

1.6 Optical fibres as sensors

Generally, optic sensor consists of light source, optical fibres and detector. The sensors are Two types viz., active sensors and passive sensors.

The physical changes directly changes the electrical responses called active sensors; where as the physical changes are indirectly recorded to sensing is called passive sensors.

Displacement sensors

The light is sent through transmitting fibre and further it is allowed to fall on moving target. The light ray falls on the surface and gets reflected. The incident ray could mix with reflected wave and forms standing wave to which the phase angle shift can be measured. The fig indicates displacement sensors.

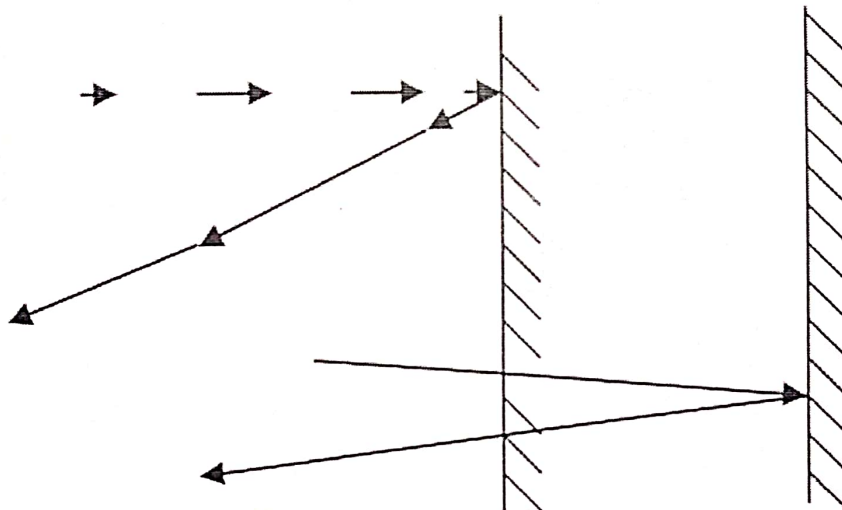


Fig.6 Displacement sensor

Temperature sensor

The light can be arranged to fall on reflecting surface and the associated phase angle is be measured. The reflecting surface can be varied using temperature variation, which causes additional phase angle to light wave as seen in the fig.5. When light thrown on the reflector by optical fibre, the initial and final response can be compared for measure of temperature by relative correlation.

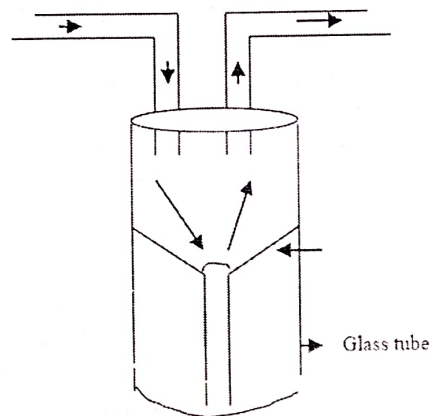


Fig.5 Temperature sensor

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The major four application of laser in the highway engineering are discussed below:

1. Road Profiling

The profile of a road is measured along any constant non-existent line or object. The profile of a road taken along a lateral line demonstrates the superelevation and crown of the road outline, in addition to rutting and different problems. The longitudinal profile demonstrates the roughness, texture, design grade.

A laser profiler is used to find the following ingredients of a road profile:

1. A reference elevation
2. A height relative to the reference, and
3. Longitudinal distance.

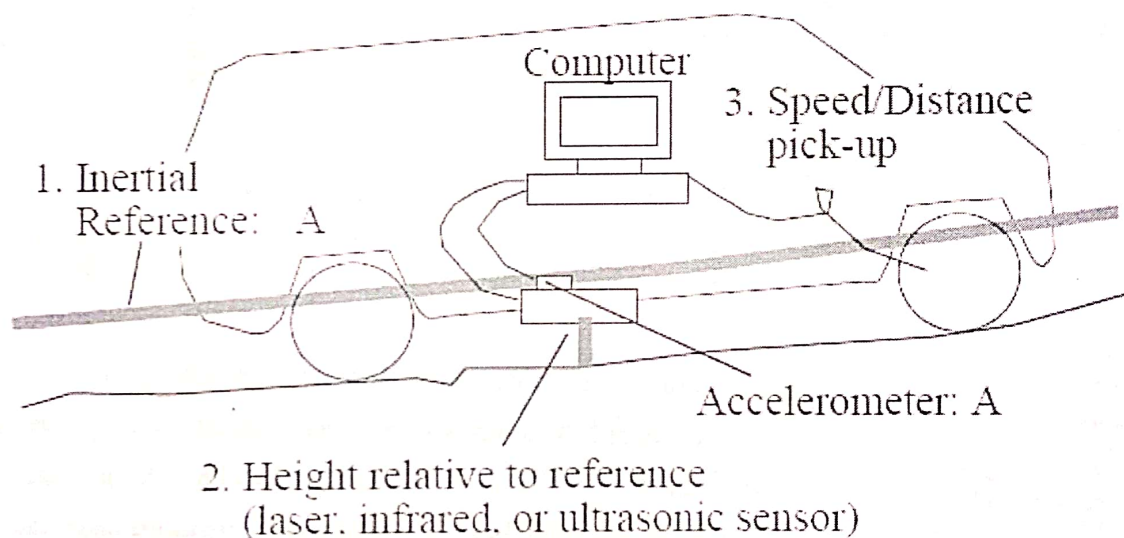


Fig 1: Ingredients of Laser profiler.

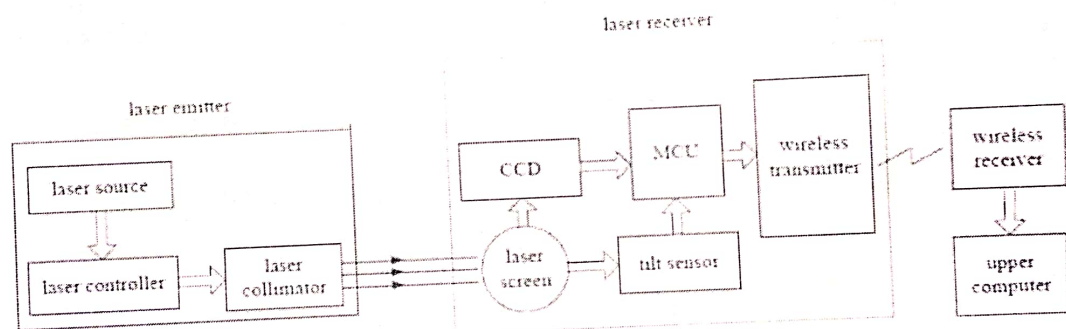
The applications of laser profiler in the highway engineering are:

1. To screen the state of a road system for pavement management systems (PMS),
2. To assess the nature of recently developed or repaired areas,
3. To analyze the state of a particular place and decide fitting cures, and,
4. To examine the state of a particular site for research. At the other end, an examination system may include incessant estimations of destinations that are only a few hundred feet long, to recognize unobtrusive types of decay at their onset.

2. Bridge Deflection

The deformation in the bridge is caused by changes in natural conditions and long-term load and overload. The measurement of the deformation is important to know the health of the bridge in order to ensure the safe use of it.

To measure the deformation, new methods of deformation monitoring with the development of computer technology, sensor technology, and network technology, such as Stretched wire, tilt-meter, GPS, optical fiber, laser image. These methods can realize real-time on-line and automatic measurement of bridge deflection, which is low on maintenance cost and high precision.



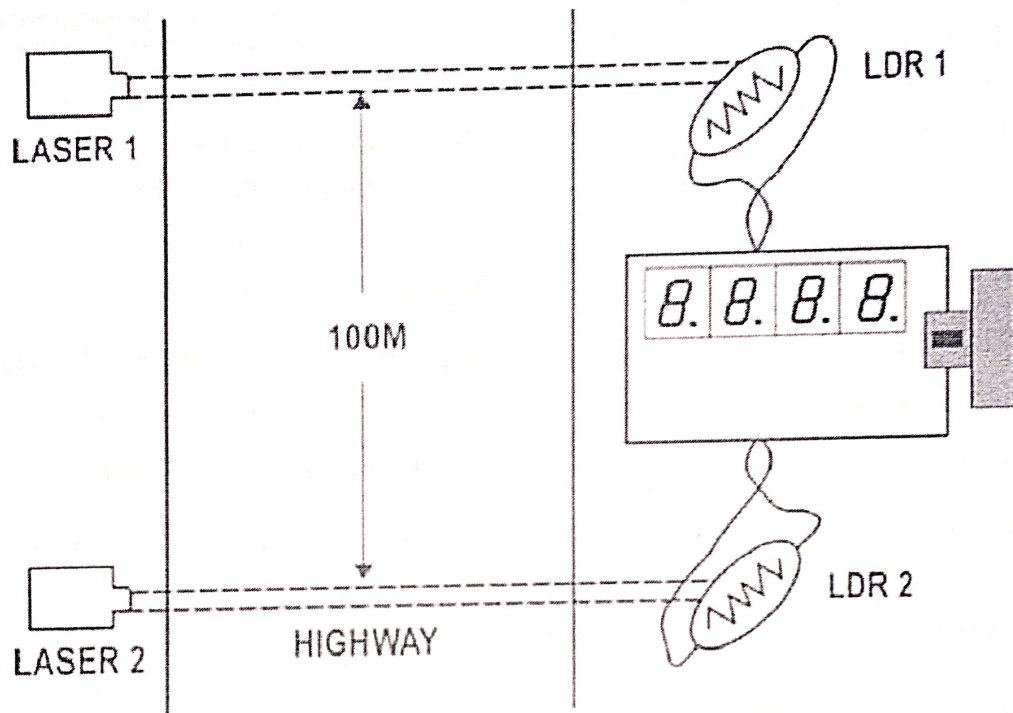
The structure of bridge deflection measurement system

Fig 3: The structure of bridge deflection measurement system.

The deflection measurement system is composed of laser emitter, laser receiver, and upper computer, as shown in the figure below. The laser beam should have long-term stability, anti-interference, and high positioning accuracy to ensure the accurate positioning of the spot center.

3. Speed Checkers

The vehicle speed detection is crucial for observing speed limitation law, and it also demonstrates traffic condition. The speed of the vehicle more than the defined limit is dangerous, which creates the chances of accidents.



The intelligent transportation system (ITS) is a new approach to manage traffic vehicles. These systems are becoming more critical due to their advantages like saving lives, money, and time. Lasers have been used in the detection of the speed of the vehicle to mitigate the hazardous events on the road. The highway speed checker comes handy for the traffic police, especially against the speed limit violators because it provides the digital display as well as buzzing sound or alarm to detect any vehicle speed if the vehicle exceeds the permitted speed limit.

Application of Lasers in Highway Engineering

1. The laser-based system can measure the road profile and deflection accurately while traveling at an average speed.
2. It results in rapid measurement and quick data collection.
3. Multiple locations can be measured from a single instrument position.
4. It doesn't require any setup or break down.
5. It can be installed on any vehicle required by the user.
6. It can operate at a speed of 105 km/h.
7. It collects data in real-time as it traverses the pavement's surface.
8. It eliminates the need for lane closures or traffic control while testing.

1. What are the uses of lasers in the field of Highway Engineering?

The uses of lasers in highway engineering are road profiling, pavement surface deflection, bridge deflection, speed checkers, etc.

2. What is the use of lasers in the speed detection of vehicles?

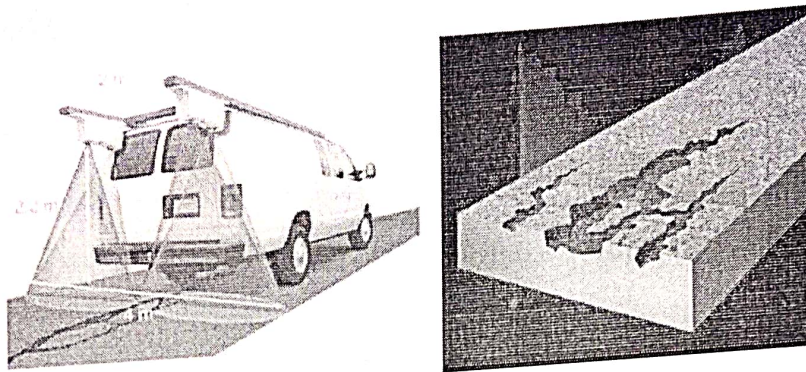
The highway speed checker comes handy for the traffic police; especially against the speed limit violators because it provides the digital display as well as buzzing sound or alarm to detect any vehicle speed if the vehicle exceeds the permitted speed limit.

Applications of the Lasers in Highway Engineering

Road Profiling

The profile of a path is calculated around some in-existent line or point which is permanent. Besides, the rutting and the other issues, the profile of a path which is taken along a lateral line shows over the altitude and crown of the route outline. The longitudinal profile displays the ruggedness, hardness, and grade of the material.

It is used for tracking the status of a pavement management system road network (PMS) network, for determining the existence of built or separated environments.



Laser Profiling of Cracks

Bridge Deflection

Bridge Deformation is induced by the shifts in the geological environments, including the long-term loading including the overloading. Measuring the deformation is necessary for knowing the bridge's safety, for ensuring its healthy usage. The deflection measuring device is composed of the laser emitter, laser receiver and upper computer. The laser beam will provide long-term reliability and high precision of positioning to guarantee the spot centre's precise positioning.

Speed Checkers

Lasers have been used for monitoring the vehicle's speed to minimise dangerous road accidents. The road speed checker is useful for the traffic police, especially against speed limit violators as it offers the digital monitor as well as the buzzing sound or warning for identifying the vehicle speed if the vehicle speed reaches the limit required.

There is a developing requirement for the vital administration of the national roadway system for saving huge capital investment. Pavement administration exercises require exact, quick and practical pavement test systems for recording the current status of the pavement structures in a fast way. Laser strategy has the qualities of high correctness, high resolutions and repeatability, and has been connected in the range finding.

Profiler working them is:

1. A reference elevation
2. A height relative to the reference, and
3. Longitudinal distance

These three components are combined in different ways, based on the design of the profiler.

Advantages of Using Lasers in Highway Engineering

- The laser-based system can be used for measuring the road profile and deflection accurately while travelling at the normal speed.
- The laser-based system also results in the rapid measurement and quick collection of the data.
- It is used for measuring the multiple locations from the single instrument position.
- It does not require any setup or breaks down.
- It is the system which can be fitted on any vehicle required by the user.
- The laser-based system can operate at a speed of 105 km/hr.
- It is the system which collects data in the real-time as it traverses the pavement's surface.
- It eliminates the need for lane closure or traffic control while testing.