Few appreciate the tremendous effect the automobile has had on the American social and economic life. Even fewer realize that a large measure of the automobile industry's development and success is directly attributed to a program of painstaking and intelligent research. The progress of the automobile industry and the story of highway transportation has no parallel in modern history.

The automobile industry, spurred by free enterprise, has poured millions of dollars into experimental and research work which resulted in a continual improvement of its product. During the last decade the industry has reached such phenomenal efficiency in production, that the leaders in the field have become somewhat concerned about possible future curtailment in production, simply because the motoring public have indicated a tendency to shy away from overcrowded highways.

In direct contrast to the automobile industry, the highway transportation system has principally been developed and constructed with public funds provided by legislative acts. The Highway Research Board deserves the highest praise for its achievements in national planning and co-ordination of design standards and construction, to meet the ever increasing demand of a fabulously mounting traffic volume.

We in Michigan, are fully aware of the importance of careful planning for the future. We also realize that our present rate of highway taxation is not sufficient to meet today's traffic demand. A large percentage of our highways have become inadequate geometrically, principally because of the improved auto design, likewise, the accident rate has risen in proportion to the increased volume of traffic.

While we recognize the desperate need for a radical revision in our design of past years, the magnitude of a complete reconstruction of an already established network, is simply beyond the economic reach of a highly tax conscious public. By careful planning, however, and by special methods of financing, as in the case of the Detroit Crosstown Expressways, we are making some progress in re-designing our major arteries in the state.

Where limited access cannot be provided, it is true that we favor a wide median design in separating opposing traffic lanes of multi-lane highways. These divider strips should be sufficiently wide to allow a safe turning movement and to permit a landscape treatment. We have a standard design for divided highways with 50 ft. between centerlines of roadways and a median width of 26 ft., measured from the inside edges of the pavement. While I frankly admit that our present mileage of this type of construction is rather low, we do have a stage construction policy for our most congested arteries which we have followed during the past 14 years. This policy includes the acquisition of limited access right-of-way of sufficient width to permit the addition of future lanes.

On certain locations, and as an economy measure, we have also con-
structured some divided highways with a curbed and sodded median from 4 to 8 ft. wide. Throughout interchange areas, and on larger structures, especially within urban limits, we are using a curbed and paved median from 2 to 4 ft. wide. (Figs. 1 to 4).

a narrow divider strip placed directly on the pavement. Two types of design were selected, one of bituminous concrete and one of Portland Cement Concrete construction. This paper will specifically deal with the former type.

Since funds are not adequate to permit a drastic reconstruction of our existing transportation system, we have made a study of what could be accomplished by giving some of our most congested trunklines, a "face lifting", to meet our immediate requirements. It is often too costly to secure more than the original right-of-way along these routes but we do have sufficient room to widen the existing pavement. For the purpose of economy and to increase safety we decided to experiment with

THE HIGHWAY

US-23, a three lane highway from Bay City (Pop. 48,000) and north about 10 miles, and located approximately 100 miles north of Detroit was our first experimental job completed. Most of this location is of a semi-urban nature with a large number of small business establishments such as, grocery stores, restaurants, and gasoline stations adjacent to the project for practically its entire length. (Fig. 7)
This particular trunkline carries a heavy load of local traffic in addition to a tremendous seasonal load of tourist traffic. It is an interstate highway and one of the "Gateways to the North Country" for the population of industrial cities such as Detroit, Flint, Saginaw, and Bay City, combined with an ever-increasing influx of tourists from our neighbors south of the border, Ohio, Indiana and Illinois.

A contract was awarded to widen the original three lane (and a small portion of four lane) pavement with 9 in. uniform concrete pavement to obtain a total overall width of 47 ft. The 3-ft. bituminous concrete divider strip was placed directly on the pavement, thus providing for two separate 22-ft. roadways. (Fig. 8)

The shoulders conform to our standard design for primary trunklines. Our experience has proved that adequate shoulders will greatly add to the safety and feeling of security they give the driver.

It is an established fact that a narrow shoulder will decrease the effective driving surface of the highway and seriously hamper the vehicle movement whenever a car breakdown occurs. Consequently, our standard shoulder width on major trunklines is 10 ft. This usually consists of a 2-ft. strip of gravel next to the metal, surfaced with a seal coat mixture, while the remaining 8 ft. are constructed of stabilized earth.

As a three-lane highway it did not function properly to accommodate an all-time high post war traffic. This was especially evident from the increased percentage of head-on collisions with an unusually high rate of fatalities.

The matter of dimensions and frequencies of median openings is perhaps a subject for further discussion. Generally on highways with a narrow
median, openings are restricted to intersections of important roads and approaches.

On this particular location, however, of areas with large numbers of business establishments along the highway, we decided to provide median openings at all approaches and all drives to buildings. Openings were not provided at seldom used field entrances. It was felt that the elimination of all driveway openings would result in a large number of U-turning movements at intersections which would prove extremely hazardous. The theory was to construct a dual highway which would partially retain the turning movements of an undivided four lane highway. While we are not entirely convinced that our spacing of openings is correct, traffic statistics and driver behavior over an extended period of time, will serve as a guide for the future.

It was decided to provide a median opening 95 ft. in length at intersections and 75 ft. at drives. This is generally in accordance with AASHO policy. (Fig. 10)

In order to give a feeling of median continuity, the bottom divider layer, 3 ft. wide and 2 in. high was carried across all driveway openings. The median was entirely omitted at intersecting approach roads.

A control speed zone with a 50 m.p.h. limit was established over the entire experimental section in 1947. This was partly due to the proximity of Bay City, and as a precautionary measure to reduce the high rate of accidents. All turning movements are restricted to the designated median openings, while traffic caution lights are placed at important intersecting roads. Because of the high volume of traffic at Linwood Road, at the extreme north end of the

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**Figure 5. Typical Cross Section, US 24 South of Pontiac**

**Figure 6. Typical Cross Section, US 23 Bay City North**
initial construction a standard overhead control signal was required to permit crossing with safety.

Approximately one half of the project traverses an old lake bed consisting of wave cut glacial till, while the other half follows a sandy beach left by a former glacial lake. Since the profile of the highway and surrounding terrain is extremely level, the principal drainage problem consisted of the disposal of surface water. Special "scuppers" or openings through the median, were designated to take the surface water across the pavement on super-elevated curves. (Fig. 12) All road ditches are emptied into a network of county drains which outlet into Saginaw Bay.

Figure 7. US 23, Bay City North

THE MEDIAN

It has previously been mentioned that the primary reason for selecting a narrow divider construction of bituminous concrete was for the purpose of safety and economy. Although the plan design called for only one type of median throughout the entire 10 mi. experimental section, three different dividers were actually completed on construction.

The major section of approximately 9 mi., has 3 layers, each 2 in. thick. The bottom layer is 36 in. wide, the middle layer 24 in. wide, and the top layer 12 in. wide.

The second section was built in 2-in. layers, 36 in., 30 in. and 24 in. wide respectively. (Figs. 13 to 19)

On the third section only 2 layers were constructed, one 36 in. wide, the other 24 in. wide. Each of the layers were 2½ in. thick.

The actual construction of the median was rather simple. A standard bituminous concrete surfacing mixture consisting of coarse aggregate, fine aggregate, mineral filler and bituminous material were used, while a regular bond coat was applied to the concrete pavement prior to the placing of the bottom course.

All courses were laid by ordinary equipment with adjustable spreader for width and height. Each layer, except the top course, was rolled separately with rollers 36 to 38 in. wide and weighing respectively from 2 to 4 tons. The top layer was rolled by a 15-in. garden roller weighing 350 pounds.

In order to increase visibility of the strip at night, a 4-in. yellow line was painted on each side of the bottom layer of the strip. Also, a white line 2 ft. wide and spaced diagonally every 20 ft. was painted across the median. To further increase the visibility, a reflector type paint containing minute glass beads was used.

THE COST

The contract price of the entire project consisting of 10.3 mi. of grading for widening and surfacing, including the bituminous divider strip was $463,819.00. The cost of the bituminous divider was $34,400.00, or approximately 82 cents per lin. ft. It is estimated that a comparable divider strip constructed of Portland Cement Concrete would cost about $2.00 per lin. ft.
Figure 8. Typical Cross Section US 23 Bay City North

Figure 11. Openings in Median US 23 Bay City North

Figure 9. US 23, North of Bay City

Figure 12. Detail of Median US 23 Bay City North

Figure 10. Openings in Median US 23 Bay City North

Figure 13. Three Layer Bituminous Concrete Median
Figure 14. Placing Bottom Median Layer

Figure 15. Placing Second Median Layer
Figure 16. Placing Top Median Layer

Figure 19. Two Layer Median

Figure 17. Rolling the Bottom Layer

Figure 20. Daily Vehicle Volume Count Intersection US 23 and Linwood Drive - Turning Movements at Intersection with Linwood Road

TRAFFIC

The average daily 24 hour traffic volume is approximately 7,000 vehicles. However, this volume fluctuates sharply as it exceeds 12,000 vehicles on weekends and holidays during recreational seasons. About
20 percent of the traffic consists of commercial vehicles.

The following data has been compiled by our Traffic Engineers:

1. Average Daily Traffic Data - The 1949 average daily traffic on US-23 near Linwood Road was 7,560 vehicles.
2. Peak morning hours are 8 AM to 12 Noon with 25.3% of total traffic. Peak afternoon hours are 1 PM to 5 PM with 28.6% of total traffic.
3. Peak directional hours are the same as listed above with peak AM Northbound hour 9 AM - 10 AM, PM Northbound hour 1 PM - 2 PM, AM Southbound hour 11 AM - 12 Noon, PM Southbound hour 2 PM - 3 PM.
4. Traffic Composition

<table>
<thead>
<tr>
<th></th>
<th>Southbound</th>
<th>Northbound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passenger cars</td>
<td>75.5</td>
<td>77.5</td>
</tr>
<tr>
<td>Passenger cars with trailer</td>
<td>2.9</td>
<td>2.4</td>
</tr>
<tr>
<td>Panel or Pickup &amp; Dual rear tire - 2 axle trucks</td>
<td>13.9</td>
<td>13.0</td>
</tr>
<tr>
<td>Tractor - Semi &amp; Trailer - Busses</td>
<td>7.7</td>
<td>7.1</td>
</tr>
</tbody>
</table>

SPEED

Speed checks were made before and after the construction of the divider with the following result: August 1949, (Before Construction) Speed check of 3600 vehicles. The average speed of these vehicles was 51.9 m.p.h. 85 percent of the vehicles did not exceed 61.9 m.p.h. November 1950, (After Construction) speed check of 1326 vehicles. The average speed of these vehicles was 51.5 m.p.h. 85 percent of the vehicles did not exceed 59.4 m.p.h. These spot checks were made within the 50 m.p.h. speed zone area.

VEHICLE PLACEMENT STUDY

A study was made by visual observation of vehicle placement by means of paint marks on pavement at one foot intervals from the median edge. The total vehicles shown obviously represent a small percentage of practical roadway capacity for the periods of observation. For this reason, it is reasonable to assume that most of the vehicles observed in the lane adjacent to the median were engaged in a passing maneuver.

Accident Experience - As a three lane highway US-23 had unrestricted sight distance both horizontally and vertically. The accident rate was nevertheless high with a large number of fatalities.

During the tourist season, when the traffic flow reached its peak, the average speed was approximately 45 m.p.h. While the average speeds were normal there were times when drivers were traveling at the rate of 60 to 80 m.p.h., three lanes abreast, forcing the opposing traffic to use the roadway shoulders. Over 6 months period 1946-1947, three collisions killed 13 persons.

Special precautionary measures were taken in an attempt to reduce the accident rates. ReflectORIZED lanes were painted twice a year, oversized signs were erected cautioning the motorist that the center lane was for passing only, and a speed limit of 50 m.p.h. was established.

Accident statistics were also recorded for a comparable three months period before and after the median was constructed. During these same periods accidents on the State rural system increased 22 percent in 1950 over 1948. For this reason, the preliminary short period studies were not expected to show an appreciable drop from the total of 40 accidents reported in 1948 within the median section. Classification of these accidents, however, revealed a sharp reduction in opposite direction collisions from 10 to zero after construction of the median.
Likewise, our records indicate a distinct reduction in the number of injuries since construction of the divider. In the three month periods mentioned above, 1 person was killed and 27 injured before placing the median, against no fatalities and 13 persons injured after the median was built.

It may be of interest to note that one of the factors which increases the total reported accidents is the close proximity of a State Police Post to the area of accident concentration.

It is too early, of course, to form any definite conclusions regarding the accident ratio, the State Police point out, however, that they believe the opposite directional type of collisions will be practically eliminated on this section in the future.

THE SUMMARY

Reason for choice of design - The ideal solution to our transportation problem on this particular highway would, of course, have been to reconstruct the entire section of highway in accordance with the highest standards for divided highways.

As a more realistic approach, economy being one of the primary factors, we attempted to introduce a low cost divider strip with the principal objective of eliminating the high percentage of head-on collisions.

It has already been mentioned that any additional right-of-way would have been difficult to obtain and at a prohibitive cost. Consequently, a process of expensive stage construction would have been

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ACCIDENT RECORD BY TYPE AND SEVERITY
FOR
THREE YEARS PRIOR TO MEDIAN CONSTRUCTION

US-23 From N. Union St. Through Linwood Road
Bay County
Years 1946, 1947 and 1948

| Type                | Accidents Between Intersections | Severeity | |
|---------------------|---------------------------------|-----------|
|                     | No. of Accidents | Fatal       | Injury  | Damage | Killed | Injured |
| Opposite Direction  | 63                | 2           | 26  | 35  | 10     | 65      |
| Sidewipe (Same Direction) | 11            | 0           | 2   | 9   | 0      | 2       |
| Rear End            | 85                | 0           | 21  | 64  | 0      | 27      |
| Ram Off Road        | 27                | 0           | 9   | 18  | 0      | 10      |
| Pedestrian          | 4                 | 1           | 3   | 0   | 1      | 3       |
| U-Turn              | 6                 | 0           | 3   | 3   | 0      | 8       |
| Miscellaneous       | 9                 | 1           | 2   | 6   | 2      | 8       |
| Sub-Total           | 205               | 4           | 66  | 135 | 13     | 123     |

| Accidents of Intersections | Sub-Total | 76 | 1  | 20 | 55 | 1  | 38 |
| Total                      | 281        | 5  | 86 | 190 | 14 | 161 |
exceedingly slow, without any immediate relief for a major part of this congested trunkline.

DEMONSTRATED ADVANTAGES
(CONCLUSIONS TO DATE)

While it is too early to form a positive conclusion, after only four months of operation, it is safe to assume that nearly all of the opposite directional type of accidents have been eliminated. The severity of other types of accidents have also been considerably reduced since the installation of the divider strip.

Construction of the bituminous divider strip and the pavement widening can be accomplished without completely disrupting the traffic.

Cost of the bituminous concrete median is considerably less than that of Portland Cement Concrete construction.

Additional openings for future driveways can easily be made.

Figure 21 Vehicle Placement Study - US 23 North of Bay City - 4 Lane Divided Highway with 3-in. Bituminous Median
SUGGESTIONS FOR FUTURE DESIGN

From observations made to date, it appears that the two layer divider 36 in. at bottom, 24 in. at top, with each layer 2½ in. thick, will be the choice for a future design. The 24-in. top provides a wider signing surface, which in turn distinctly increases the overall visibility of the median. To further improve the visibility of the divider at night, it may be advisable to erect reflectorized delineators in the center of the median. Delineators erected, say four feet above the pavement, would also serve as a guide when snow might cover the median for a short period of time.

On future construction special equipment and perhaps a special bituminous mixture will, no doubt be developed to increase efficiency in construction as well as improvement in appearance. Critical shortage of Portland cement may also favor this type of a median.

Figure 22. Vehicle Placement Study - US 23 North of Bay City - 4 Lane Divided Highway with 3-in. Bituminous Median
In conclusion I again want to emphasize that we are experimenting and have not as yet reached conclusive proof that our problem is entirely corrected. We realize that a narrow median has its limitations. We have previously used successfully, a narrow type of a divider when we had limited access and where side friction was practically nonexistent.

Perhaps the success of a narrow divider strip should be judged by the driver behavior. If our statistics over a period of say 2 years, reflect an improved driver behavior, demonstrated by a proportional reduction in accidents, especially head-on collisions, we will feel that our experiment was justified.

### APPENDIX

The Michigan State Police have issued the following two statements regarding their observations and experience, while patrolling this highway, since the three foot median was constructed.
Subject. Observations and Reaction to the Median Divider on US-23 North of Bay City

To Captain William Hansen, Superintendent, Uniform Division, East Lansing

This report is with reference to the request contained in your letter of November 10, 1950, regarding the median divider installed on highway US-23 between Bay City and Linwood, a distance of about twelve miles.

Since the installation of the median divider on highway US-23, north of Bay City, personnel of the Bay City Post have made daily observations of driver behavior under daytime and night time driving conditions, speed, lane usage and the appearance of the median divider under adverse weather and driving conditions. From these daily observations, we have noted a marked improvement in driver behavior generally with emphasis on lane usage.

The median divider, we believe from our observations and experience since its installation, has eliminated the wandering lane driver, third lane passing, and head-on collisions which were quite frequent and of serious consequences prior to the installation of the median divider. Since the installation of this divider, we have not experienced a serious accident involving two motor vehicles.

We have observed that the median divider, in our opinion, has created a mental hazard (alertness) which tends to keep the driver alert and attentive to his driving responsibilities.

Public reaction has been very favorable to the divider with exception to the median divider being fairly difficult to observe under adverse weather conditions especially misty rainy nights. Personnel of the Bay City Post concur with the public regarding the difficulty to observe the divider under adverse weather conditions. To correct this condition, we suggest that additional painting would materially improve the drivers problem to observe the divider under adverse weather and driving conditions. It is further suggested that some thought be given the installation of four foot markers with reflector heads every one hundred fifty feet atop the median divider. Markers of this type, if installed, would not only guide the driver during adverse weather conditions but also during the winter months when snow becomes a problem.

Under weather conditions which have prevailed since the installation of the median divider, the reaction of the personnel assigned to the Bay City Post is very favorable. However, winter driving conditions may create problems which will discredit the median divider. Answers to drifting snow, ice, snow removal, etc., in relation to the median divider have yet to be learned. Weather conditions and experience during the winter months will, in my opinion, determine the feasibility of the median divider.

Respectfully submitted,
/s/ Dan L. Wurzburg
Dan L. Wurzburg, Sergeant
Commanding Officer

cc 3rd Dist Commander

Bay City Post
Subject: Reaction to medial divider on US-23, North of Bay City

To: Captain William D. Hansen, Superintendent of Uniform Division, East Lansing, Michigan

This is with reference to your letter of November 10, pertaining to the above captioned subject.

The medial divider in question is located on US-23 and extends from the north limits of Bay City north to the Linwood Road, a distance of approximately ten and one-half miles.

The highway was formerly a three lane pavement. The fourth lane was added and completed for travel on November 13, 1949. From that time on there were occasional accidents of all types. However, undoubtedly fewer than on the standard width four lane pavement, because this highway was built wider to allow the medial divider to be added at a later date.

Then on, or about July 3, 1950, the medial divider was completed and since that time the front to front, or head-on accidents have been extinct.

The only accidents on the above mentioned highway since the installation of the medial divider have been rear-end collisions of not too serious a nature, which are caused by drivers stopping suddenly in the inside lane when intending to make a left turn at intersections and regular cross traffic intersection accidents.

The personal injury list has been exceptionally low and of a minor nature up to this time. Of course, hazardous driving conditions have been at a minimum since the installation of the medial divider. Many persons are of the opinion that the medial divider will cause hazardous driving conditions during the winter months, by preventing the water and slush from draining off during the day time, which will naturally freeze during the night.

The outstanding complaint being received from motorists is that they are unable to see the divider at night, especially in rainy, misty, or foggy weather, when traffic is very light.

On Sunday, November 19, between the hours of 2:30 PM and 9:30 PM, during misty weather conditions, the heaviest traffic flow in history traveled south on US-23 and during that time there were just two very minor rear-end property damage accidents on the highway in question.

In our opinion, the medial divider has aided greatly in the reduction of accidents this far and we are anxiously waiting to see what changes winter weather will bring, if any.

Respectfully submitted,
/s/ E E. Secrist
Captain E E. Secrist
District Commander
District No 3