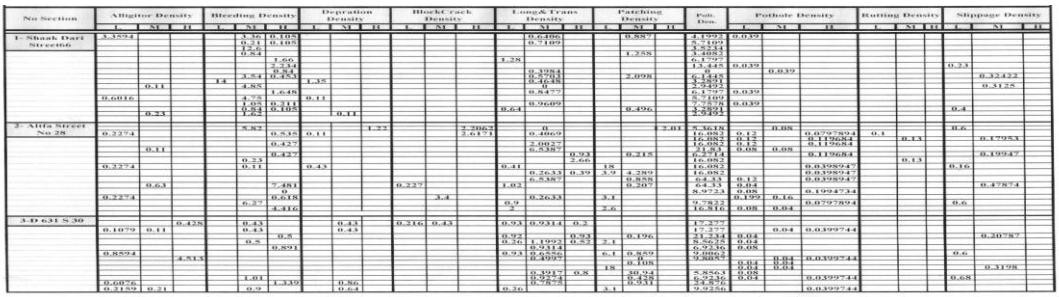

Table (A3) Computed of Pavement Condition Rating