

SAFE AND EFFECTIVE ROADWAY HUMPS
THE SEMINOLE COUNTY PROFILE

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This paper provides a summary of the research, field testing, application and evaluation procedures leading to the development of a safe and effective speed control roadway hump profile.

Roadway humps have been installed in parking lots and along residential streets throughout the United States and abroad in an effort to reduce or maintain safe travel speeds within neighborhoods and dense pedestrian traffic areas. These efforts have met various degrees of success and in recent years many agencies have discontinued promoting their use and/or have removed pilot installations due to limited effectiveness or concerns for safety.

Most existing hump applications have been derivatives of a design profile developed in England, commonly known as the "Watts" profile. This profile, (shown in Figure 1) typically twelve feet long along the base and three to four inches tall, has been found to be less than desirable as it only permits comfortable passage at speeds of the order of 10 mph. Variations of this profile have effectively raised the "discomfort band" to a 15 or 20 mph range but were also comfortable at speeds above 30 mph.

Seminole County initiated field testing of various roadway hump profiles in search of a profile geometry which would allow comfortable passage only at travel speeds up to 25 to 30 mph without compromising vehicle control. This testing led to the development of a design profile which provides a gentle undulation and smooth passage at speeds of 25 mph or less and increasingly uncomfortable travel at any higher speed. This geometry consists of a segment of a circle with an approximate radius of 72 feet followed by a three inch high, ten foot long plateau with the same arc on the downstream end.

The testing consisted of first constructing three and four inch "Watts" profiles and observing driving and ride characteristics. I noted the roughness of the ride was due to the front wheels descending prior to the rear wheels ascending the hump. At higher speeds it was noted the suspension system of the vehicle collapsed on contact with the hump with the front wheels rising into the wheel wells while the chassis of the car continued on a level path. These conditions create a situation where the ride is rough at speeds below 15 mph but smooth above 30 mph.

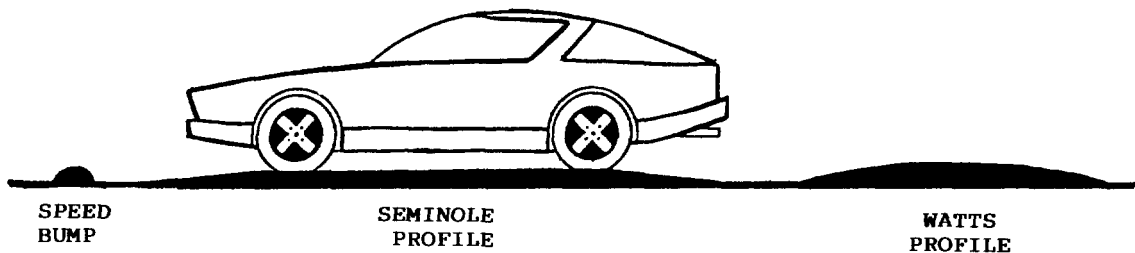


Figure 1

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The plateau was developed to address these conditions. At low speeds the rear wheels begin their ascent before the front wheels begin to descend. At higher speeds the front shock absorbers extend while still in the elevated section. This permitted a smooth ride at speeds consistent with the posted speed but becoming increasingly severe as speeds increase.

Our testing of the final design included driving various types of vehicles across the hump. These consisted of a fire engine, a four wheel drive truck with boat and trailer, several sizes of motorcycles, bicycles and various cars. I find that trucks seem to prefer a speed of 20 to 25 mph and cars prefer a range of 20 to 30 mph. Wheel base, suspension and driver preference appear to account for the variations.

The question of liability is an issue I also investigated prior to design. In my research of experience from agencies using the "Watts" profile I found there has been no successful litigation worldwide identifying the speed hump as a contributing cause.

I consulted with our attorney's office and in summary it was their opinion that while no case law in Florida regarding this matter exists a position must be based on ideas that the action be reasonable and responsible and in accordance with standards of care and common sense. With this in mind our testing involved various vehicles encountering the hump at various speeds. There was no impairment of control of any vehicle within a range well in excess of the clearly posted speed and that speed was reasonable for the normal conditions of this roadway. At the time of this writing the installation has been in place for eight months. To date there have been no reports of accidents or vehicle damage related to the hump installations and only minimal complaints reported by non-residents regarding inconvenience.

Following this testing we selected a roadway in Seminole County for a test application. Eastbrook Boulevard is a residential street which terminates at a major arterial on one end and a minor arterial at the other with a pre-

installation ADT of 3848. The section in our County is 1.3 miles long with a posted speed of 25 mph.

Studies indicated 34.5% of all vehicles were traveling in excess of 30 mph (Table 1). For years we have attempted to address the homeowner reports of a small percentage of vehicles traveling at excessive speeds as well as large number of cut-through cars and commercial vehicles. The usual "lesser measures" of street lights, signing, centerline and edgeline with RPM's and enforcement have had little if any lasting effect. Discussions were held with the homeowners association followed by a petition of all residents with special attention to those owners living on Eastbrook Boulevard itself. Following Board approval we installed nine (9) hump locations. I attempted to stay within a spacing range of 350 feet to 450 feet. Because of geometric considerations such as intersections, drainage structures as well as vertical and horizontal curves this was not always possible. As a result our shortest spacing is 375 feet and the longest is 668 feet.

During the course of our studies I requested our Sheriff's Department to suspend enforcement two weeks prior to and throughout the study time. Shown below are the results of our "before" and 90 day "after" studies. Results are shown in percentage of vehicles.

| | | After | | | |
|-------|-----------|-------|------|-------|-------|
| | | 1/90 | 9/90 | 10/90 | 11/90 |
| SPEED | 0-20 mph | 2.5 | 14 | 11 | 16 |
| | 21-25 mph | 19 | 47 | 47 | 44 |
| | 26-30 mph | 44 | 32 | 35 | 32 |
| | 31-35 mph | 26.5 | 6 | 6 | 7 |
| | > 35 mph | 8 | 1 | 1 | 1 |

Percentage of Vehicles
Table 1

Speed counters placed on a hump mid-project show speeds across the hump to closely match those throughout the roadway.

The construction of the humps consist of installing the three inch (3") by ten foot (10') plateau and shaping the ramps with a form cut with the appropriate arc. The cost per hump varies depending on the width of roadway. The installation of these locations required approximately two days. They were preceded with standard "bump" signs and "next 1.3 miles" at each end of the project with loop driven flashers. In addition signs were posted midproject to reinforce this. Prior to beginning we considered a pavement marking to support these installations. Those currently in use with speed humps had short-comings we sought to over come. The "zebra" markings commonly used have a limited target valve and little use for advance notification. Our design consist of 12" white bands perpendicular to the roadway. They are shorter upstream than downstream and the spacing decreases as they approach the installation. This creates an optical illusion of increasing speed as they are encountered in a moving vehicle.

The 24 hour volumes on the roadway have exhibited a slight reduction from 3848 to 3559 over the time of our testing (Table 3). I cannot however attribute this solely to the test as there may be seasonal variations to account for this reduction. Also, although I cannot document this, the residents report a reduction in the number and speed of cut-through commercial truck traffic.

In summary I can report our test site has proven to be a major success. We have accomplished a reduction in speeds from 34.5% above 30 mph down to 8%. The residents have expressed great appreciation to our Board for "returning their street to it's former neighborhood feeling". We have experienced no adverse affects with regard to accidents or residents complaints. Many cities in our area are preparing programs for test sites in their jurisdictions. Local law enforcement supports this program as it frees much of their time for duties elsewhere. Based on these results I anticipate an expansion of their use County-wide to address on-going safety concerns in our neighborhoods.

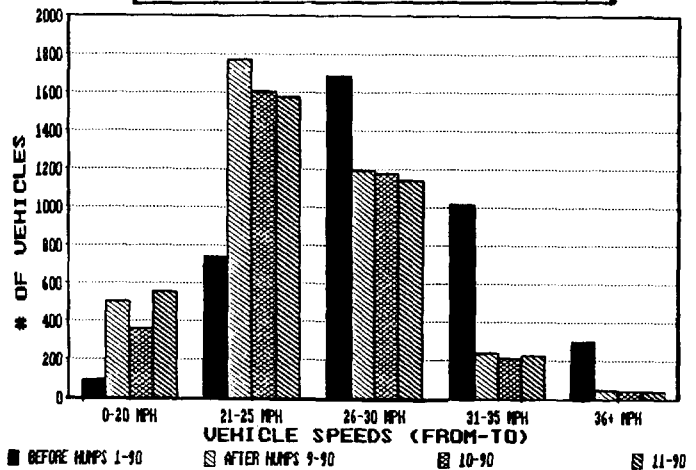
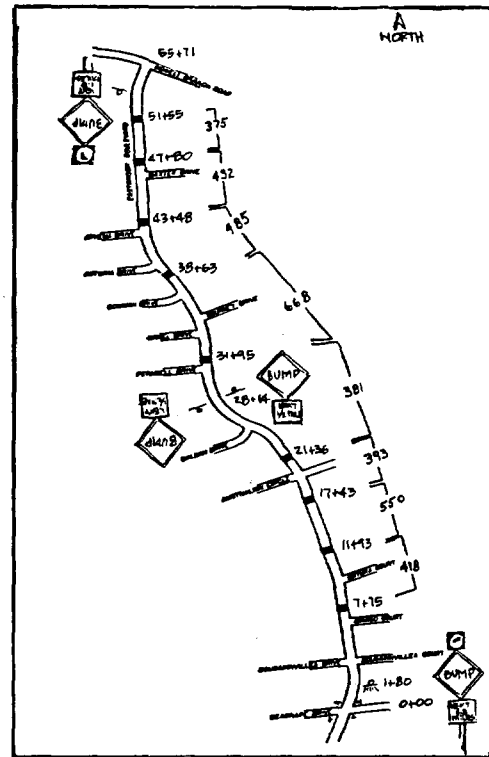


Table 2

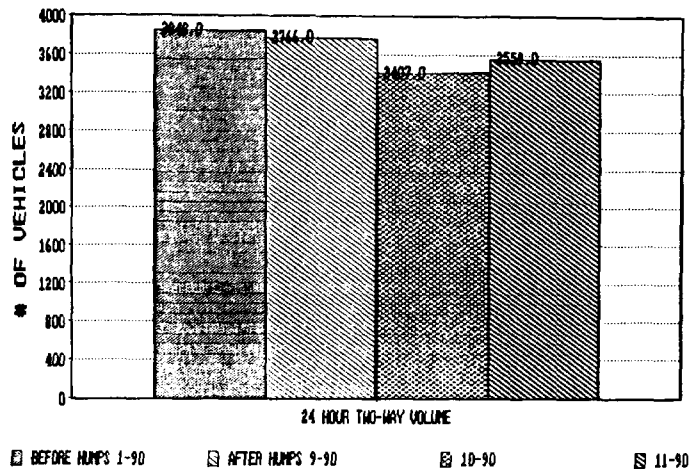
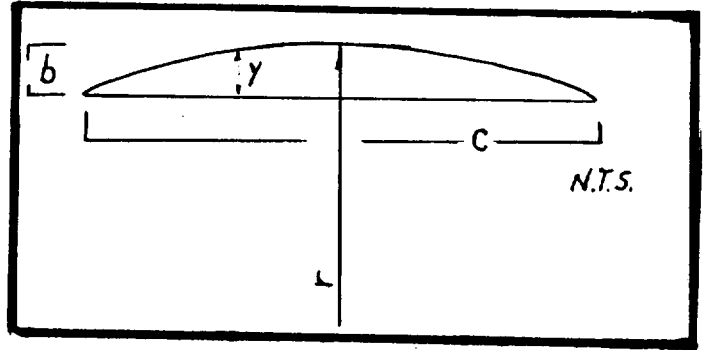
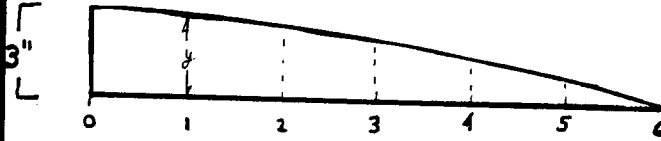


Table 3

Design Data



X=1

$$0.25 - 72.125 + \sqrt{72.125^2 - 1^2}$$

$$= -71.875 + 72.12$$

$$Y = 0.243' = 2.92''$$

X=2

$$-71.875 + 72.10$$

$$Y = 0.222' = 2.67''$$

X=3

$$-71.875 + 72.104$$

$$Y = 0.188' = 2.25''$$

X=4

$$-71.875 + 72.0139$$

$$Y = 0.139' = 1.67''$$

X=5

$$-71.875 + 71.95$$

$$Y = 0.0765' = 0.92''$$

$$r = \frac{4b^2 + c^2}{8b} = 72.125$$

$$b = \text{height} = (0.25')$$

$$c = \text{cord distance} = (12')$$

$$y = b - r + \sqrt{r^2 - x^2}$$

| x(ft) | y(ft) | = | inches |
|-------|-------|---|--------|
| 0 | 0.25 | = | 3.0 |
| 1 | 0.243 | = | 2.92 |
| 2 | 0.222 | = | 2.67 |
| 3 | 0.188 | = | 2.25 |
| 4 | 0.139 | = | 1.67 |
| 5 | 0.077 | = | 0.92 |
| 6 | 0 | = | 0 |

