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# Highway application control enhanced by algorithm-based new interface software

## *Algoritma tabanlı yeni arayüz yazılımı ile karayolu uygulaması kontrolünün artırılması*

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**Abstract**

One of the significant challenges encountered during the implementation of highway projects today is the inability to perform accurate and timely inspections. This results in both loss of time and the potential for uncontrolled construction at various points due to insufficient control capabilities at every site. During the preparation of highway projects, cross-sections of only specific points can be obtained, which limits the scope of inspection during implementation. The ability to inspect points outside these cross-sections and control the areas beyond the axis line of the cross-section points during the project execution would provide a significant advantage. Additionally, this approach would result in time and cost savings, enabling the swift execution and control of construction at points outside the cross-section axis line according to project requirements. In this context, an algorithm has been designed to instantly calculate the distance of any point from the starting point, its distance from the road axis, and the required elevation along the designed elevation profile. This algorithm has been utilized to develop a computer program (interface software) to instantly calculate all relevant data for any given point during the project construction phase. For instance, in a completed highway project, using this interface facilitated the analyses of cost benefits achieved.

**Keywords:** Algorithm, Earthwork, Highway, Optimization, Software, Vertical alignments

***Öz***

*Günümüzde karayolu projelerinin uygulanması sırasında karşılaşılan en önemli problemlerden birisi, karayolu proje denetimlerinin doğru ve kısa sürede yapılamayışıdır. Bu yüzden hem zaman kaybı söz konusu olmakta hem de her noktada tam kontrol imkânı bulunmadığından; kontrol dışı yapımlar söz konusu olabilmektedir. Karayolu projeleri hazırlanırken sadece belirli noktaların enkesitleri alınabilmektedir. Bu kapsamda uygulama sırasında sadece belirli noktaların kontrolü mümkündür. Bu enkesit noktalarının dışındaki noktaların kontrol edilebilmesi ve projedeki enkesit noktalarının yol genişliğince eksen hattı dışındaki noktaların kontrolünü sağlayabilmek önemli bir avantaj kazandıracaktır. Bunun yanında hem zaman ve maliyet tasarrufu sağlanması, hem de çok kısa sürede uygulama sırasında projeye uygun şekilde enkesit eksen hattı dışında kalan noktalardaki imalatların yapımı ve kontrolünün sağlanabilmesi önemli kolaylık getirecektir. Bu bağlamda, herhangi bir noktanın ilk önce başlangıç noktasına uzaklığını (kilometrajını) ve aynı zamanda o noktanın yol eksenine olan uzaklığını hem de o noktaya ait kırmızı çizgisi üzerinde olması gereken yükseklik kotunu anında hesaplanabilması için bir algoritma tasarlanmıştır. Bu çalışma sonunda, elde edilen algoritma sayesinde bir bilgisayar programı (arayüz yazılımı) tasarlanmıştır. Proje yapım aşamasında bu arayüz kullanılarak herhangi bir nokta için, anında o noktaya ait tüm veriler gösterilebilmektedir. Örnek olarak; inşaatı tamamlanmış bir karayolu projesinde, bu arayüz kullanıldığı taktirde maliyet açısından ne kadar kar edildiğine dair analizler gerçekleştirilmiştir.*

**Anahtar kelimeler**: *Algoritma, Toprak işleri, Karayolu, Optimizasyon, Yazılım, Kırmızı çizgi*

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## 1. Introduction

The road body consists of two parts: infrastructure and the superstructure. Infrastructure refers to subsoil, which is the part under the leveling surface that is formed per the project at the end of earthworks (cutting and filling). The performance of the superstructure is directly related to the physical properties and condition of the subsoil. In this regard, the subsoil must always meet the requirements. The superstructure is a layered system that distributes traffic loads to the subsoil. It is designed to carry traffic throughout its economic life without experiencing significant deformation or cracks while withstanding environmental and climatic conditions (Sütaş & Güven, 1986).

In a road study, some solutions were produced through a computer for the quick inspection and control of certain critical points, and some problems that might arise during the application were avoided thanks to these solutions. Tangential alignment for a highway has a significant impact on road safety, construction costs, and operating costs. The importance of the optimum design concept has been recognized and studied since the 1960s, with the increase in the use of computers (Özkan, 2013).

Theoretically, there are an infinite number of alternatives to evaluate the horizontal alignment optimization problem. In some previous applications, the cost functions of the optimization problem were formulated ambiguously. Thus, it is inevitable to use fast and efficient search algorithms to solve such a problem (Kim et al., 2005).

Chew and others used numerical research in calculating the amounts of basic cross-section earthworks in their work (Chew et al., 1989).

In the other study, the volume of the land was calculated only on the length section and without using a cross section. Some of these studies include step-by-step genetic algorithms (Kim et al., 2005; Kim et al., 2003; Kim et al., 2007; Jha & Schonfeld, 2004).

Easa presented a cross-section template with the help of a linear program to calculate the land volumes in his studies on vertical alignment (Easa, 1988).

There are some other estimates for the optimization of the vertical alignments so that earthworks can be minimized. For example, (Moreb, 1996; Goh et al., 1988) have performed some studies on dynamic programming and state parameterization models with linear programming, (Fwa et al., 2002) on genetic algorithms, (Goktepe et al., 2005) on vertical alignment optimization with dynamic programming.

The excavation amount calculated from the profile is only an approximation and can sometimes cause serious errors in analysis. In order to achieve more efficient results, Göktepe et al. proposed the "Weighted Ground Line Method" for vertical alignment optimization studies (Goktepe & Lav, 2003; Goktepe & Lav, 2004; Goktepe et al., 2005; Goktepe et al., 2009).

Li & Shi, 2016 used the Visual Basic for Applications (VBA) program to complete a large number of height calculations in vertical curves, since the elevation calculation in the design of vertical and horizontal curves was a large workload and very tedious.

(Che, 2017) provided automatic calculation of the coordinates of the middle pile points of the road using the Excel VBA program in highway design. The results showed that this fast and accurate calculation method has strong practicality and generality and can be used as a reference for highway construction personnel.

A Particle Swarm Optimization (PSO) algorithm enhanced with Genetic Algorithm elements is proposed for optimizing 3D highway alignments. The model accounts for construction and environmental constraints and is tested using MATLAB and Digital Terrain Model data (Bosurgi et al., 2013).

The optimization of highway vertical alignment was achieved using the Colliding Bodies Optimization (CBO) algorithm, which demonstrated superior performance compared to Genetic Algorithm (GA) and Particle Swarm Optimization (PSO) in reducing earthwork costs (Ghanizadeh & Heidarabadizadeh, 2018).

Evaluating Genetic Algorithm (GA) and Particle Swarm Optimization (PSO) for optimizing vertical road alignments, this research focuses on cost reduction and design constraints. Both algorithms enhance alignment quality and lower earthwork costs compared to manual methods, with GA proving most effective for cost optimization and smoothness (Babapour et al., 2018).

As can be seen from the literature to date, only optimizations made in a highway design are described. However, achieving the best result in road construction is not possible by design alone. Implementation of optimized designs, application of each point of the project to the ground, and capability of mobile inspection and control are also very important in the construction phase of a project. In this context, it was decided to conduct this study based on the inspection and control of every point desired in the application.

The results given by the designed Highway Full Control Algorithm regarding the inspection of the application control points were found to be very satisfactory. Software coding was performed to instantly make calculations through this algorithm. Thanks to this algorithm, a computer program (interface software) was designed at the end of this study.

## 2. Material and method

It is well-known that, a project is first designed manually or through a computer program in the construction of highways. Therefore, all details of the road to be built, that is, all routes and the slopes of the vertical alignments and the details of all horizontal and vertical curves, are made according to the highway specifications.

### 2.1. Fixed details of the project

A highway plan consists of tangents (straight sections) and horizontal curves. The coordinates of any point considered for inspection of the design are read through the total station device. Then, the kilometerage of that point must be found according to the project starting point in the design. Therefore, for every project, all calculations regarding the project, including some details and dimensions, must be made on the approved maps prior to the commencement of the project and kept constant during the construction phase of the project. The road plan and initial coordinates consisting of tangent and horizontal curves are shown in Figure 1.

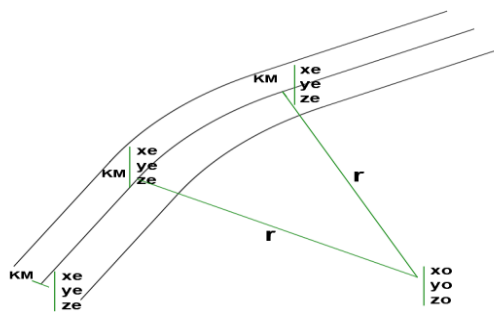


**Figure 1.** Initial coordinates of the tangent and horizontal curve parts of the road on the plan

The coordinates of any necessary point on the highway project are read through the total station device to obtain the coordinates (x, y, z) of that point. To find the kilometerage of that point with the help of these coordinates, the boundaries corresponding to the tangent or horizontal curve are found on the design according to the coordinate system of that point and kept constant until the completion of the road construction. The tangent and curve start kilometer points, the coordinates of each point, the radii of the curves, and the center coordinates of the curves were used in the algorithm that was designed to be fixed until the end of the project.

### 2.2. Angle in the project according to the trigonometric circle and trigonometric functions

If the point where the kilometer is desired to be determined (point C) is in the tangent part of the road, calculations were made using the formulas (1-3) given below, as shown in Figure 2.

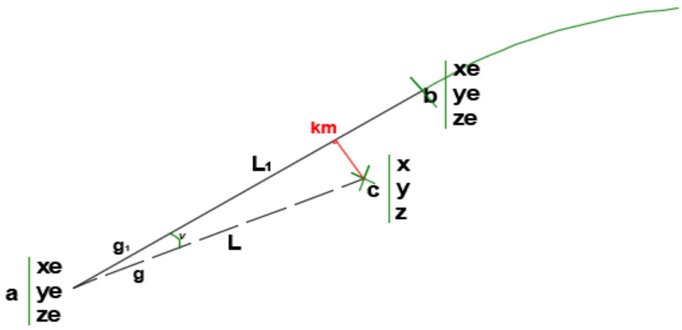


**Figure 2.** Point C on the tangent

$L = \sqrt{(x - xe)^2 + (y - ye)^2}$ (The coordinate of point C (x, y, z), the coordinate of the road axis (xe, ye, ze)) (1)

$V = \arctan\left|\frac{x-xe}{y-ye}\right|$ (2)

İf in first zone: $g \text{ ve } g1 = a'$ (The azimuths of any point, g and g1)
İf in second zone: $g \text{ ve } g1 = 180 - a'$
İf in third zone: $g \text{ ve } g1 = 180 + a'$
İf in fourth zone: $g \text{ ve } g1 = 360 - a'$ (3)

Action will be taken according to the zone of the coordinate system where the amount (a′) is found. That is, (g) or (g1) is calculated as shown in Figure 3.

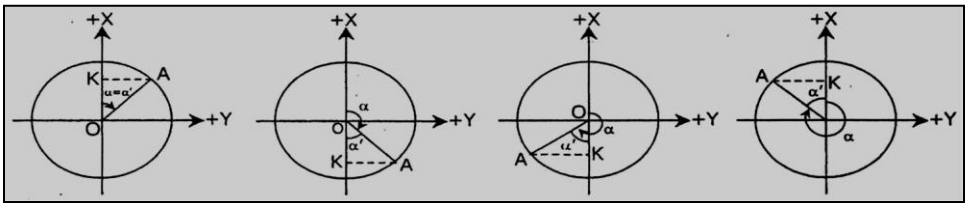


**Figure 3.** Four zones in a trigonometric unit circle

If the point whose kilometer we want to find (point C) is in the section with a horizontal curve, it is found through the formulas (4-5) given below, as in Figure 4.

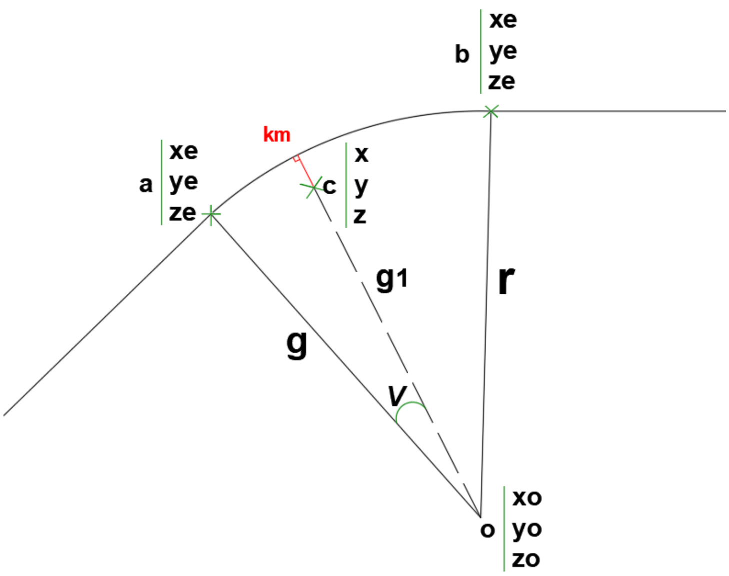


**Figure 4.** Point C on a horizontal curve

$$V = \arctan\left|\frac{x-xe}{y-ye}\right| \tag{4}$$

$$\begin{aligned} &\text{İf in first zone:} && g \text{ ve } g1 = a' \\ &\text{İf in second zone:} && g \text{ ve } g1 = 180 - a' \\ &\text{İf in third zone:} && g \text{ ve } g1 = 180 + a' \\ &\text{İf in fourth zone:} && g \text{ ve } g1 = 360 - a' \end{aligned} \tag{5}$$

The action will be taken based on the zone of the coordinate system where the value (a') is located. Specifically, the details labeled (g) or (g1) were calculated as illustrated in Figure 3.

### 2.3. The distance of the road to the starting point (in kilometer)

The kilometer of a sample point C given in Figure 2 with the calculations given above, which corresponds to the tangent part of the road axis, is found through the following formula based on the start of the highway project.

$$km_c = (L \times \cos(g1 - g)) + km_a \tag{6}$$

The kilometer of point C, situated within the horizontal curve area and corresponding to the road axis, is calculated using the following formula based on the starting point.

$$km_c = (g - g1) \times \frac{\pi}{180} \times r + km_a \tag{7}$$

### 2.4. Distance to the road axis

After finding the kilometer of any desired point in the road construction, the distance of that point to the road axis at that kilometer (Figure 5) is calculated by the formulas (8-9) below.

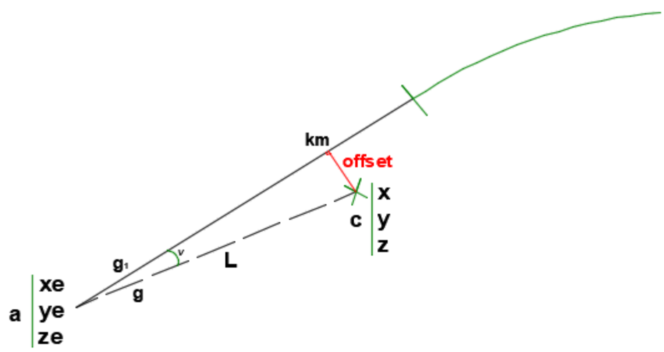


**Figure 5.** Distance to the axis

$$L = \sqrt{(x - xe)^2 + (y - ye)^2} \tag{8}$$

$$\text{Offset} = L \times \sin(g1 - g) \tag{9}$$

### 2.5. Height of any point on the axis

During the implementation of a highway project, the kilometer of any point is found according to the road axis, and then the elevation of that point can be obtained. To this end, some information is kept constant during the construction phase. Therefore, these figures and information are written in an Excel file and read by the Matlab program to find the elevation of any point. In other words, the required level of that point on the vertical alignments is found, and it can be thoroughly examined according to the final (at the moment of control) state of the project. In the construction phase of a highway project, the numerical values of certain critical points are kept constant. For example, the straight alignment sections of the project consist of one slope, and the vertical curve sections consist of two slopes (Figure 6).

If it is in the alignment section, its elevation on the axis:

$$H = km \times \frac{g1}{100} + h \qquad \text{(km: the kilometer of the starting point, h: the elevation of the starting point)} \qquad (10)$$

If it is in the vertical curve section, its elevation on the axis:

$$H = \left(\frac{g2-g1}{2(km2-km1)} \times km1^2 + (g1 \times km1)\right) \div 100 + h1 \qquad \text{(km1 and km2: start and end of the horizontal curve)} \qquad (11)$$

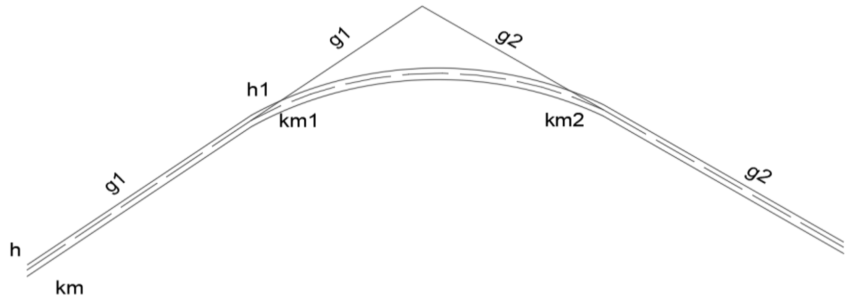


**Figure 6.** Alignment and vertical curve parts

## 2.6. Elevation of any point outside the axis

The elevation calculated in formulas 10 and 11 is the elevation of the kilometer corresponding to the axis of any point on the design. To determine the elevation of any point on the vertical alignments, it is essential first to calculate the elevation at the specified kilometer mark on the axis. Following this, the slope on both the right and left sides of the road, the lengths of these sides, and the elevations at their endpoints must be considered. Additionally, the slope ratios on the right and left sides of the road, as illustrated in Figure 7, should be taken into account. Using the formulas (12-14) provided below, the elevation of any point on the vertical alignments can then be calculated based on the distance from the axis.

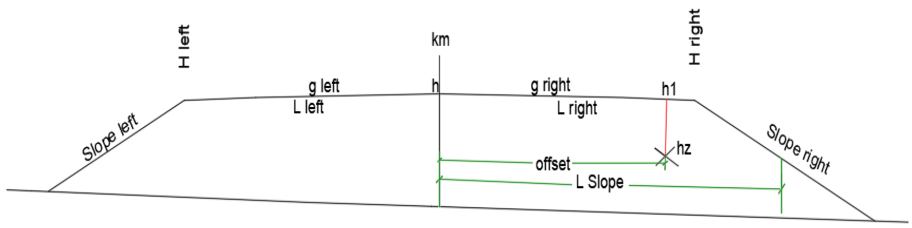


**Figure 7.** Elevation on the axis

$$H\ right = (L\ right \times g\ right) + h \qquad \text{(h: height, L: length, g: slope)} \qquad (12)$$

$$h1 = (offset \times g\ right) + h \qquad \text{(offset: distance from the axis)} \qquad (13)$$

$$L\ Slope = L\ right + (h1 - hz) \times Slope\ right \qquad \text{(Slope: gradients of the road slopes)} \qquad (14)$$

## 3. Findings and examination

For the study, a kilometer calculation algorithm was designed to allow for instant calculation of the distance from any point to the starting point during the construction phase. The straight and horizontal curve flow chart for the designed kilometer calculation algorithm is given in Figures 8 and 9. Then, an algorithm was designed to find the distance of the point at which a kilometer was found to the road axis as well as the design elevation of any point (Figure 10). Thanks to these algorithms, one of the most important steps in determining the distance of any point to the road axis at any given stage, as well as the necessary elevation required by the end of the project, has been revealed. Consequently, the infrastructure (flow diagram) for comprehensive control and inspection at each point and stage of the arrangement has been established.

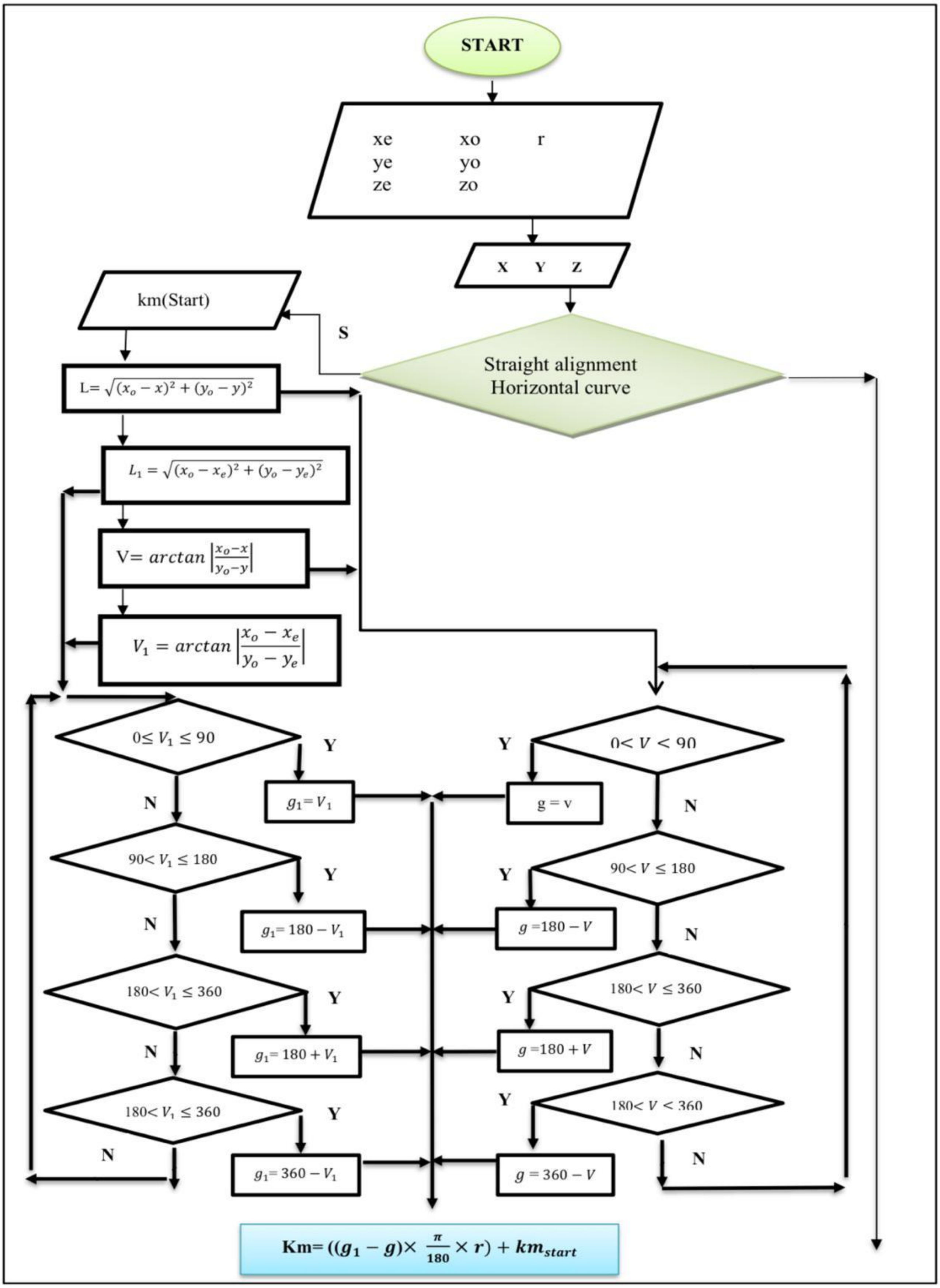


**Figure 8.** Algorithm for calculating the distance to the road axis and the elevation on the vertical alignments

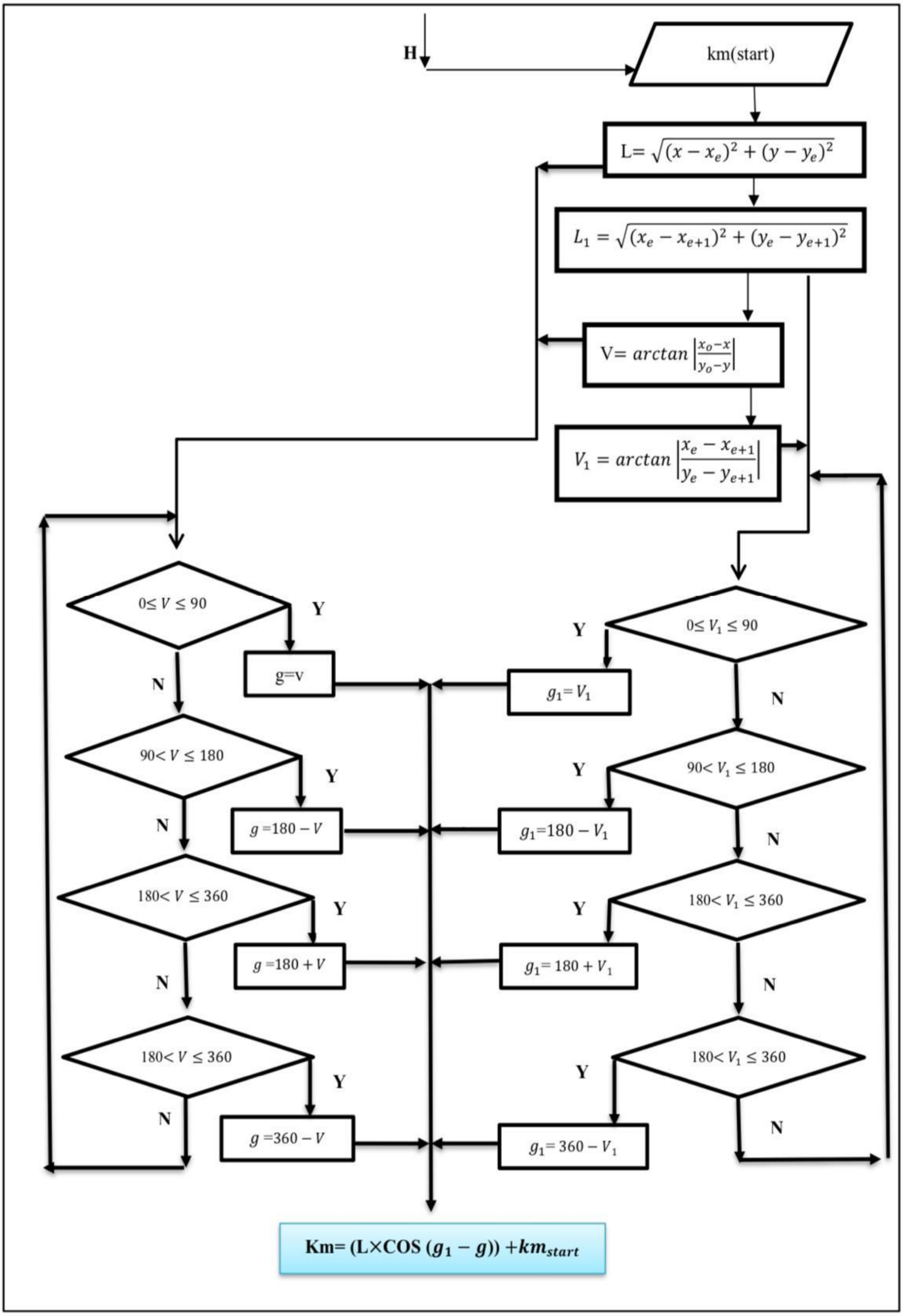


**Figure 9.** Kilometer calculation algorithm on a horizontal curve

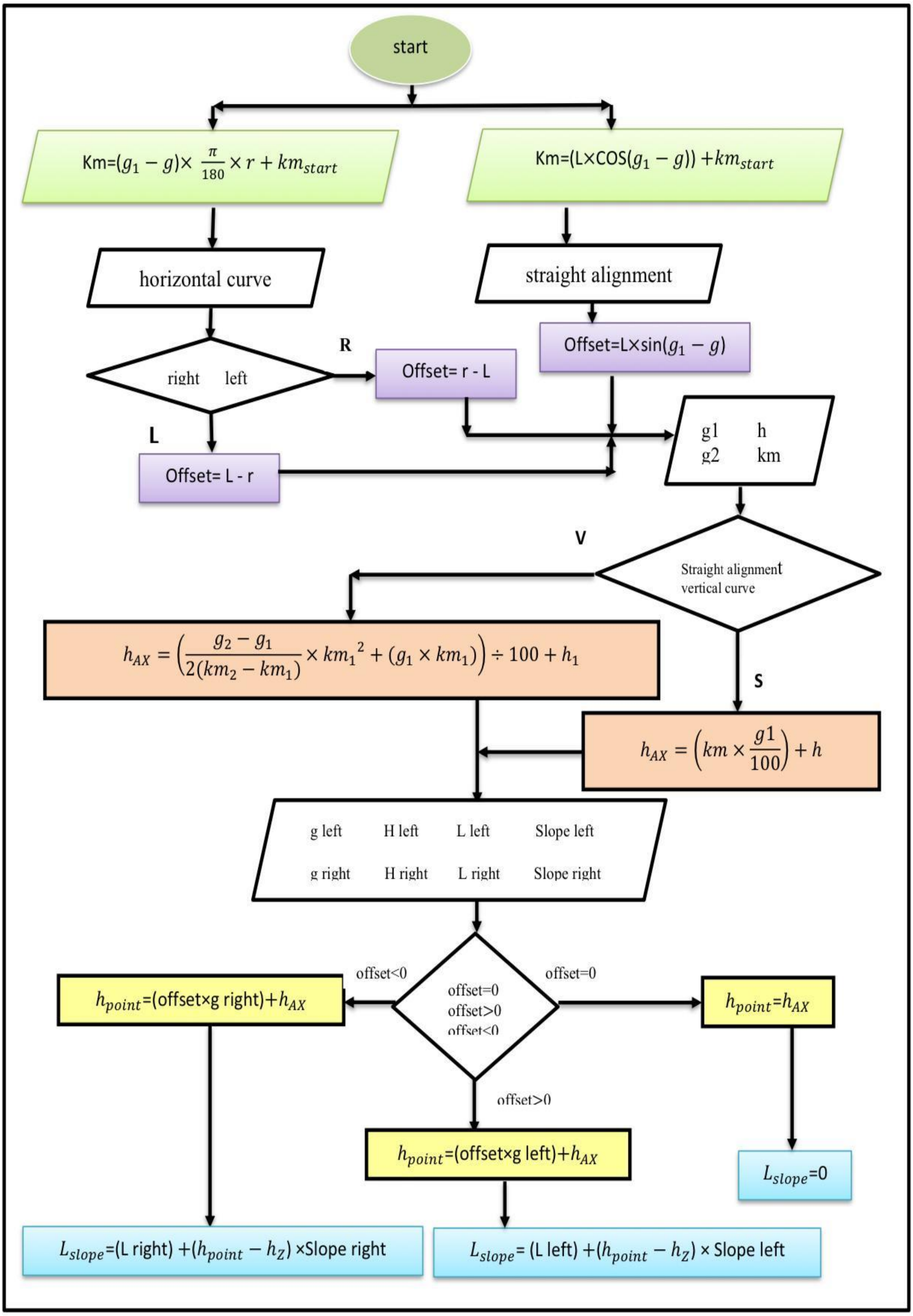


**Figure 10.** Algorithm for distance to the road axis and elevation on the vertical alignments

### 3.1. Interface design

It is a fact that the coordinates and elevation of each point required in the implementation of a highway project are read through the total station device and compared with the elevations on the cross-sections and longitudinal sections. In summary, the accuracy of a highway project is ensured by minimizing errors through the verification of cutting and filling operations after each earthwork application. This is achieved by systematically comparing the existing land elevations with the designed elevations along the road's vertical alignments. In a typical highway project, only the coordinates of the designated kilometers along the axis are provided to the design firm responsible for the implementation. Thus, any point is made correctly can be checked by many mathematical and measurement formulas. Consequently, within the scope of this study, the interface program developed using Matlab-based software is capable of rapidly computing all relevant mathematical formulas and simultaneously determining the kilometer location of any given point. Therefore, this program allows you to access all the information on that point very easily.

After entering the coordinates of any point in the required field, all details of that point can be viewed through this interface by pressing the keys shown in Figure 11. Table 1 shows the functions of these keys.

**Table 1.** Description of the keys pressed

| *Key Name* | *Description* |
|---|---|
| *Left* | Distance from axis in left side |
| *Right* | Distance from axis in right side |
| *Ax* | Elevation on the axis |
| *H* | The current elevation |
| *S.KM* | Starting kilometer |
| *C.KM* | Current kilometer |
| *Offset* | The distance of the point to the road axis according to its elevation |
| *E D* | Elevation difference |
| *Start* | Button for displaying gradients of profiles and cross-sections |
| *Clear* | Deleting all screens |

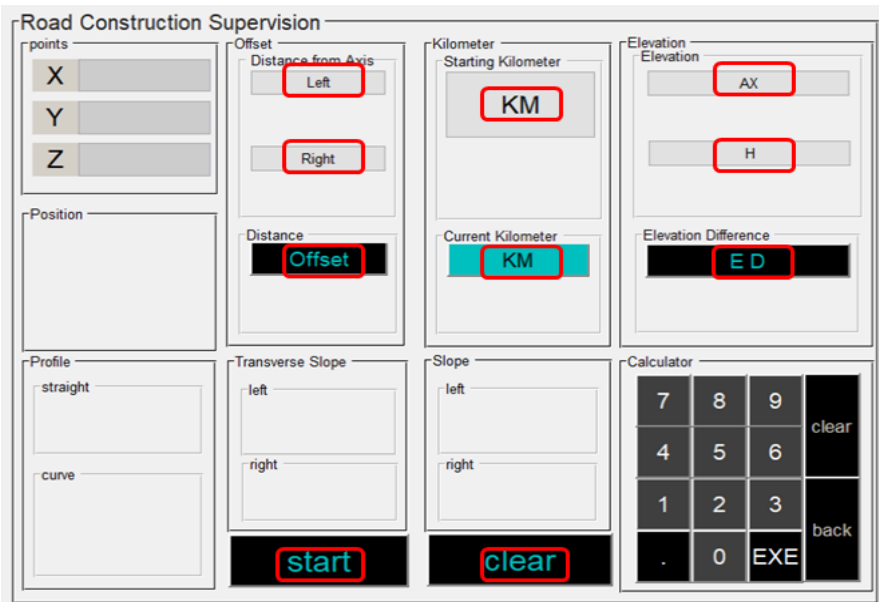


**Figure 11.** The locations of the keys that can be pressed

### 4. Discussion

Although modern design software such as AutoCAD 3D and NetCAD are highly professional in design capabilities, they fall short in ensuring the same level of professionalism during the implementation of a highway project designed for optimal performance in all aspects. These programs primarily allow for the control of a limited number of cross-sections points rather than facilitating a comprehensive implementation process. None of the aforementioned programs allows for controlling all other points (points between cross-sections) except for cross-sectioned points. During the road construction works, the operators and supervisors can inspect and control kilometers with determined cross-sections only. So, for example, let's make a simple calculation: if the elevations are constructed with an average error of 5 mm in a 2-lane road with a width of 12 meters and a length of 1 kilometer, the resulting volume deficiency could amount to approximately 60 cubic meters per layer. Such a discrepancy would likely go undetected. This is because only cross-section points are controlled, while the parts between cross-sections are controlled very roughly. Today, to minimize this error, leica company added the interface software named Roadworks 3D to its TS09 series Total Station devices in the leica version and made it available for a certain fee. Even this available interface does not give the data of the road platform at any point along the road, but only the elevation on the road axis line. However, it does not account for all relevant data at any point along the road platform outside of the designated cross-sections, such as road width, transverse slopes, slope curves, and key points like skirt and crest. Addressing this issue requires the development of an algorithm and corresponding software to control points beyond the designated cross-sections.

All details obtained by running this interface program on a highway project taken as an example within the scope of this study are explained below, step by step. This example highway project consists of approximately 1.5 kilometers of the project implemented on a first-class highway in Iran. Specifically, the study covers the segment between KM 71+242.93 and 72+353.99 (Figure 12). Furthermore, a horizontal curve between these kilometer points passes between two-line segments, and approximately four vertical curves are located between these kilometer points.

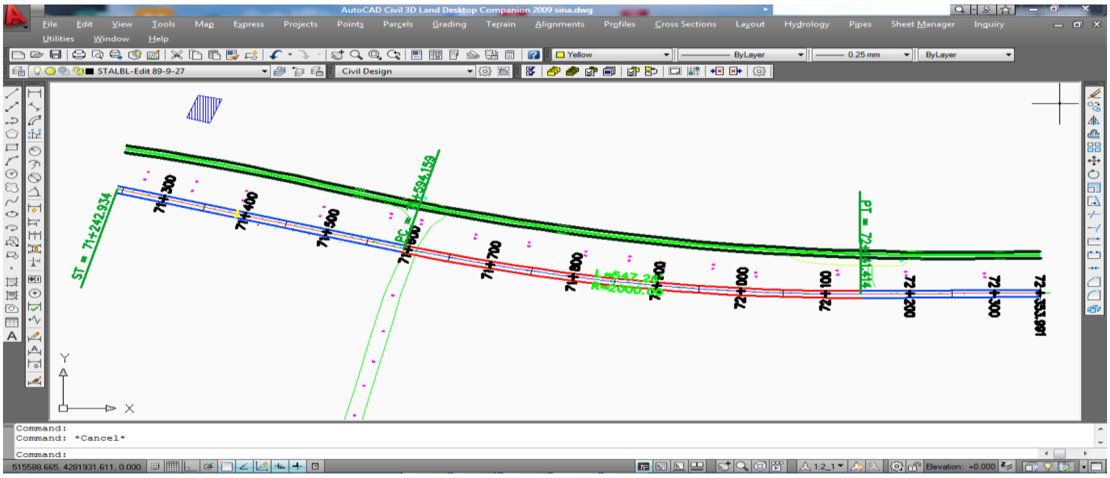


**Figure 12.** An exemplary road project in AutoCAD Civil 3D environment

The coordinates of a point we read randomly were written in the required place in Figure 13 according to Table 2 with the help of a calculator. The coordinates of this point are shown below.

X = 514968,892
Y = 4281672,468
Z = 998,000

**Table 2.** The coordinates required for the calculator

| *No* | *Description* |
|---|---|
| *1* | Calculator |
| *2* | X-Coordinate |
| *3* | Y-Coordinate |
| *4* | Z-Coordinate |

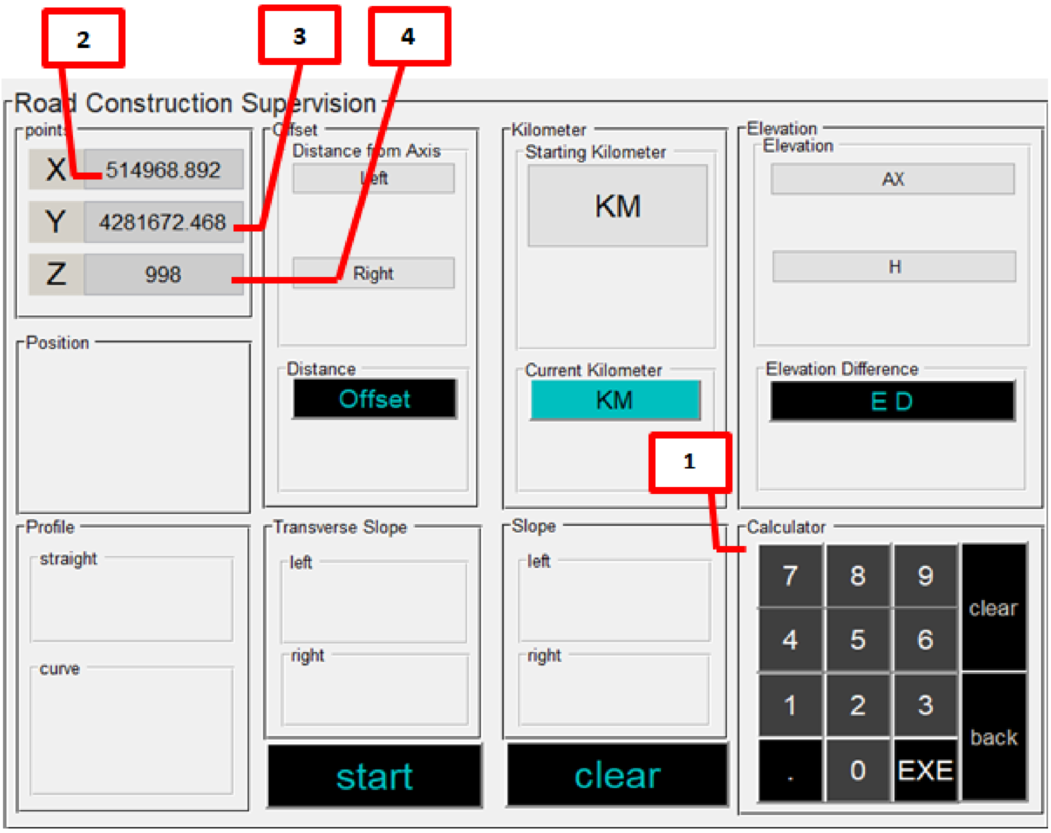


**Figure 13.** The place to write the coordinates

By pressing the keys named left and right first, the point is on the right or left edge of the road axis in the field, and the distance of that point to the road axis is also seen. Then, by pressing the key named the current KM, the kilometer of the point at its perpendicular intersection with the road axis can be seen. Additionally, by pressing the button called the start KM, the starting kilometer of that point on the straight or horizontal curve can be seen. An example point from the project has been analyzed using both AutoCAD Civil 3D software (Figure 14) and the interface developed within the scope of this study (Figure 15). The comparison indicates that the results are reliable.

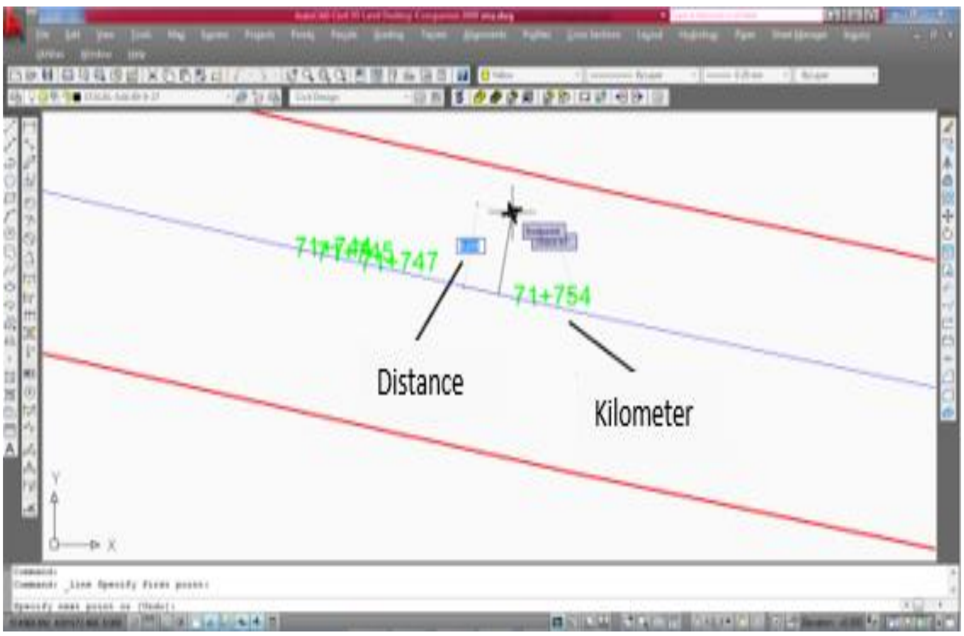


**Figure 14.** A kilometer of the point and its distance to the axis in AutoCAD Civil 3D program

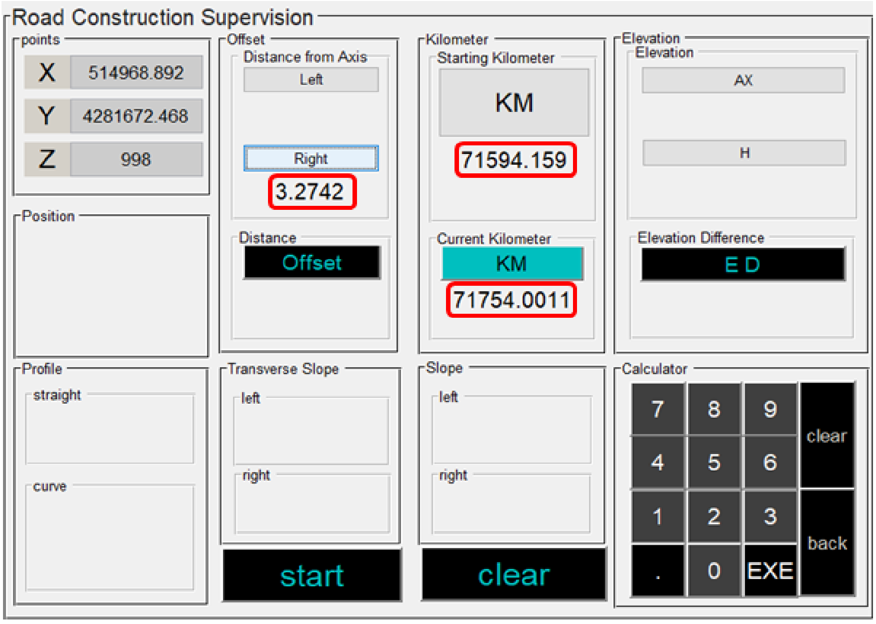


**Figure 15.** A kilometer of the point and its distance to the axis viewed in the Matlab interface

After finding the kilometer of the determined point and its distance to the road axis, the elevation of that kilometer point on the road axis is calculated by pressing the button named AX. Furthermore, it will be sufficient to press the button named H to calculate the distance of that point to the road axis and its elevation on the vertical alignments, considering the cross-section and longitudinal slopes. Thus, the status of the project at the time of control is compared according to the elevation at the end of the project, and it is always instantly learned how close the project is to the end. The accuracy of these calculations is verified by drawing the cross-section in AutoCAD Civil 3D (Figure 16) and comparing it with the results obtained from the interface.

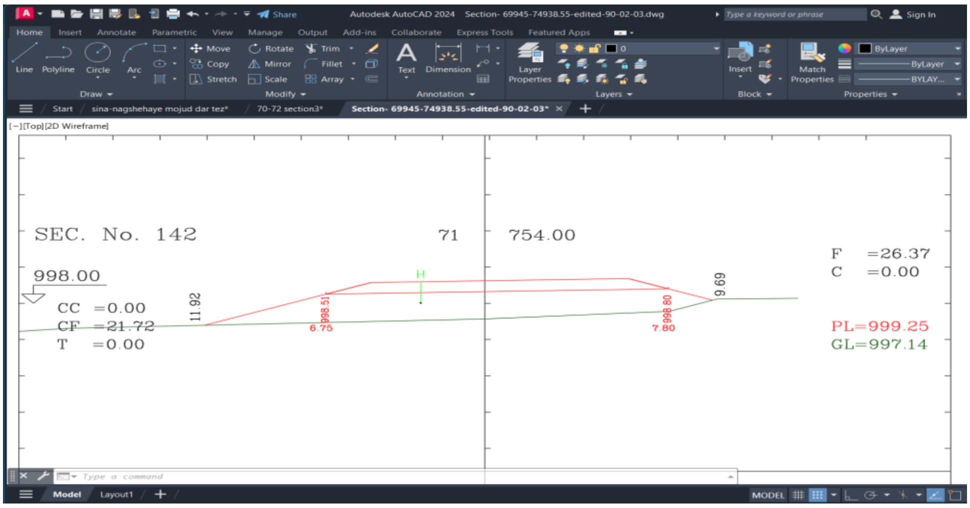


**Figure 16.** Elevation of the point relative to the vertical alignments in AutoCAD Civil 3D

The randomly selected point's distance to the road axis is 3.274 meters. Since this point is on the right side of the road, it is evident from the cross-section that the slope is -0.020. Thus, the elevation of the road at this point on the vertical alignments is 999.25. The method used to calculate this elevation via the interface is illustrated in Figure 17. Therefore, as demonstrated in the computational analysis below, the interface program also produces the same result. Figure 17 shows this interface.

$$H = (3.274 \times (-0.02)) + AX$$
$$H = (-0.06548) + 999.2482 = 999.1827$$
$$H\ D = 998 - 999.1827 = -1.1827$$

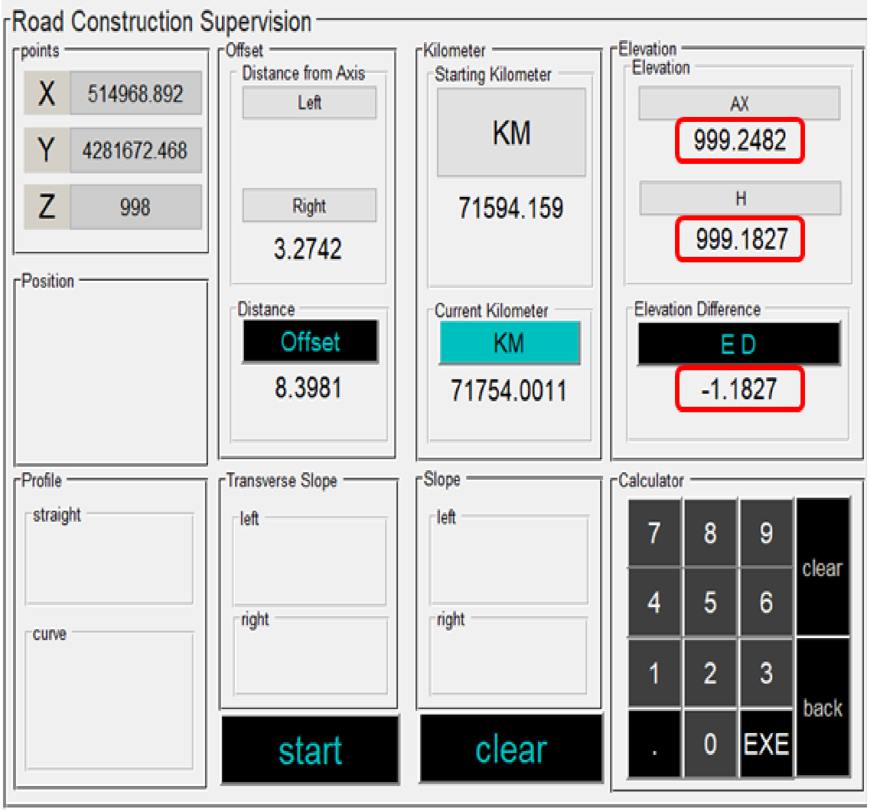


**Figure 17.** Elevation calculation in Matlab interface

After comparing the elevation of the found point with the elevation of the same point on the vertical alignments, if the difference between these two elevation numbers is plus, it means that the status of the project at the time of control refers to cutting. If it is negative, filling is required to the extent of the negative value. If the elevation difference is negative, the road width should be increased. The length of this distance (Figure 18) shown in the AutoCAD Civil 3D program can be instantly viewed by pressing the Offset button in the designed interface (Figure 19).

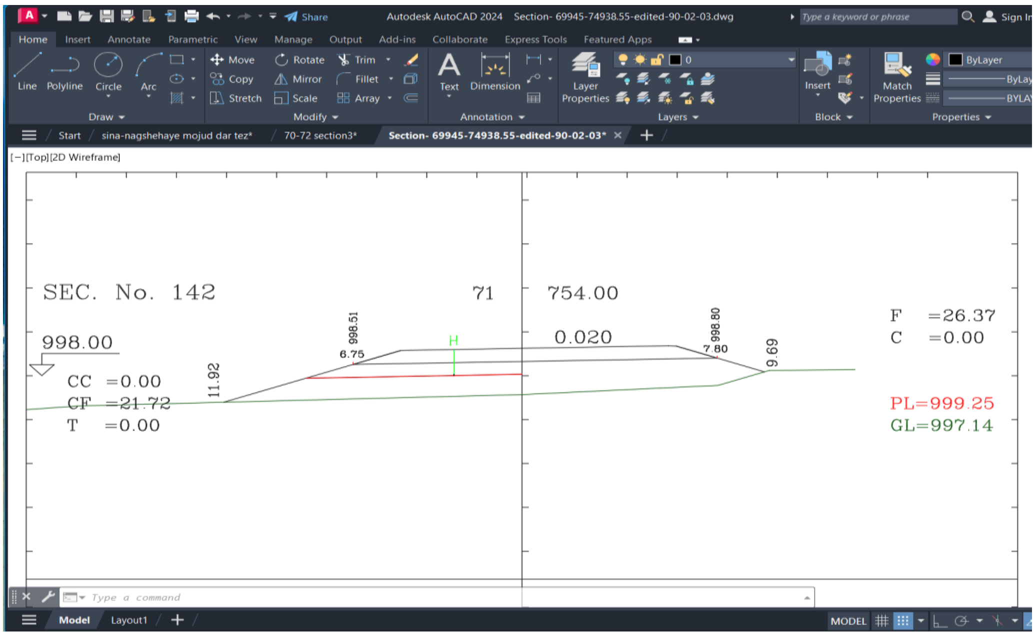


**Figure 18.** The distance of the point to the road axis according to its elevation

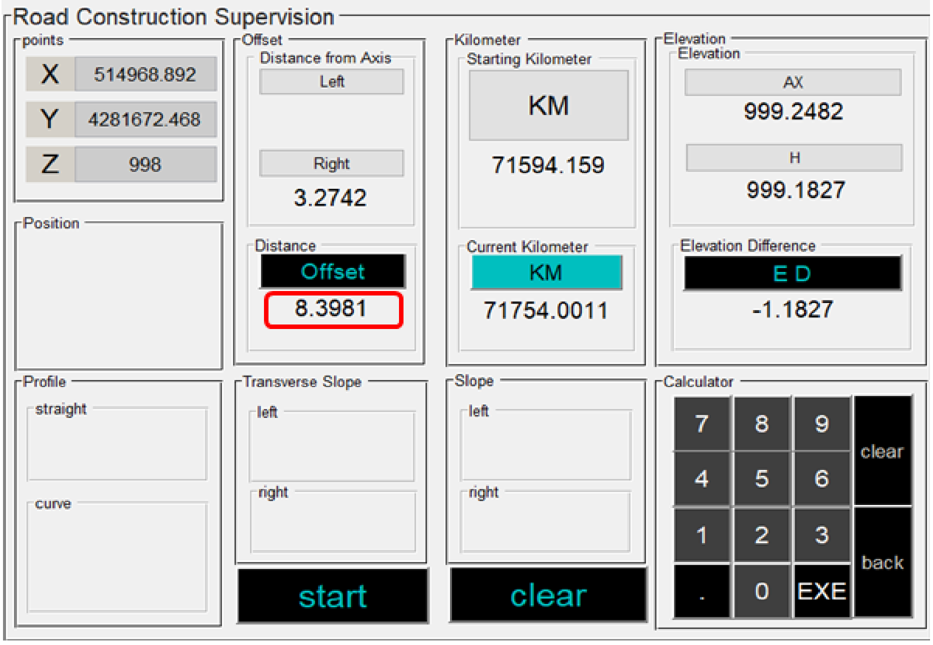


**Figure 19.** The required distance of the point to the road axis with the help of Matlab interface

When the START button is pressed on the interface created with the software program to access all the information of any point on the project, specific details related to that point can be displayed. For example, the point's position on the plan, the radius length if it is on a horizontal curve, the cross-section slope, and the road's slope (gradients) can be viewed. Subsequently, the position and slope of the point on the longitudinal section are displayed. Figure 20 shows all these details displayed on the screen after pressing the Start button.

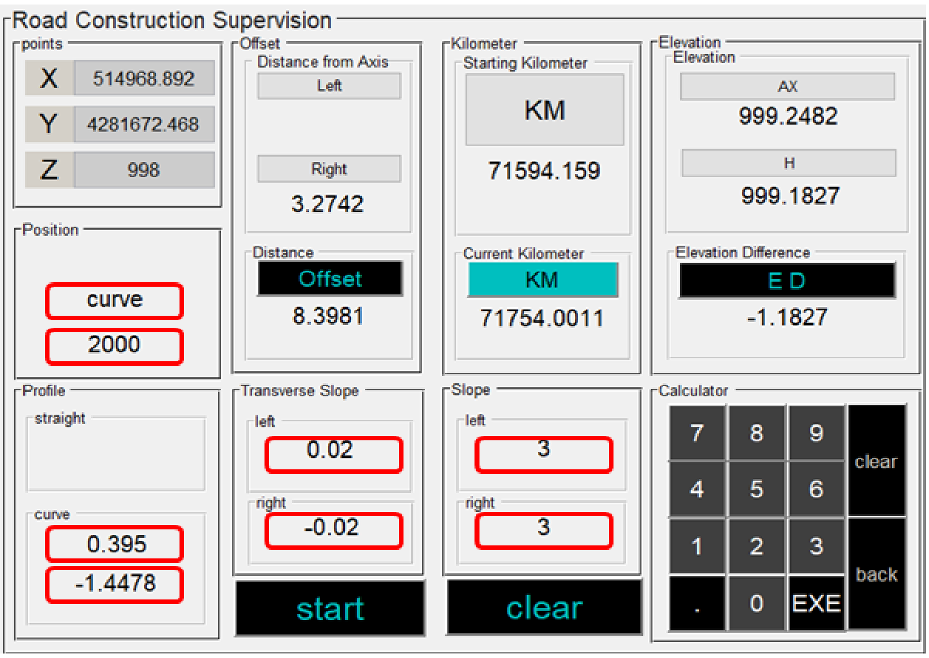


**Figure 20.** The location and gradients of the point

Finally, the CLEAR button on this interface has the feature of deleting all screens to check the coordinates of other control points.

In conclusion, a person who has this interface program can get all the details listed in Table 3 only by entering the coordinates of a random point in the required spaces and individually pressing the keys shown in Figure 21.

**Table 3.** All details obtained as a result

| *No* | *Description* |
|---|---|
| *1* | Current distance to the left of the axis |
| *2* | Current distance to the right of the axis |
| *3* | Starting kilometer |
| *4* | The current elevation |
| *5* | Elevation on the axis |
| *6* | Elevation difference |
| *7* | Current kilometer |
| *8* | Left slope |
| *9* | Right slope |
| *10* | Left transverse slope |
| *11* | Right transverse slope |
| *12* | Vertical curve slopes |
| *13* | Slope of the stright part on the profile |
| *14* | The distance of the point to the road axis according to its elevation |
| *15* | Location of point |

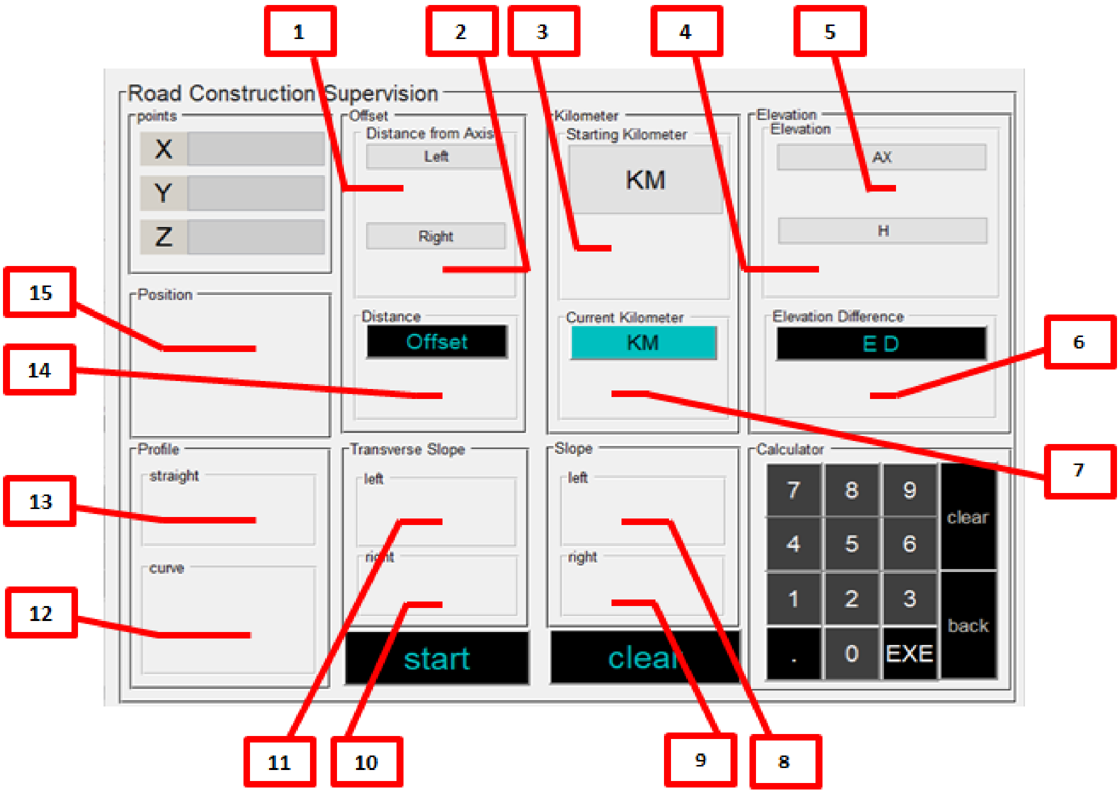


**Figure 21.** All the data related to road construction inspection

## 5. Conclusions

In recent years, the standards for road transportation between cities and countries, which have become a significant global issue, have been implemented at the highest level, leading to the construction of more comfortable roads. Therefore, the aim is to ensure the most optimal construction of projects with less material and greater economic efficiency through fast and efficient inspections. In this context, a study was undertaken to develop a fast, efficient, and easy method for inspection and control during highway construction. As part of this effort, an interface program was developed, and an application was implemented based on a sample project transferred to the AutoCAD Civil 3D program. The results obtained in the study can be summarized as follows:

1. To perform any operation on a specific point within the project, the kilometer location of that position on the project is first obtained by simply pressing a button in the interface. The kilometer of the point can be calculated with an error of one millimeter, as described in the findings section.
2. The distance of the point, the kilometer of which was found, to the road axis can be obtained with almost zero error. Furthermore, this interface displays the position of that point, namely the right or left side relative to the road axis.
3. After determining the distance of the point from the road axis, the slopes on the right and left sides of the road cross-section are precisely defined.
4. The slope of the point on the cross-section is displayed on the designed interface screen.
5. After determining the cross slopes and embankment slopes of the road section, the elevation of any point measured by the total station device is identified. Subsequently, the final elevation that this point is expected to reach at the end of the project, corresponding to the red line, can be instantly calculated by pressing a single button on the interface program.
6. Once the elevation is found, it is very easy to decide whether is cutting or filling. Therefore, if the elevation difference is plus, it refers to the cutting, and if it is minus, it refers to filling.

The current height of the point read by the total station device is compared with the elevation of the vertical alignments at the end of the project. The interface program displays how many centimeters the point should be from the road axis to the slope, depending on the gradients.

Typically, a limited number of cross-sections are included in highway designs Therefore, practitioners may not be able to fully control every point during the implementation phase. However, by using the interface developed within the scope of this study, it will be possible to draw cross-sections for every millimeter of the project and access the numerical data of these sections. In this context, the use of the interface will enable more comprehensive inspection and control at every point of the road project, thereby providing the opportunity to achieve a much more economical project in terms of excavation and filling. Furthermore, during the pavement phase of the project, it will be possible to save on the amount of asphalt to be used. Thus, the smoothness of the road surface can be achieved more effectively. The more important a highway design project is, the more important is the implementation of the same project with the least error. The designed interface will be installed on a tablet and connected wirelessly to the total station device, making it possible to achieve the desired results instantly. In this context, an EXE file has been prepared to transform the designed interface into a program that can run independently. Therefore, highway operators and supervisors will be able to contribute to the most efficient and economical implementation of projects in terms of time and cost by reaching the results instantly using this interface.

## Author contribution

Sina ATABEY was involved in the data collection, application, and writing stages of the study, while Şeref ORUÇ contributed to the writing process, topic identification, and problem definition, providing consultancy support.

## Declaration of ethical code

The authors of this article declare that the materials and methods used in this study do not require ethics committee approval and/or legal-special permission.

## Conflicts of interest

The authors declare that there is no conflict of interest.

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