Utah's Use of Dynaflect Data for Pavement Rehabilitation

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•MANY EXISTING flexible pavement structures require resurfacing and strengthening to carry increasingly heavy traffic loads, to correct post-design and construction errors, and to overcome the effects of wear and deterioration because of age. Perhaps the most familiar type of distress is the development of a crack pattern, which is usually the result of base failure or shrinkage of the bituminous surface. The development of a crack pattern tends to rapidly increase in extent because water intrudes into and softens the base.

Before undertaking the resurfacing of an existing pavement, it is necessary to determine how much new surfacing will be required to carry the load. On most of our state highways the grade can be raised as necessary without involving difficulties in city street grade changes. Thus, it is possible to make full use of whatever carrying capacity remains in the highway structure. The problem is, then, what should be the thickness of the new surface? Distress will not occur in the new pavement if it, in combination with the existing structure, has adequate strength to carry the traffic loads.

The AASHO Road Test demonstrated that deflection measurements are a useful tool in determining the structural adequacy of pavements. Perhaps the best known device for measuring deflections is the Benkelman beam. With this device a measurement is made between the dual wheels of a 15,000 or 18,000-lb single-axle load. Utah used the 15,000-lb single-axle load. A trained crew of approximately 4 men with the proper equipment can take deflection measurements quite efficiently.

Utah now uses a Dresser-Atlas (formerly Lane-Wells) Dynaflect for deflection measurements. The system consists of a small trailer towed behind a vehicle with the control unit located in the vehicle beside the operator. Figure 1 shows the system with the towing vehicle. The unit is very compact and is easily towed at highway speeds en route to a test site. Cables between the Dynaflect and the tow vehicle provide power and permit control from the driver's seat. Figure 2 shows the control unit that is carried in the seat beside the driver. The entire operation of the system is controlled from this unit, and the deflection readings are taken from the upper left meter. The lower left control permits selecting the sensor or geophone to be read, and the lower center control provides a multiplier for the deflection. This system measures the dynamic deflection between 2 rigid steel wheels that are subjected to an oscillatory load of 1,000 lb peak-to-peak varying sinusoidally at the rate of 8 cycles per second. The magnitude of the deflections are sensed by means of 5 geophones spaced at 1-ft intervals beginning with one placed between the force wheels. Figure 3 shows the Dynaflect in operating position with the force wheels and the geophones down in position for obtaining measurements. Figure 4 shows a rear view of the Dynaflect in operating position for taking measurements. The entire weight of the trailer is being carried on the steel force wheels. When the Dynaflect is in this position, it should be towed at very slow speeds of about 5 mph between test sites.

The shape of the deflection basin may then be determined by utilizing the values from all geophones. The deflections are read on the meter in the control unit in the tow vehicle. The Dynaflect is very efficient because it can be operated by one man.

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Figure 1. Dynaflect and towing machine.

As many as 50 readings per hour can be achieved by one operator. A driver and an operator can obtain as many as 100 readings per hour.

There is good correlation between the data obtained with the Benkelman beam and those obtained with the Dynaflect. Measurements taken with either device on bituminous pavements require corrections to a standard temperature. Deflections are read in thousandths of an inch or in mils with a total range of 0.01 to 30 mils.

Figure 5 shows plots of deflection readings taken on two different projects, one having good stability and the other poor stability. The deflection value is shown by the vertical scale on a semilogarithmic plot. The distance from the load or force wheels is shown on the horizontal scale. Each inclined line trending downward to the right represents the deflection readings taken at one location on the pavement. The highest point represents the deflection between the force wheels of the Dynaflect, and the other points represent the deflections at 1-ft intervals out from the force wheels. The various deflection lines or basins at each test site on each project are connected at the high points to indicate trends. Deflection measurements are recorded in mils, and it will be noted that maximum deflections on the good-stability project are all below 0.6 mils, whereas the poor-stability projects are generally above 1.5 mils. The relationship between these deflection values and those obtained with the Benkelman beam is

Figure 2. Dynaflect control unit.

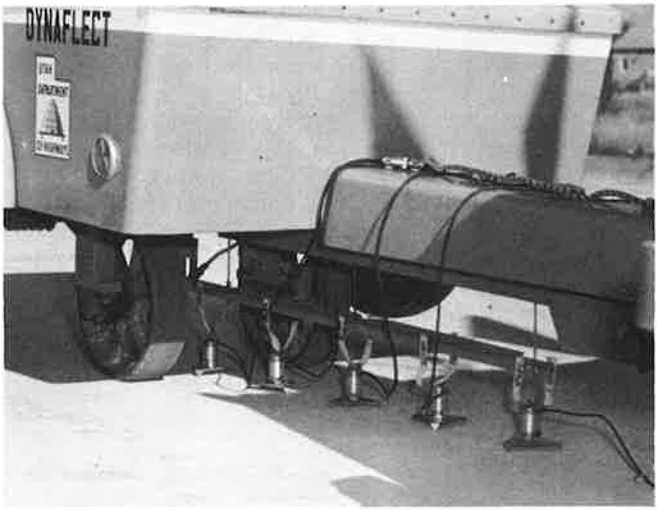

Figure 3. Dynaflect force wheels and geophones.

Figure 4. Dynaflect in operating position.

approximately 1 to 28 based on work done in Texas for 18,000-lb single-axle loads. Other studies have indicated a ratio of 1 to 20 or 22 for 15,000-lb single-axle loads.

Performance-deflection relationships were established as part of the AASHO Road Test and equations for fall or spring normal deflections were developed. These equations were modified for the Dynaflect and used to develop two families of curves correlating Dynaflect deflections, daily equivalent 18-kip loads, and pavement life. Figure 6 shows the family of curves for fall deflections. The horizontal scale is the Dynaflect deflections in mils and the vertical scale is years of service. Each curve represents daily equivalent 18-kip loads. For a given deflection on a pavement of known traffic, the anticipated remaining years of service can be determined. The reverse procedure can be used to determine allowable deflections when a certain number of years of service is desired. For example, if a service life of 10 years is desired on a pavement of 100 daily equivalent 18-kip loads, the allowable deflection for fall would be about 1.1 mils. The surfacing required for rehabilitation would then be the amount required to reduce the actual deflection to the allowable deflection. The family of curves is based on a serviceability index of 2.5.

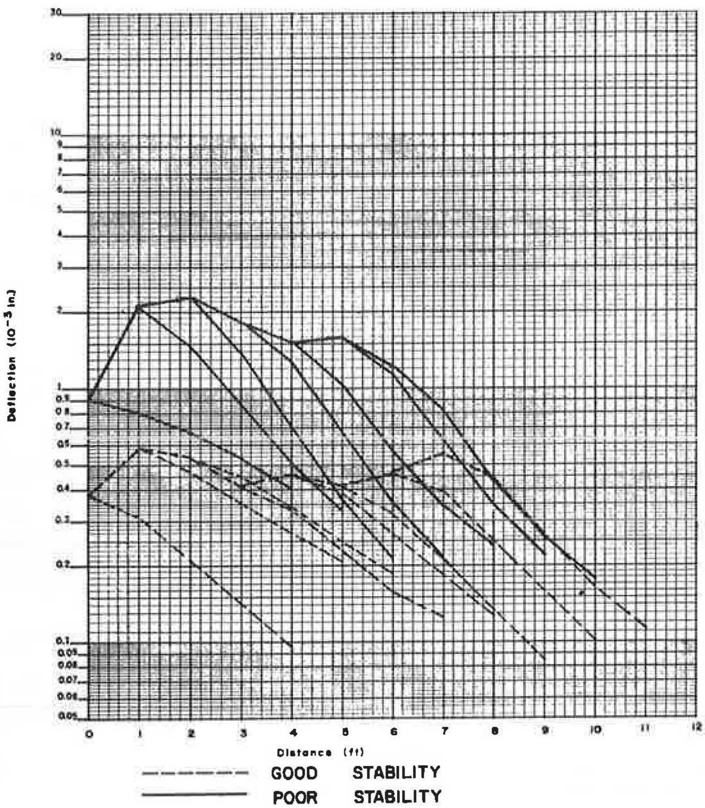

Figure 5. Dynaflect readings taken on project with good stability and on one with poor stability.

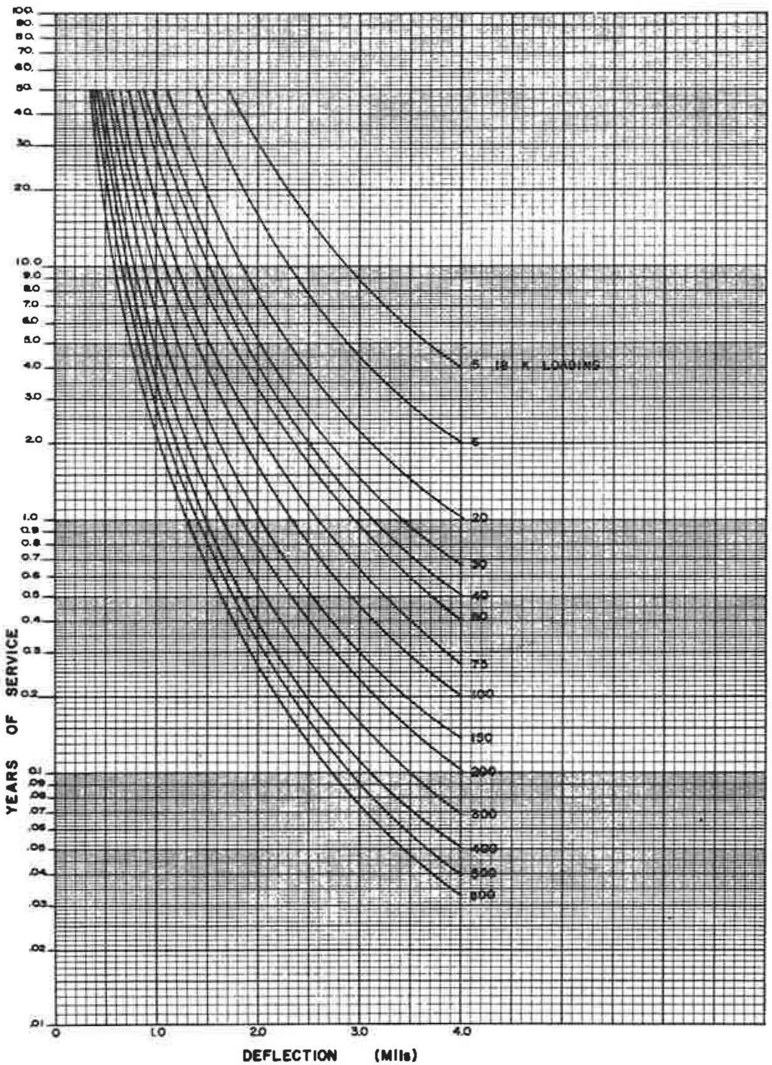

Figure 6. Fall deflection curves.

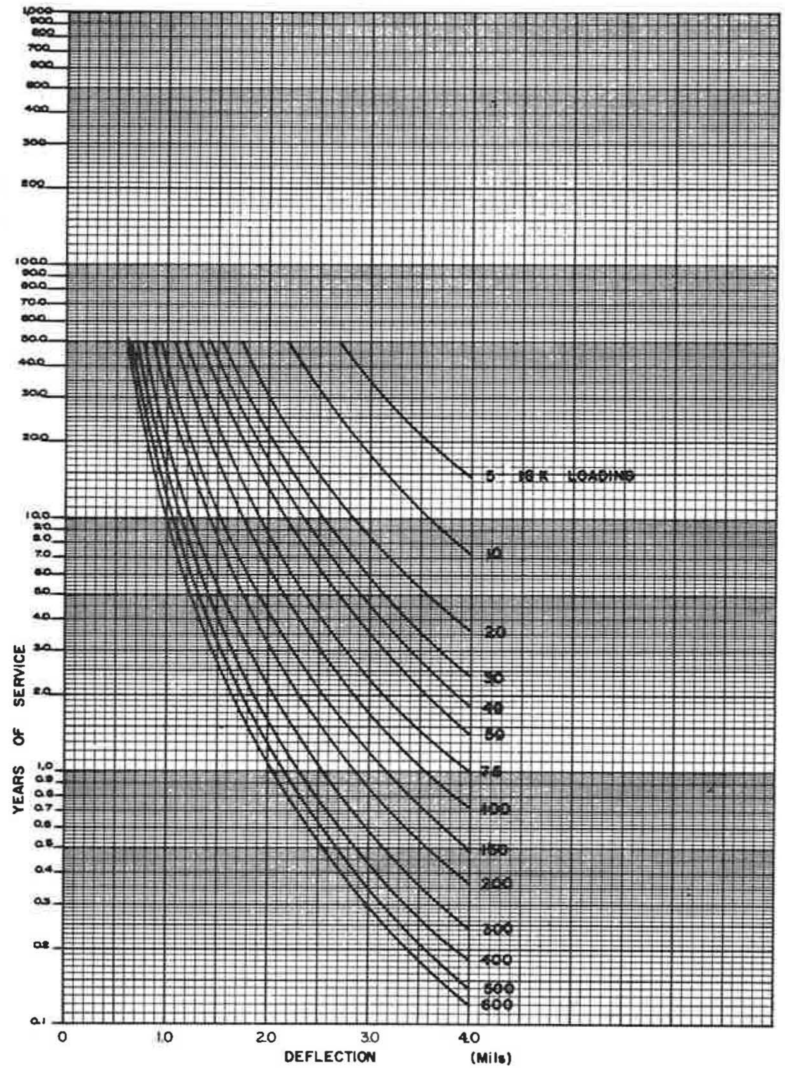

Figure 7. Spring deflection curves.

The curves for spring deflections, shown in Figure 7, are used in a similar manner. The period of time during the spring months when the spring readings can be taken is very critical in Utah. To properly determine the spring normal deflection would require obtaining deflections for approximately 2 months on a weekly basis. It is for this reason that we rely more on fall deflections for determining surfacing requirements.

Figure 8 shows the difference between the fall and spring curves for 100 daily equivalent 18-kip loadings. The relationship shown here generally holds true on projects in Utah if a weekly survey can be made for spring readings. It will be noted that the allowable deflections in spring are greater. If the weather conditions in the spring are such that the higher deflections are maintained for an extended period of time, then serious breakup of the roadway could occur. In this case deflections could be used to reduce traffic loads over the critical period.

Data are presently being developed in Utah for determination of the thickness of a new surface course required to reduce the deflection to a point at which it will meet

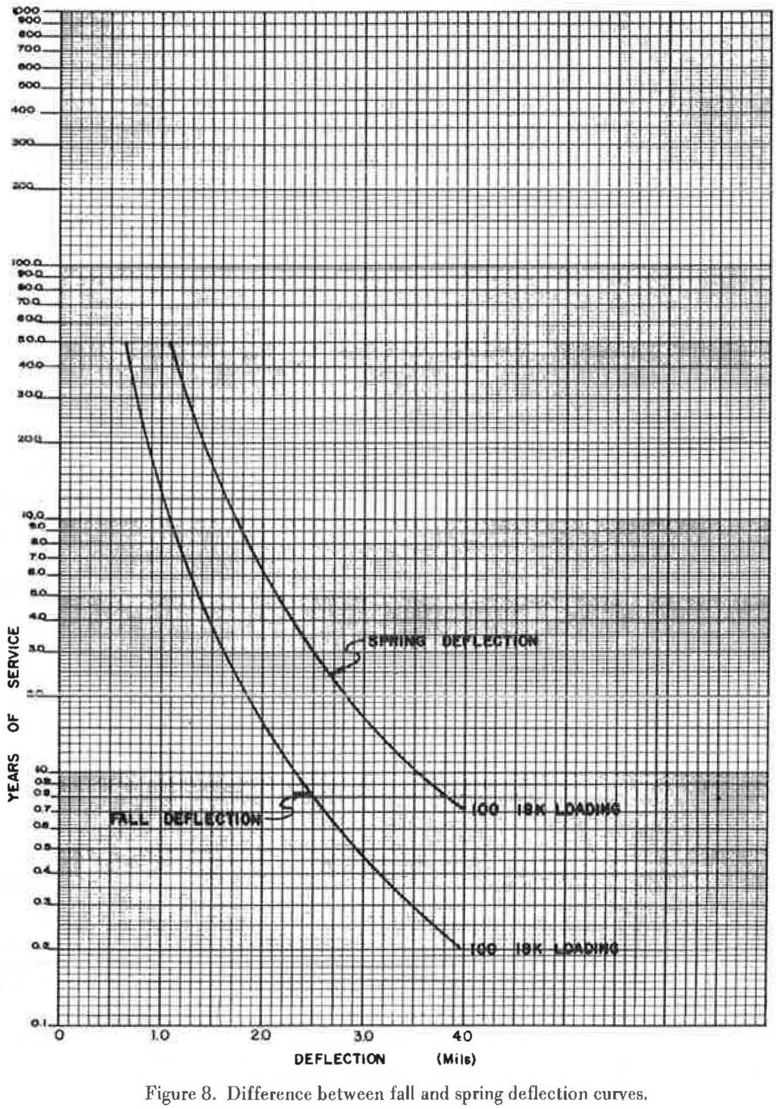

Figure 8. Difference between fall and spring deflection curves.

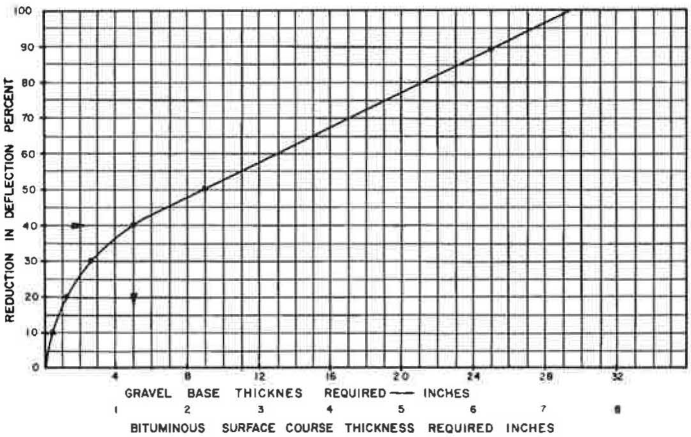

Figure 9. Thickness of surface course required to reduce deflection.

the design-life criteria. Until sufficient data are available we are using the curve developed by the California Department of Highways shown in Figure 9. The reduction in deflection in percent is shown on the vertical scale and the gravel base thickness required is shown on the horizontal scale. Utah uses an equivalency of 4 to 1 for bituminous surface to gravel base. This relationship is shown by an additional horizontal scale on the graph. For any reduction in deflection, the surfacing requirements can be rapidly determined.

Additional data will be required before a final evaluation of the method described here can be made, but all indications are that it is working very well. This method has been in use for about 9 months in Utah, and we are of the opinion that it is a valuable aid to maintenance in pavement rehabilitation.

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