

## **CHAPTER THREE**

### **DATA COLLECTION & PREPARATION**

**This chapter Contains:**

- 3.1 Linear Referencing Events.
- 3.2 Surveying of Linear Referencing Events Using GPS.
- 3.3 Event Table.
- 3.4 Entering Data to GIS.

## CHAPTER THREE

### DATA COLLECTION AND PREPARATION

#### 3.1 Linear Referencing Events

Table (3.1) shows the different types of linear events and their possible causes




TYPE OF DISTRESS	POSSIBLE CAUSE	MAINTENANCE SUGGESTIONS
Fatigue(Alligator) Cracking 	<ol style="list-style-type: none"> <li>1. Excessive loading</li> <li>2. Weak surface, base, or subgrade</li> <li>3. Thin surface or base</li> <li>4. Poor drainage</li> <li>5. Any combination of 1-4</li> </ol>	Full-depth patch
Block Cracking 	<ol style="list-style-type: none"> <li>1. Old and dried out mix</li> <li>2. Mix was placed too dry</li> <li>3. Fine aggregate mix with low penetration asphalt &amp; absorptive aggregates</li> <li>4. Aggravated by low traffic volume</li> </ol>	Any surface treatment or thin overlay
Edge Cracks 	<ol style="list-style-type: none"> <li>1. Lack of lateral support</li> <li>2. Settlement of underlying material</li> <li>3. Shrinkage of drying out soil</li> <li>4. Weak base or subgrade layer</li> <li>5. Poor drainage</li> <li>6. Frost heave</li> <li>7. Heavy traffic or vegetation along edge</li> </ol>	Improve drainage. Remove vegetation close to edge. Fill cracks with asphalt emulsion slurry or emulsified asphalt Crack seal/fill

Table (3.1): Line Events


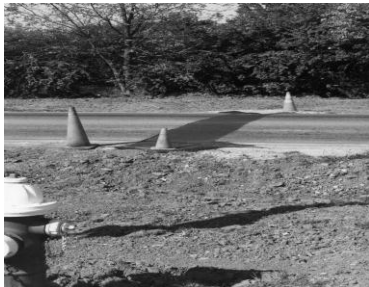

<p>Longitudinal(Linear)&amp; Transverse Cracking</p> 	<ol style="list-style-type: none"> <li>1. poorly constructed paving joint crack</li> <li>2. Shrinkage of the asphalt layer</li> <li>3. Daily temperature cycling</li> <li>4. Cracks in an underlying layer that reflect up through the pavement</li> <li>5. Longitudinal segregation caused by the improper operation of the paver</li> </ol>	<p>Improve drainage by removing the source that traps the water</p> <p>Seal crack or fill with asphalt emulsion slurry or light grade of asphalt mixed with fine sand.</p> <p>Provide side drainage ditches</p> <p>Crack seal/fill</p>
<p>Utility Cuts/Patch Failure</p> 	<ol style="list-style-type: none"> <li>1. A portion of a pavement has been removed and replaced</li> <li>2. A portion of a pavement where additional material has been added</li> <li>3. Poor installation techniques such as inadequate compaction, inferior or improper materials</li> </ol>	<p>Replace patch with deep or full-depth patch</p>
<p>Pot Hole</p> 	<ol style="list-style-type: none"> <li>1. Poor surface mixtures</li> <li>2. Weak spots in the base or subgrade</li> <li>3. Severity of the surrounding distress and traffic action accelerate potholes</li> </ol>	<p>Partial, full-depth or injection patching</p>

Table (3.1): Line Events continue

### 3.2 Surveying Of Linear Referencing Events Using GPS

Fieldwork and field survey were basic modules in every aspect of this study, especially to confirm the data collected during the site visits, identify and mapping the existing target street characteristics.

GIS was used as a tool and multi-layers were generated. Field measurements were carried out by means of Global Positioning System (GPS) to locate the coordinates of street events.

A survey meter is used to measure street events dimensions

Photo (1) shows the asphalt crack event



Photo (1): Crack Event

The survey event is entered to Event tables contain information about assets, conditions, and events that can be located along route features. Each row in the event table references an event and its location is expressed as measurements along named (identifiable) linear features.

There are two types of events: point events and line events. A point event describes a discrete location along a route (a point) whereas a line event describes a portion of a route (a line). A point event location uses only a single measure value to describe a discrete location while a line event uses both from- and to-measure values to describe a portion of a route.

Because there are two types of route event, there are two types of route event tables: point event tables and line event tables. All event tables must contain a route identifier and measure location field(s) containing measure information. A point event table uses a single measure field to describe their discrete location. A line event table requires two measure fields (a from- and to- measure) to describe their location.

Route locations and their associated attributes are stored in an event table based on a common theme. For example, four event tables containing information on speed limits, year of resurfacing, present condition and accidents could be included and used to dynamically locate events on a route feature class.

An event table can be any type of table that ArcGIS supports. This includes INFO, dBASE, geodatabase tables, delimited text files, and database management system (DBMS) tables accessed via an Object Linking and Embedding database (OLE DB) connection

With linear referencing, locations along linear features are referred to in terms of their route measure, or distance from a known point.

To determine a location along a linear feature, a system of measurement is required. When a measurement system is stored along with a linear feature, any location along that linear feature can be expressed in terms of the measure values.

In addition to making data more intuitive, storing data as a relative location along a linear feature has the added benefit of ensuring that spatial phenomena you know to fall on a linear feature is located on the feature. For example, in the absence of a very accurate base map, locating accidents using x,y coordinates may end up displaying accidents that do not fall on the road network as they should. This will not happen if the accidents are located using linear referencing.

The following photos illustrate some of the survived events



Photo (2): Asphalt Crack Event





Photo (3): Pavement Section Event



Photo (4): Hole Event in the Middle of Street

### 3.3 Event Table

Table (3.2) shows the surveyed line events

R_ID	Fmp	Tmp	ITEM	MATERIAL	CONDITION	STATUSE	LENGTH_M	WIDTH_M	NOTE
125	20	20	Crack	Asphalt	Poor	Need to fill	9.07	0	cross track
125	20.94	32.62	Trench	Asphalt	Poor	Need to repair	5.02	0.45	Null
125	32.66	39.32	Trench	Asphalt	Poor	Need to repair	6.87	1.53	Null
125	61.39	62.25	Trench	Asphalt	Poor	Need to repair	1.12	4.86	Null
125	63.12	87.36	Trench	Asphalt	Poor	Need to repair	22.63	0.9	Null
125	87.56	92.69	Trench	Asphalt	Poor	Need to repair	5.35	4.73	Null
125	90.14	102.51	Crack	Asphalt	Poor	Need to fill	12.39	0	Longitudinal crack
125	101.41	102.59	Trench	Asphalt	Poor	Need to repair	0.77	4.22	Null
125	113	113	Crack	Asphalt	Poor	Need to fill	4.6	0	cross track
125	112.18	116.02	Trench	Asphalt	Poor	Need to repair	3.99	1.14	Null
125	126.04	128.18	Crack	Asphalt	Poor	Need to fill	4.55	0	cross track

Table (3.2):Surveyed Line Events



125	143.02	143.02	Trench	Asphalt	Poor	Need to repair	0.21	5.5	Null
125	168.44	168.66	Trench	Asphalt	Poor	Need to repair	2.82	4.98	Null
125	180.52	183.33	Trench	Asphalt	Poor	Need to repair	0.49	4.72	Null
125	192.57	193.36	Trench	Asphalt	Poor	Need to repair	0.89	4.33	Null
125	210.88	211.89	Trench	Asphalt	Poor	Need to repair	0.89	5.24	Null
125	221.83	280.57	Trench	Asphalt	Poor	Need to repair	58.72	0.71	Null
125	257.33	257.33	Crack	Asphalt	Poor	Need to fill	3.75	0	cross track
125	259.53	272.54	Trench	Asphalt	Poor	Need to repair	12.8	0.46	Null
125	281.32	281.57	Trench	Asphalt	Poor	Need to repair	0.27	4.38	Null
125	284.05	332.21	Trench	Asphalt	Poor	Need to repair	47.31	0.83	Null
125	401.73	427.99	Trench	Asphalt	Poor	Need to repair	24.96	10.8	Null
125	453	455.47	Pump	Asphalt	Poor	Need to repair	2.43	7.44	Null
125	509.88	512.67	Pump	Asphalt	Poor	Need to repair	2.72	6.27	Null
125	560.18	627.49	Crack	Asphalt	Poor	Need to fill	67.02	0	Longitudinal crack
125	592.48	592.48	Crack	Asphalt	Poor	Need to fill	5.25	0	cross track
125	635.03	649.61	Guardrail	Steel	Does not exist	Need to set	13.55	0	Null
125	640.54	642.73	Pump	Asphalt	Poor	Need to repair	1.59	5.63	Null
125	661.34	709.37	Crack	Asphalt	Poor	Need to fill	46.88	0	Longitudinal crack
125	716.78	753.77	Crack	Asphalt	Poor	Need to fill	37.73	0	Longitudinal crack
125	650.52	805.05	Trench	Asphalt	Poor	need to repair	51.04	1.74	Null
125	782.18	784.19	Trench	Asphalt	Poor	need to repair	2.26	6.96	Null
125	829.08	833.6	Trench	Asphalt	Poor	need to repair	4.42	5.45	Null
125	866.99	918.63	Crack	Asphalt	Poor	Need to fill	51.39	0	Longitudinal crack
125	919.07	925.44	Trench	Asphalt	Poor	Need to repair	6.79	1.15	Null
125	925.05	935.18	Retaining wall	Concrete	Does not exist	Need to set	9.61	0	4.5 m height
125	927.66	935.9	Crack	Asphalt	Poor	Need to fill	8.15	0	Longitudinal crack
125	936.59	944.15	Trench	Asphalt	Poor	Need to repair	7.65	2.87	Null
125	942.79	964.36	Crack	Asphalt	Poor	Need to fill	21.58	0	Longitudinal crack
125	964.79	974.39	Trench	Asphalt	Poor	Need to repair	9.03	1.27	Null
125	986.41	993.29	Trench	Asphalt	Poor	Need to repair	6.85	1.5	Null
125	993.29	1003.7	Crack	Asphalt	Poor	Need to fill	10.45	0	Longitudinal crack
125	1006.83	1049.79	Trench	Asphalt	Poor	Need to repair	42.94	1.2	Null
125	1051.07	1051.87	Trench	Asphalt	Poor	Need to repair	0.8	5.83	Null
125	1052.6	1059.27	Trench	Asphalt	Poor	Need to repair	6.62	2.5	Null
125	1060.83	1074.32	Crack	Asphalt	Poor	Need to fill	13.79	0	Longitudinal crack
125	1075.84	1087.9	Crack	Asphalt	Poor	Need to fill	11.94	0	Longitudinal crack
125	1096.7	1112.44	Trench	Asphalt	Poor	Need to repair	17.38	2.85	Null
125	1025.22	1025.5	Crack	Asphalt	Poor	Need to fill	4.14	0	cross track
125	1151.34	1151.74	Trench	Asphalt	Poor	Need to repair	0.4	5.98	Null
125	1214.33	1223.95	Crack	Asphalt	Poor	Need to fill	9.7	0	Longitudinal crack

Table (3.2): Surveyed Line Events, continue

**CHAPTER THREE****DATA COLLECTION & PREPARATION**

125	1226.77	1255.17	Crack	Asphalt	Poor	Need to fill	28.83	0	Longitudinal crack
125	1255.93	1259.92	Trench	Asphalt	Poor	Need to repair	3.95	1.5	Null
125	1263.95	1273.17	Trench	Asphalt	Poor	Need to repair	9.22	1.5	Null
125	1366	1367.8	Pump	Asphalt	poor	Need to repair	1.83	5.61	Null
125	1393.99	1409.27	Widening	Asphalt	Dose not exist	Need to set	15.34	2.84	Null
125	1421.21	1424.54	Pump	Asphalt	Poor	Need to repair	3.3	7.59	Null
125	1472.86	1475.92	Pump	Asphalt	poor	Need to repair	3	5.96	Null
125	1477.63	1506.14	Crack	Asphalt	Poor	Need to fill	28.97	0	Longitudinal crack
125	1508.87	1510.03	Trench	Asphalt	Poor	Need to repair	1.24	6.58	Null
125	1520.52	1525.19	Trench	Asphalt	Poor	Need to repair	4.69	1.43	Null
125	1547.91	1548	Crack	Asphalt	Poor	Need to repair	4.58	0	cross track
125	1593.3	1615.65	Crack	Asphalt	Poor	Need to fill	22.32	0	Longitudinal crack
125	1606.96	1616.62	Crack	Asphalt	Poor	Need to fill	11.55	0	Longitudinal crack
125	1621.76	1621.8	Crack	Asphalt	Poor	Need to fill	6.15	0	cross track
125	1628.85	1654.69	Crack	Asphalt	Poor	Need to fill	25.61	0	Longitudinal crack
125	1635.6	1645.44	Trench	Asphalt	Poor	Need to repair	11.3	3.44	Null
125	1648.76	1658.86	Trench	Asphalt	Poor	Need to repair	9.85	1.45	Null
125	1658.86	1658.9	Crack	Asphalt	Poor	Need to fill	5.81	0	cross track
125	1668.83	1668.9	Crack	Asphalt	Poor	Need to fill	5.74	0	cross track
125	1731.56	1734.42	Pump	Asphalt	poor	Need to repair	2.76	5.6	Null
125	1738	1752.77	Trench	Asphalt	Poor	Need to repair	14.72	0.86	Null
125	1752.86	1754.05	Pump	Asphalt	poor	Need to repair	1.36	6.39	Null
125	1754.8	1754.85	Crack	Asphalt	Poor	Need to fill	0.66	0	cross track
125	1754.44	1754.5	Crack	Asphalt	Poor	Need to fill	1.72	0	cross track
125	1754.5	1775.72	Crack	Asphalt	Poor	Need to fill	27.44	0	Longitudinal crack
125	1782.32	1782.35	Crack	Asphalt	Poor	Need to fill	4.2	0	cross track
125	1793.62	1800.66	Trench	Asphalt	Poor	Need to repair	6.95	0.82	Null
125	1802.14	1807.16	Trench	Asphalt	Poor	Need to repair	29.2	0.89	Null
125	1841.31	1867.91	Crack	Asphalt	Poor	need to fill	26.72	0	Longitudinal crack
125	189.72	192.57	Crosswalk	paint	Dose not exist	Need to set	3	5	Null
125	400	403	Crosswalk	paint	Dose not exist	Need to set	3	6	Null
125	526	529	Crosswalk	paint	Dose not exist	Need to set	3	6	Null
125	603	606	Crosswalk	paint	Dose not exist	Need to set	3	6	Null
125	806	809	Crosswalk	paint	Dose not exist	Need to set	3	6	Null
125	1009	1012	Crosswalk	paint	Dose not exist	Need to set	3	6	Null
125	1212	1215	Crosswalk	paint	Dose not exist	Need to set	3	7	Null
125	1415	1418	Crosswalk	paint	Dose not exist	Need to set	3	6	Null

Table (3.2): Surveyed Line Events, continue

Table (3.3) shows the surveyed point events

R_ID	Measurement	ITEM	MATERIAL	CONDITION	STATUS	LENGTH_M	WIDTH_M	DIAMETER_M	OFFSET_M
1	26.9494	Trench	Asphalt	Poor	Need to fill	5.0175	0.4542	0	0
1	32.8756	Trench	Asphalt	Poor	Need to fill	6.8679	1.5324	0	0
1	58.7543	Trench	Asphalt	Poor	Need to fill	4.8229	1.1227	0	0
1	78.5931	Trench	Asphalt	Poor	Need to fill	9.1389	1.0459	0	0
1	86.7221	Trench	Asphalt	Poor	Need to fill	5.3538	4.7257	0	0
1	98.8411	Trench	Asphalt	Poor	Need to fill	1.5959	4.4245	0	0
1	111.3391	Trench	Asphalt	Poor	Need to fill	3.1872	0.8602	0	0
1	170.2507	Trench	Asphalt	Poor	Need to fill	0.2055	5.5128	0	0
1	183.7943	Trench	Asphalt	Poor	Need to fill	2.8204	4.9825	0	0
1	187.8758	Trench	Asphalt	Poor	Need to fill	0.4856	4.6408	0	0
1	194.8305	Trench	Asphalt	Poor	Need to fill	0.8948	4.446	0	0
1	212.9728	Trench	Asphalt	Poor	Need to fill	0.8883	5.1675	0	0
1	241.4219	Trench	Asphalt	Poor	Need to fill	35.9515	3.7463	0	0
1	268.4218	Trench	Asphalt	Poor	Need to fill	12.7972	0.4819	0	0
1	283.4882	Trench	Asphalt	Poor	Need to fill	0.8027	4.3389	0	0
1	321.7291	Trench	Asphalt	Poor	Need to fill	23.9137	1.0992	0	0
1	356.5489	Hole	Asphalt	Poor	Need to fill	0	0	0.4	0
1	406.7499	Trench	Asphalt	Poor	Need to fill	24.9646	10.8034	0	0
1	446.8582	pump	Asphalt	Poor	Need to repair	2.4265	7.4412	0	0
1	454.6768	Hole	Asphalt	Poor	Need to fill	0	0	1	0
1	458.8364	Hole	Asphalt	Poor	Need to fill	0		1	0
1	506.8366	Trench	Asphalt	Poor	Need to fill	2.725	6.2737	0	0
1	611.7175	Hole	Asphalt	Poor	Need to fill	0	0	0.8	0
1	636.9467	Trench	Asphalt	Poor	Need to fill	2.9873	5.6324	0	0
1	770.1091	Trench	Asphalt	Poor	Need to fill	51.0371	1.7376	0	0
1	775.1624	Trench	Asphalt	Poor	Need to fill	2.2552	7.109	0	0
1	823.3059	Trench	Asphalt	Poor	Need to fill	4.4233	4.4727	0	0
1	836.8504	Hole	Asphalt	Poor	Need to fill	0	0	1	0
1	854.1364	Patch	Asphalt	Poor	Need to repair	4.2702	1.6427	0	0
1	857.5935	Patch	Asphalt	Poor	Need to repair	3.1874	3.5263	0	0
1	909.861	Hole	Asphalt	Poor	Need to fill	0	0	0.6	0
1	913.7048	Trench	Asphalt	Poor	Need to fill	6.7855	1.3556	0	0
1	931.9233	Trench	Asphalt	Poor	Need to fill	7.5664	2.8713	0	0
1	961.1174	Trench	Asphalt	Poor	Need to fill	9.0292	0.7928	0	0
1	967.4756	Patch	Asphalt	Poor	Need to repair	0	0	4	0
1	969.518	Hole	Asphalt	Poor	Need to fill	0	0	2	0
1	1047.6885	patch	Asphalt	Poor	Need to repair	6.5188	2.4956	0	0

Table (3.3): Surveyed Point Events

1	1072.9382	MH	Concrete	Good	-	0	0		0
1	1103.5364	Trench	Asphalt	Poor	Need to fill	54.7431	0.9421	0	0
1	1114.9655	Hole	Asphalt	Poor	Need to fill	0	0	1.2	0
1	1129.2758	Hole	Asphalt	Poor	Need to fill	0	0	0.6	0
1	1152.225	pump	Asphalt	Poor	Need to repair	1.5007	2.9046	0	0
1	1190.6294	Trench	Asphalt	Poor	Need to fill	9.2168	1.3733	0	0
1	1201.2478	pump	Asphalt	Poor	Need to repair	2.5623	1.8462	0	0
1	1216.457	pump	Asphalt	Poor	Need to repair	4.1895	1.5013	0	0
1	1251.0023	Hole	Asphalt	Poor	Need to fill	0	0	1	0
1	1268.107	Patch	Asphalt	Poor	Need to repair	0	0	1	0
1	1288.1091	pump	Asphalt	Poor	Need to repair	1.7947	5.3511	0	0
1	1323.418	widening	Asphalt	-	need to wide	15.9009	2.172	0	0
1	1345.4472	pump	Asphalt	Poor	Need to repair	3.9772	7.3147	0	0
1	1396.9681	pump	Asphalt	Poor	Need to repair	3.0788	5.568	0	0
1	1411.2674	Patch	Asphalt	Poor	Need to repair	0	0	1	0
1	1432.4725	Trench	Asphalt	Poor	Need to fill	1.1658	6.5804	0	0
1	1438.8927	Trench	Asphalt	Poor	Need to fill	13.7897	6.5804	0	0
1	1548.8734	Patch	Asphalt	Poor	Need to repair	13.2815	5.1861	0	0
1	1567.3335	Trench	Asphalt	Poor	Need to fill	3.6372	1.333	0	0
1	1589.4743	Hole	Asphalt	Poor	Need to fill	0	0	1	0
1	1591.2748	Hole	Asphalt	Poor	Need to fill	0	0	1	0
1	1626.7309	Patch	Asphalt	Poor	Need to repair	27.263	0.6893	0	0
1	1641.9281	Patch	Asphalt	Poor	Need to repair	2.9475	0.6893	0	0
1	1653.6667	pump	Asphalt	Poor	Need to repair	2.9936	5.6031	0	0
1	1656.9892	Trench	Asphalt	Poor	Need to fill	3.3955	0.8612	0	0
1	1666.0905	Trench	Asphalt	Poor	Need to fill	14.8326	0.8612	0	0
1	1674.4221	pump	Asphalt	Poor	Need to repair	1.0051	6.3716	0	0
1	1680.9305	Patch	Asphalt	Poor	Need to repair	10.7682	1.7168	0	0
1	1701.7929	Trench	Asphalt	Poor	Need to fill	9.0741	0.799	0	0
1	1708.1242	Patch	Asphalt	Poor	Need to repair	3.6112	0.2997	0	0
1	1715.3437	Patch	Asphalt	Poor	Need to repair	10.6891	0.2997	0	0
1	1743.0628	Trench	Asphalt	Poor	need to fill	34.4544	1.4636	0	0
1	1761.0088	Patch	Asphalt	Poor	Need to repair	4.8661	2.6233	0	0

Table (3.3): Surveyed Point Events, continue

### 3.4 Entering data to the GIS

In ArcGIS, features are stored in a feature class. Every feature has a geometry associated with it. This geometry is stored in a special field that is typically called ‘shape’. A feature can have one of these types of geometries: point, multipoint, polyline, or polygon. Each

geometry is composed of two-dimensional (x,y) or three-dimensional (x,y,z) geographic coordinates.

In order to handle the linear referencing requirement that attribute information can be recorded in terms of a linear feature and a measurement along it, a method for defining discrete locations along a linear feature was devised. Instead of being composed of x,y coordinates, a feature's geometry in ArcGIS can be composed of x,y,m (or x,y,z,m) values. When data is linearly referenced, multiple sets of attributes can be associated with any portion of an existing linear feature, independent of its beginning and ending. These attributes can be displayed, queried, edited, and analyzed without affecting the underlying linear feature's geometry.

When linearly referenced features in ArcGIS are referred to, the terms routes, route locations, and route events are used. A route is any linear feature, such as a city street, highway, river, or pipe, that has a unique identifier and a measurement system defined (x,y,m). This measurement system defines discrete locations along the linear feature.

A collection of routes with a common system of measurement is stored in a feature class—for example, a set of all highway routes in a county. In ArcGIS, a route feature class can exist in a coverage, as a shapefile, or as a geodatabase feature class. In a geodatabase, many feature classes containing routes can be stored in a single feature dataset. For example, a state's department of transportation might maintain a feature dataset with feature classes for milepost routes, reference marker routes, and so on.