

## **The Effect of Windscreen on Field of Vision in Tractors**

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**Abstract:** Tractors are used in dusty and muddy conditions because of its functionality. However, apparatus using for increasing the field of vision in tractors can not eliminate the risks associated with these conditions. In some situations, windscreen may be entirely covered with mud and field of vision may be limited by the only part of the wipers sweep. Efficiency of tractor wipers are assessed according to the current regulations (in respect to the legislation issued by Ministry of Science, Industry and Technology). "2008/2AT Type Approval Legislation related to Field of view and windscreen wipers Agricultural Wheeled Tractors or Forestry Tractors" ( Valid in Turkey and European Countries) and/or equivalent regulation "R-71 Approval of Agricultural and Forestry on drivers' field of vision" (valid in countries which are member of United Nations).

In this study, a research was carried out on agricultural tractors equipped with a cab in accordance with aforementioned legislation. These two tractors have different track width, and they operated by three expert drivers. With reference to "Type Approval Regulations 2008/2/AT and 2009/66 related to Steering Equipment of Agricultural Wheeled and Forestry Tractors" a special 100 meters 'S' shaped track formed by 2 circles has been designed. Test track was formed in respect to current regulations and average rural road and its border determined as 3 and 4 meters wide by using pins. Trials were carried out in two different speeds; at constant speed and normal drive and windscreen was clear and dirty. After trials, it was observed that number of pins overthrown were variable depends on operator's experience, track width or high clearance shape of tractor, speed and windscreen's conditions or type. The assessment of Agricultural and Forestry Tractors in this research showed the current regulations or standards cannot provide enough security. For that reason, it was concluded that current regulations and standards should be revised in order to be able to provide enough driving security.

**Key words:** Field of view, wipers, driving security, tractor

### **INTRODUCTION**

Agricultural tractors have been used in Turkish Agriculture since the foundation of the Republic. However, the number of tractors, in real terms has increased as paralel with the world after World War II. Unfortunately, Type approval of tractors and regulations to realize it and standards were not touched upon although our country has so many factories producing tractors. Especially the agreements at the beginning of 2000s in European Union due to participation process brought forth some new obligations. After that time, it was noticed that tractors need to meet 1 framework and 23 sub-regulations and referring 2 standards. Most of the regulations which tractors need to comply before

coming onto the market were developed to ensure safe drive or use. This includes so many aspects such as providing tractors with protective structure against rolling, suitable brake mechanism, mirrors, headlamp, vibration of driving seat, position and ergonomics of control organs. In this sense, main goal is to provide safety for the operator, the person who accompanies the driver and the auxiliary staff using equipment. However, fatal and serious injuries caused by tractors which are controlled this much before placing on the market are more than the other accidents in rural areas. Accidents may sometimes be caused by the operator, by the road or the vehicle which is used.

After compulsory regulations and standards were perceived in Turkey seriously tractors were started to be analyzed in a different way. Many issues which couldn't be foreseen until now by the countries that contribute to Standard development have been brought forward by our country's tractor tests. All over the world, compatibility of the tractors to the standards are decided by technical services authorized by national organizations in their country. In our country, the excellence of authorized organization to provide compliance for both Europe and OECD Standard is Agricultural Equipment and Machines Test Center (TAMTEST). About 1000 tractors which were manufactured in domestic market or imported in different size and model have been tested in this testing centre since last 15 years.

Another criterion that tractors should comply is the "Type-approval of Agricultural or forestry tractors' field of vision and windscreen wiper" (2008/2/AT). In sum, this regulation enables the person on operator's seat to see field of vision at minimum level. Additionally, it is also intended to determine wipers' performance which helps to clean the dirt interrupting vision and on rainy days if the tractor is equipped with a cab. Although all tractors on the market were tested according to the current instructions for field of vision and then, leave for, there exist so many accidents. Over time, there have been big changes in tractor cab design. Cabs with large glass surface became prominent to increase current field of vision parallel with manufacturers' and customers' needs. Glass surfaces were needed not only in front, back and side but also in the parts where foot pedals exist to see the tractor tire. Besides, tractor equipments has been designed to tie both in front and back of the tractors. By doing so, significance of vision of tractors have increased. However, in this process there hasn't been very important changes related to the tractors' field of vision. For tractors with cab, there have been significant changes in that their shape and design, but tests on wipers haven't revealed an expression like windshield wipers' field of sweep". But these test don't have the procedures that can satisfy today's technology. Because, according to accident identifications, half of the accidents happen on the farms while %18 takes place on highway route. %44

of these accidents happen on country road and the rest is seen on farm, internal and countryside, forest and forest roads. (Perktaş,2007). In this sense, it is a significant issue for tractor operators to see their environment clearly when they drive more slowly on a road on which high speed vehicles go fast. Another issue is that on stabilized or soil type rural roads there may be some risks as a result of tractors' windows get dirty and wipers' function don't work well. When we consider that the rural roads are relatively narrow and possibility of accident increases in this roads due to falling of front wheel's into a verge. In this case overturning, crash or Rolling may happen. Rate of accidents involving the tractors according to width of the road are shown below: (Perktaş,2007) According to this graph, most of the accidents(%33,21) had happened on 4-4,9 meters roads.

It is obvious that insufficiency of field of vision has an big role on the accidents happen due to the road, vehicle, operator or environmental reasons. In order to be able to reduce the number of tractor accidents and to provide safer tractors to the market and traffic, International regulations should be improved and applied in our country. By improving or revising these regulations the operator can work in safer working conditions and they will use the equipment attached to tractor safely. Additionally, while tractor is travelling on the way the operator will be able to notice unexpected situations and this will decrease the possibility of the accident in a large extent. Literature reviews has shown that a study which corresponds this issue has not been considered before.

Field of vision is a very important concept for agricultural tractors because of their structure and working conditions. When a tractor cruising from the rural road to the high way it travels with other vehicles so that its speed increases. If a problem arises with operator's field of vision it leads to accidents involving death or personal injury. Moreover, while working on the field, front and back wheels with a reference point for agricultural activity operator has difficulty in seeing the front wheel when the wind screen gets dirty or muddy. In such situations, field of vision lessens and more importantly, some risky situations that farmer don't expect may happen.

**Table 1. Range of accidents that tractors involve according to roadway width (meter)**

Width	4,0 – 4,9	5,0 – 5,9	6,0 – 6,9	7,0 – 7,9	8,0 – 8,9	Uncertain	Total
Rate (%)	33,21	17,86	15,36	9,29	6,79	17,50	100

Today, there are about 40 companies on the market and 6 of them domestic. All of these companies need to apply for TAMTEST to put their tractors into the market and they have to get National Type Approval as well. TAMTEST has performed tests and trials of more than 1000 trials and approved the compliance of these tractors by using national and international standards. More than 100 of these tests were devoted to field of vision.

Studies on field of vision are very limited numbers in the world and there haven't been found any study to correspond this research. In this sense, the study includes innovations both on national and international basis

### MATERIALS and METHOD

In this study, 2 tractors with cab which have different track widths and 3 operators with high driving experience were used. For the tractors that were brought to TAMTEST for trial necessary permissions were taken.

#### Tractor 1

Width from tyre wall 2.30 m

Power : 135 HP



Figure 1. Tractor 1

#### Tractor 2

Width from tyre wall 1.75 m

Power : 75 HP



Figure 2. Tractor 2

### Parcour

As parcour, an empty field which exists on "39.949089, 32.836976" coordinates on Atatürk Culture Center Area which has stabilised road aspects was used. (Figure 3)



Figure 3. Parcour location

In an 'S' shape parcour was formed by two semi-circles in 12 meters radius with reference to 'TYPE APPROVAL REGULATION RELATED TO STEERING EQUIPMENT'2009/66/AT' A 20 meters straight road was continued from the point of this "S" shaped path finishes and then, the road was rotated 90° with a 12 meters radius bend and it finished on in a more straight way.

Along with the parcour, two lobuts which are 1.5 meters and 2 meters were located on two sides of the road center. Diameter of the labuts were determined 60 mm while height was 210 mm. Image of parcour was showed below (Figure 4 and 5)

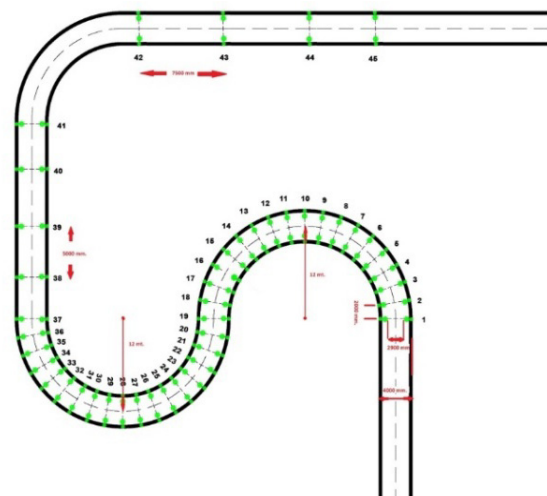


Figure 4. Parcour

## Preparation



Figure 5

## Preparation of Tractors

3 operators were used during the study. Each operator finished track with clear vision, then wind screen of the tractors were covered with mud by means of a brush. After that, with the help of wipers, just the area that wipers swept became visible so that operators can finish the parcours again (Figure 6).



Figure 6

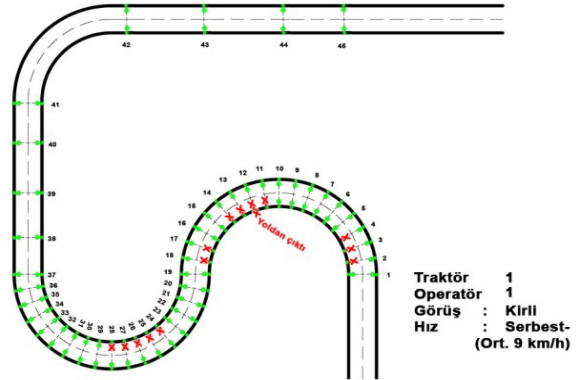
## RESULTS and DISCUSSION

### 1. Results for operator 1 after the study

#### 1.1. Operator 1, tractor 1, Clear vision

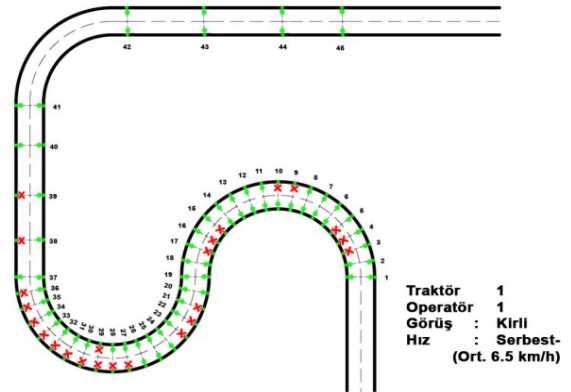
Operator's field of vision by tractor 1 is clear and in this trial with 10km/s constant speed, no labut collapsed.

#### 1.2. Operator 1 Tractor 1; Limited vision



Field of vision of operator 1 by tractor 1 was limited and at 10 km/h constant speed labuts overturned at 23 lines. (lines with red dots) At 12th line, the tractor went out of the track.

#### 1.3. Operator 1 Tractor 1, Limited vision, Free speed

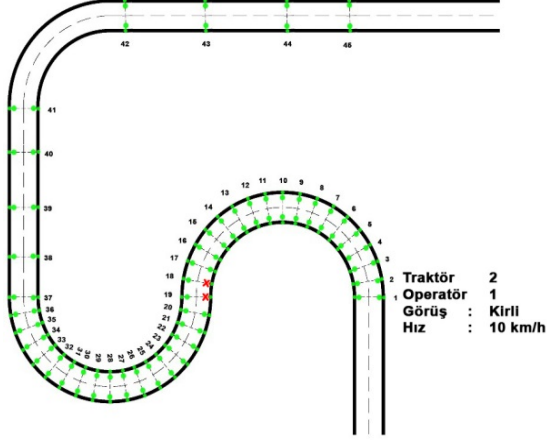


Field of vision Operator 1 by tractor 1 is limited, and at free speed trial labuts overturned at 23 lines. (lines with red dot)

#### 1.4. Operator 1 Tractor 2, Clear field of vision

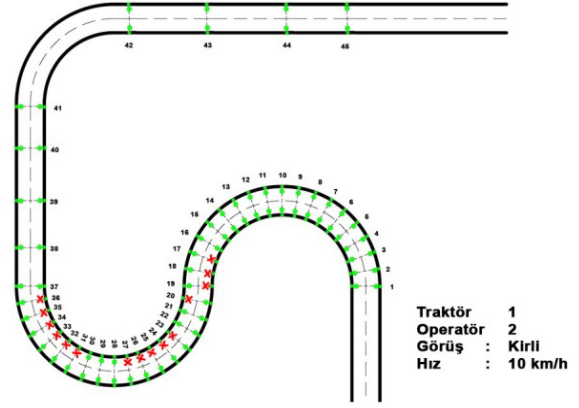
Field of vision of operator 1 by tractor 2 is clear and at this trial with free speed, no labut overturned.

### 1.5. Operator 1, Tractor 2, Limited vision



Field of vision of operator 1 by tractor 2 is limited, and at 10 km/h speed trial labuts overturned at 2 lines. (lines with red dot)

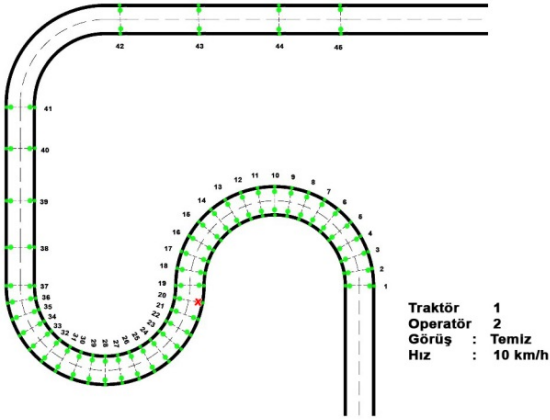
### 2.2 Operator 2, tractor 1, Limited vision



Field of vision of operator 2 by tractor 1 was limited and at 10 km/h constant speed labuts overturned at 15 lines (station with red dots)

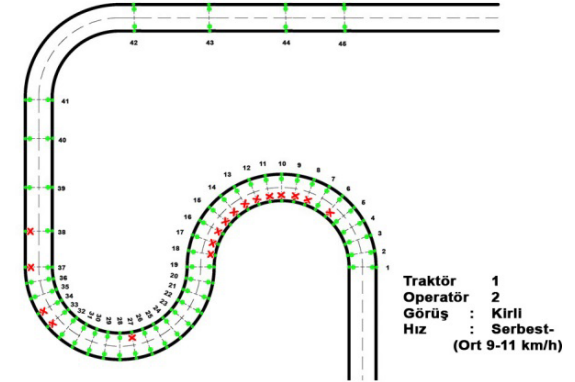
## 2. Results for Operator 2 after the study :

### 2.1 Operator 2, tractor 1, Clear vision



Field of vision of operator 2 by tractor 1 is clear at 10 km/h trial and labuts overturned at one line ( line with red dots)

### 2.3. Operator 2, tractor 1, Limited Vision



Field of vision of operator 2 with tractor 1 was limited and at free speed trial lobuts collapsed at 17 lines (stations with red dots)

### 2.4. Operator 2, traktor 2, Clear vision

Field of vision of operator 2 by tractor 2 was clear and at 10 km/h constant speed no labuts collapsed.

### 2.5. Operator 2, tractor 2, limited vision

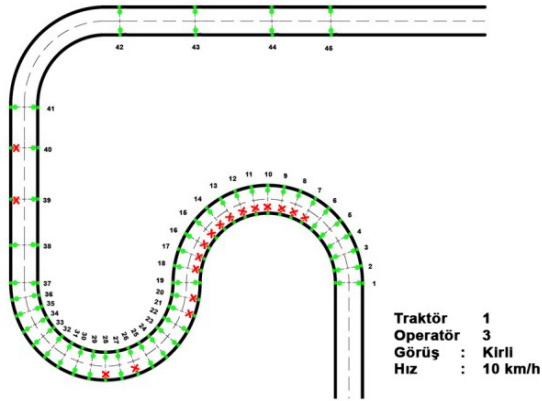
Field of vision of operator 2 with tractor 2 was limited and at 10 km/h constant speed trials , no labuts overturned.

### 3. Results that we added for operator 3 after trials :

#### 3.1. Operator 3, tractor 1, Clear vision

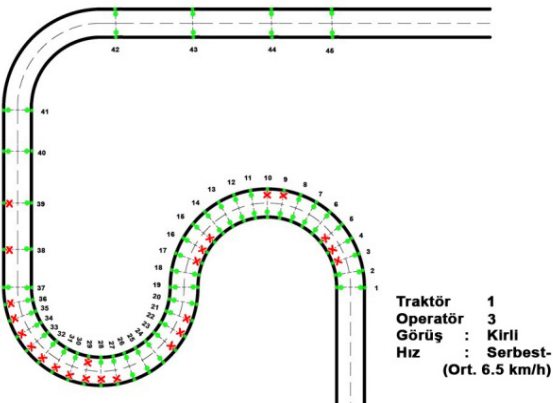
Field of vision of operator 3 with tractor 1 was clear and at 10 km/h constant speed no lobuts overturned.

#### 3.2. Operator 3, tractor 1, limited vision



Field of vision of operator 3 by tractor 1 was limited and at 10 km/h constant speed lobuts collapsed at 18 lines.(stations with red dots)

#### 3.3. Operator 3, tractor 1, Limited vision

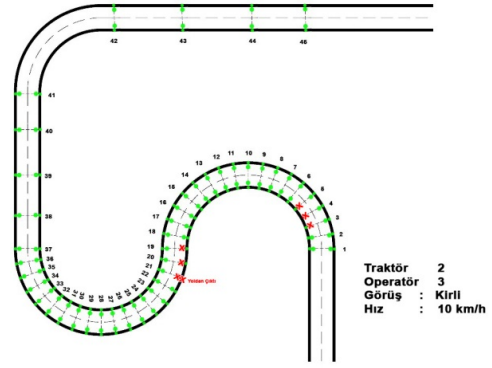


Field of vision of operator 3 with tractor 1 was limited and at free speed trial lobuts collapsed at 23 lines (stations with red dots)

#### 3.4. Operator 3, Tractor 2,Clear vision

Field of vision of operator 3 with tractor 2 was clear and at 10 km/h constant speed lobuts overturned at one line.

#### 3.5. Operator 3, Tractor 2,Limited Vision



Field of vision of operator 3 by tractor 2 was limited and at 10 km/h constant speed lobuts collapsed at 6 lines and because of insufficient field of vision at 21st line the operator got out of the track.

### CONCLUSIONS

As it can be seen from the study results, when the tractor's field of vision is clear each operator could drive it easily and they did not get out of the track.

However, if the field of vision was limited lobuts collapsed although windshield wipers swept that area. As it can be seen from these trials, areas that wipers sweep usually get mud and so, field of vision is confined.

Because of the fact that the angle between operator's sitting point and wipers' sweeping area is narrow people, animal and everything that threaten safe driving such as stone, tree, mound, hillside, cliff etc. that stay out of the field of vision cannot be seen by the operator.

It can be clearly seen that, although tractors that match with 2008/02/AT TYPE APPROVAL REGULATION FOR STEERING EQUIPMENT OF AGRICULTURAL WHEELED TRACTORS were used in this study, operators overthrew the lobuts when they just have the field of vision provided by the area that wipers swept. It shouldn't be forgotten these tractors are the ones that are on the markets for sale and they are used currently. It is obvious that regulation remains incapable and operator that has the field of vision swept by wipers hasn't sufficient security although regulation is appropriate for the legislation. So, regulations need to be revised.

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