# 3D Data Exchange Standard Complies with LandXML1.2 – Ver.1.0

National Institute for Land and Infrastructure Management Ministry of Land, Infrastructure and Transport, Japan

## 1 Introduction

### 1-1 Objectives and Scope of Application

In preparing this document, the following guidelines shall be followed when there is no element in Land XML1.2 that completely agrees with a given element assumed in designing in Japan.

- Among design data used for road and river design, data elements that should be exchanged into LandXML are defined using Feature.
- Annotations and so on other than the above are defined using desc (description).

This document aims at realizing utilization in the following ways:

(1) Utilization as electronic delivery products of design and construction works

The cross sectional data of a structure is a kind of information that should be kept after completion of construction works. It is intended for improving efficiency in detailed design, execution, and maintenance as well as preventing transcription errors by specifying and distributing the specifications of XML as electronic delivery products.

(2) Application to computerized construction and three-dimensional (3D) CAD

On the assumption of application to data entry into 3D CAD, input data for visualization using 3D data, and output data into computerized construction such as progress control of working form using TS etc., it is assumed to be utilized by CAD vendors or survey instrument manufacturers as a standard for data exchange.

## 1-2 Metadata

This document aims to promote diffusion by registering them in registry services and so on in the future. The metadata that are considered to be required for registration at the present stage are shown below.

Table 1-1 Metadata

| Classification | Name | Name (Japanese) | Metadata |
|---|---|---|---|
| Security Set | Security | Security | Not specially specified |
| Resource Set | Title Set | Title | Standard for 3D Design Data Exchange Conforming to LandXML1.2 (draft) |
| | Identifier | Identifier | － |
| | Creator | Creator | Maintenance Information Technology Div., Research Center for Land and Construction Management, National Institute for Land and Infrastructure Management (NILIM), Ministry of Land, Infrastructure, Transport and Tourism (MLIT) |
| | Publisher | Publisher | NILIM, MLIT |
| | Rights | Rights | Copyright owner: NILIM, MLIT |
| | Language | Language | ja |
| | Type | Type | Text |
| | Source | Source | Describe source of standards. |
| Summary Content Set | Subject | Subject | Geometries of roads and river levees |
| | Description Set | Description | See Table of contents and “1-1 Objectives and Scope of Application“ |
| Format Set | Coverage | Space and time ranges | Space range: jp<br>Time range: in and after 2015 |
| | Format | Format | XML |

Items of metadata were adopted from those specified by the registry service planned to offer services inside the country, while referring to Dublin Core and ISO11179.

2. About the Models for this document

2-1 Project phases for this document

(1) Road projects

Data on cross sectional geometries of road are mostly determined in Preliminary B in the figure below. Thus, the scope of application of this document shall include from Preliminary B to execution, and its objects shall be newly constructed roads and reconstructed roads. However, this shall not prevent utilization at other project phases but allows consideration of future extensibility with a mind to application to maintenance or ITS and so on or to Outline A first in the future.

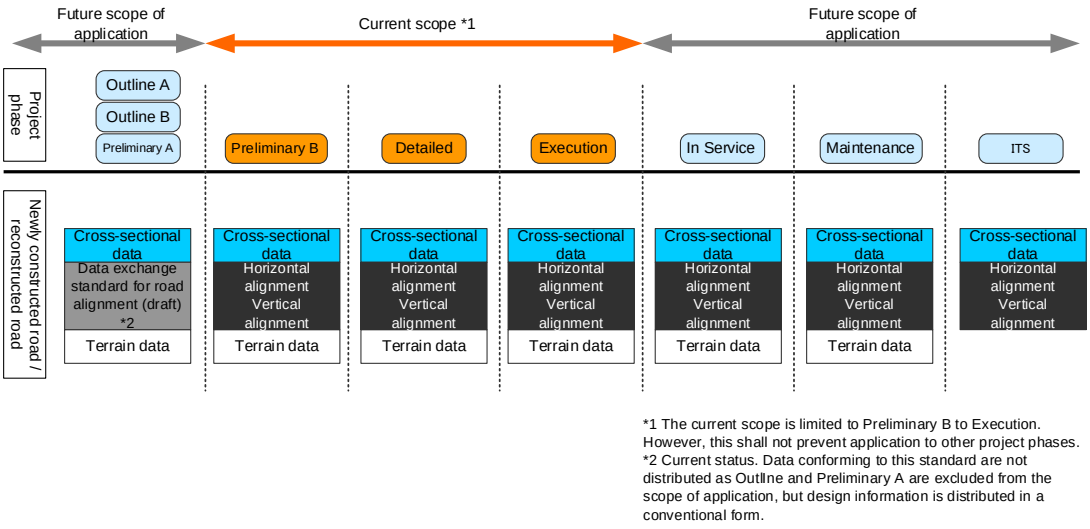



Figure 2-1 Image of application to road projects and scope of this document (conceptual diagram)

(2) River projects

The scope of application of this book shall be from preliminary design to execution as to project phases, and cover newly constructed and reconstructed river levees for which design products are produced in the conventional project process.

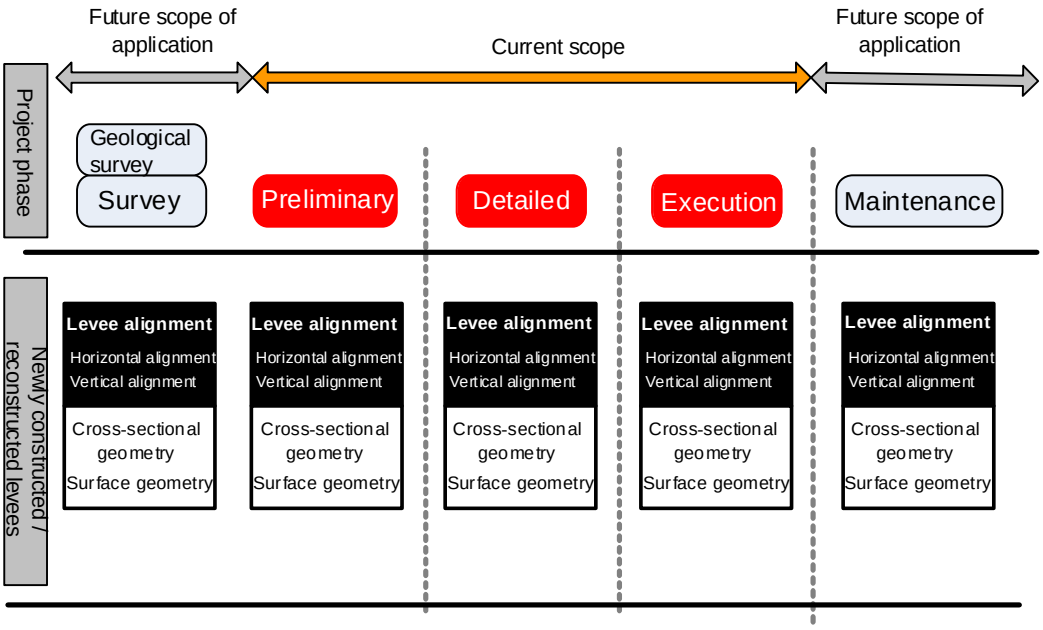



Figure 2-2　Image of application to river projects and scope of this document (conceptual diagram)

2-2　Basic idea about the model

2-2-1　Alignment data

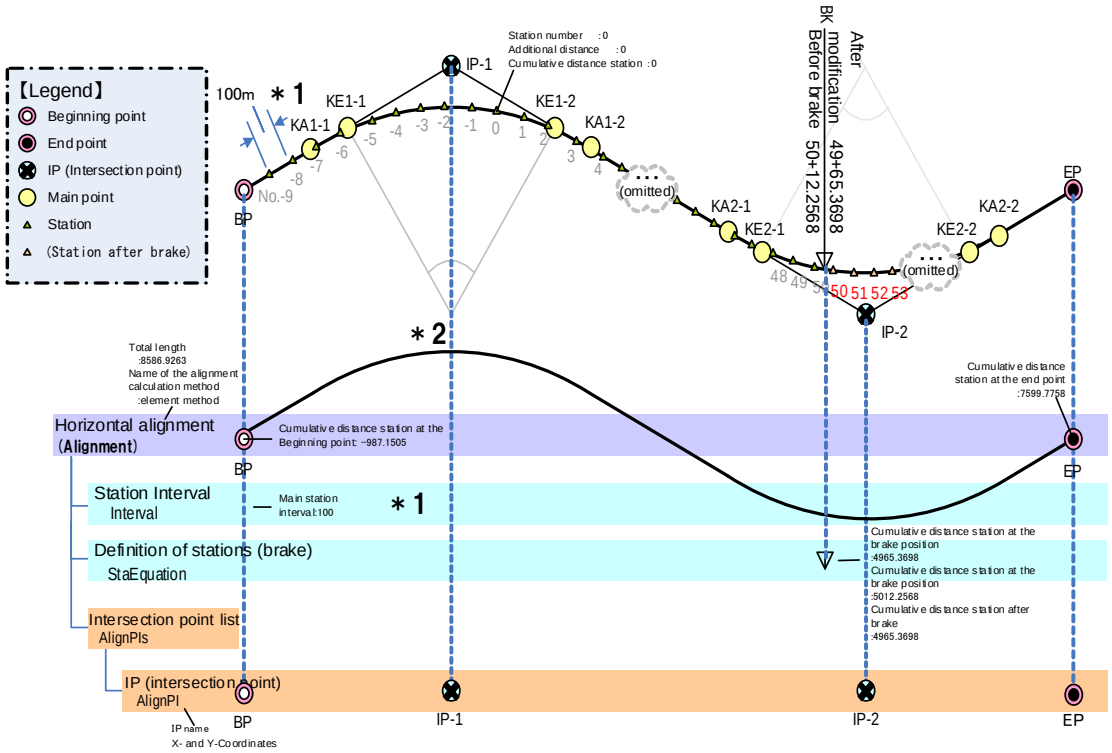
Alignment data are modeled according to the specifications of Alignment of LadXML1.2. The Model of road-center-line alignment is also applied to the levee alignment of a river. The idea in applying it to the river levee is shown below.

When defining a cross section profile with reference to the survey center line, survey center line shall be used instead of the levee alignment.

* Levee alignment:

A line drawn along the front top slope of a levee or the center of the levee crown. This forms the alignment of a levee in the plan view. On the other hand, for harbors an axis line in the direction of the length of a structure is conventionally called a normal line, which is known as a face line for a quay, and a center line for a breakwater.
[quoted from "Dictionary of Civil Engineering Terminology"]

(1) Horizontal Alignment (overall structure)




*1: Data of intermediate points are stored in Cgpoint to exchange data (optional).
*2: Geometry is held as Geometric element (CoordGeom).

Figure 2-3　Description of Horizontal Alignment

(2) Geometric Elements

The following figure shows the part of geometric elements out of "2-3-1 (1) Horizontal Alignment (overall structure)".

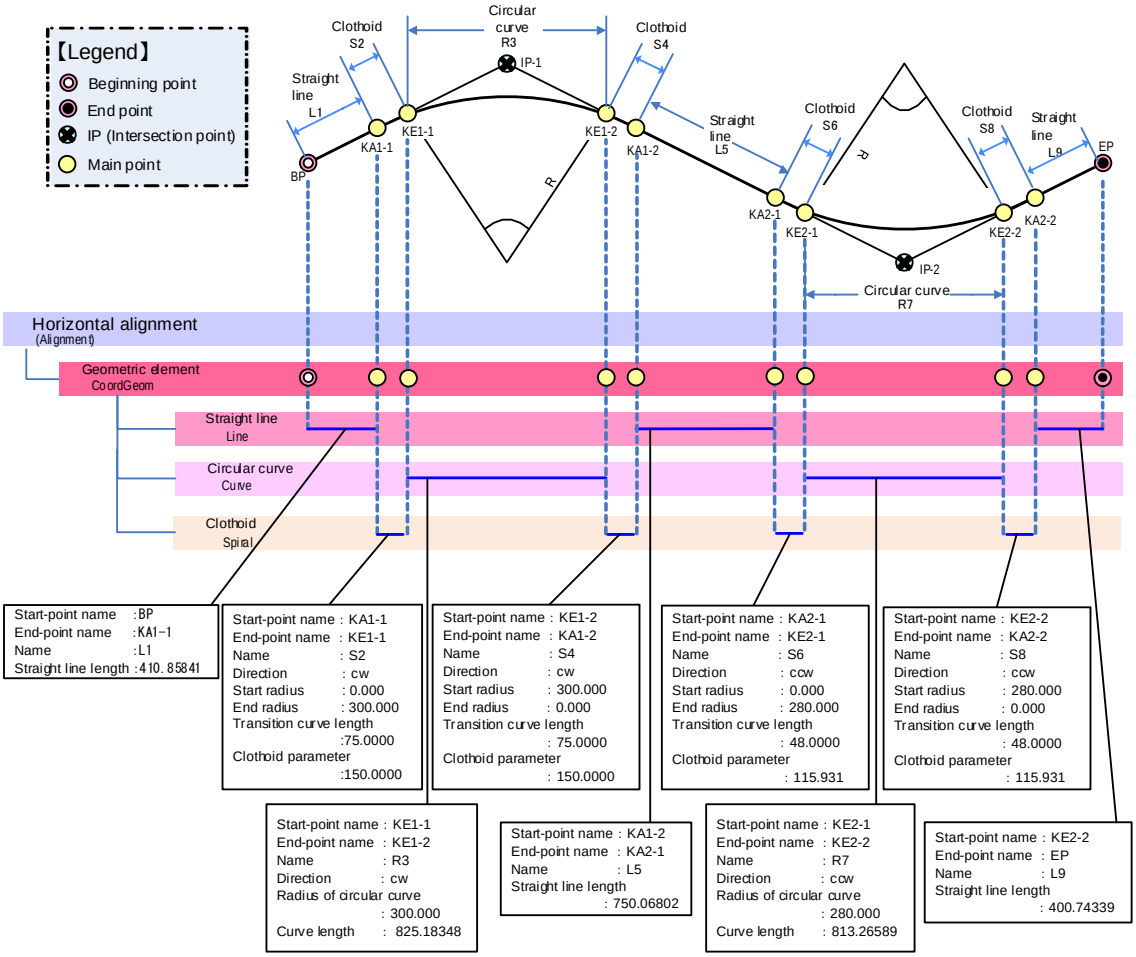



Figure 2-4 Example of description of geometric elements

[Requirements]

- Geometries shall be represented in a row of geometric elements (strait lines, transition curves, and circular curves), connecting the end point and beginning point of the adjacent geometric elements.
- Main points (connection points for every geometric element) are defined by the beginning and end points of a geometric element.

(3) Intermediate Point

Though not required, when holding the intermediate points, they are defined as a data structure as follows using coordinate point element (CgPoint).

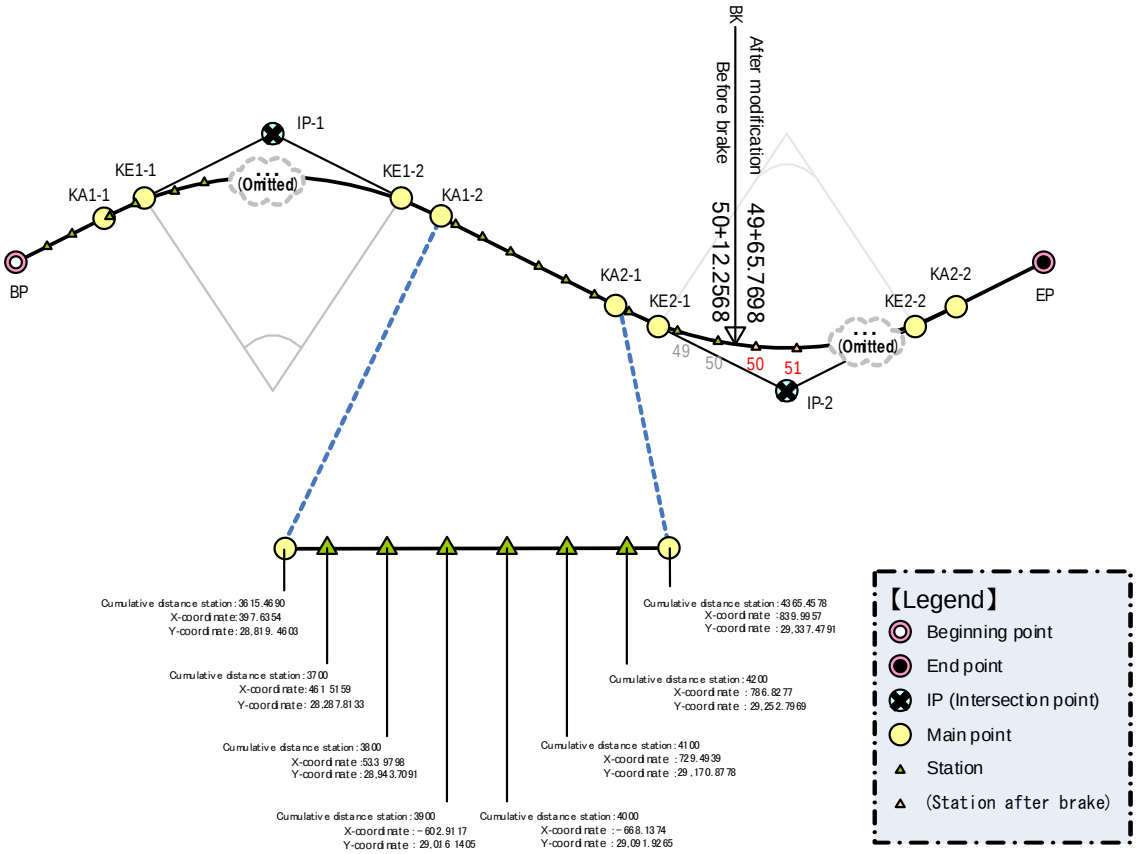



Figure 2-5　Sample description with intermediate points

[Requirements]

- Intermediate points should be set in a permutation of "beginning point, station, station ---, station, end point".
- Main points can be included as Figure 2-5.

(4) Vertical Alignment

The figure below shows correspondence between horizontal and vertical alignments.

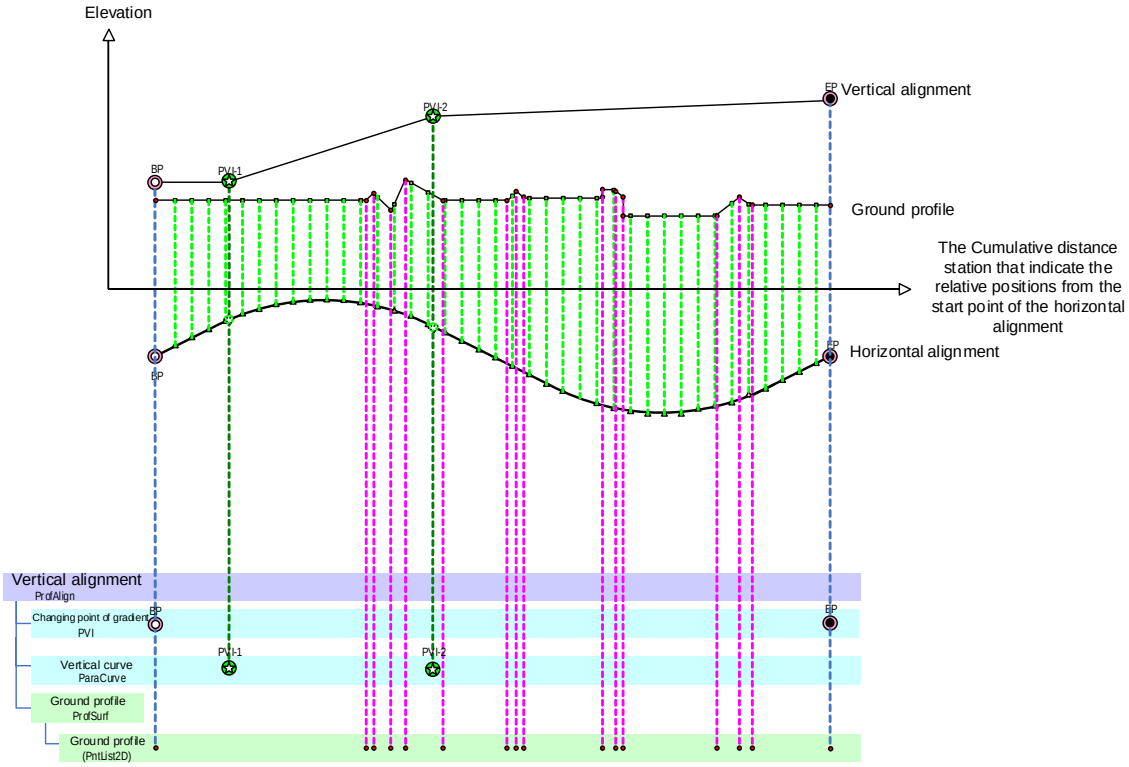



Figure 2-6　Correspondence between horizontal and vertical alignments

- The xy coordinates can be obtained from the horizontal alignment, and the elevation and design levee height (z coordinate) from the vertical alignment respectively.
- “Design levee height = planned height of the levee alignment”.
- " Intersection point of vertical tangent（PVI）" keeps the relationship with the horizontal alignment by inputting data of cumulative distance station (required) that indicate the relative positions from the start point of the horizontal alignment.
- The ground profile is composed of vertical-ground-profile points. Input the road ground level, present levee height or ground level of the area protected by levee for every station where elevation changes.

2-2-2　Cross-sectional data

This section discusses relationship between the elements described in a cross section view (see Figure 2-7) and this document, mainly taking road projects as examples.

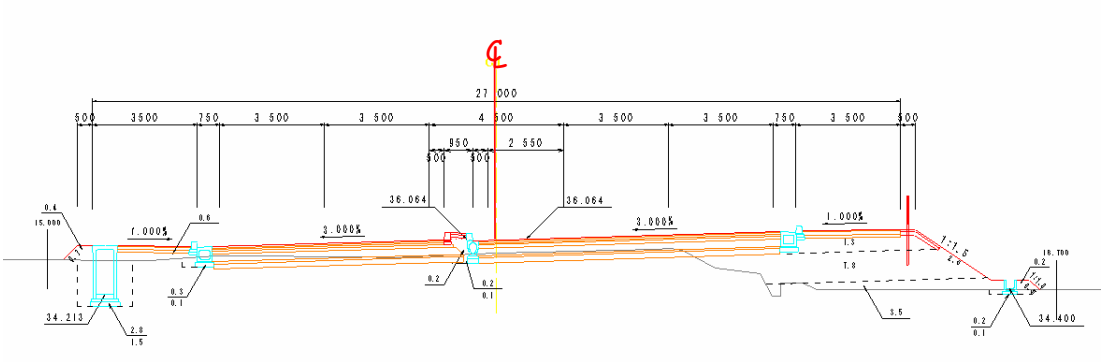



Figure 2-7　Sample cross section view

(1) Approach of "Formation Center"

- The position of the formation center is specified by the CL offset (the horizontal distance at right angles with the tangent of a horizontal alignment on the road center line) and the vertical offset (difference of elevation from design height)
- In this document, the formation center is used as a basis for dividing cross-sectional elements (points) into left and right sides.

(2) Cross Section

Similarly to conventional design, points that constitute a cross section shall be defined for every section to create a cross section view (e.g. at intervals of 20 m) and every changing point of section. In addition, types of cross-sectional elements shall be definable.

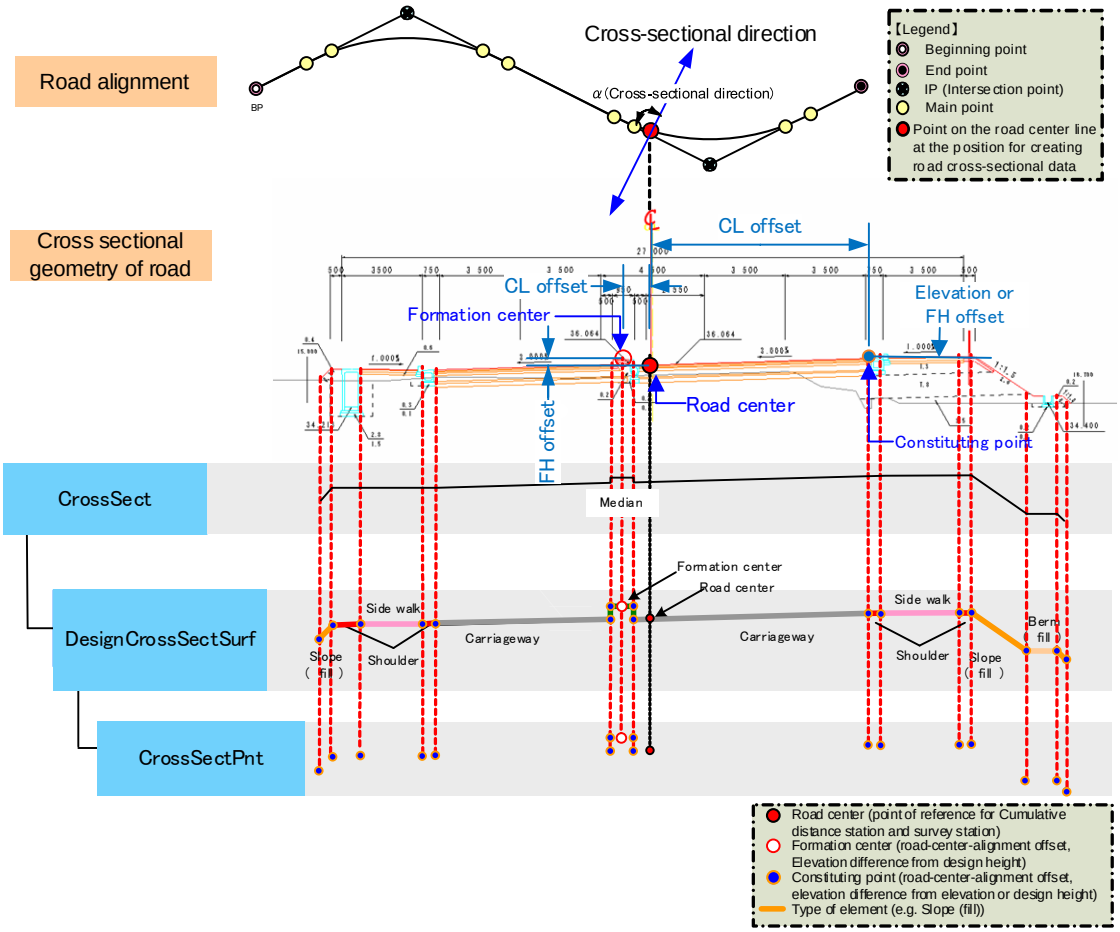



Figure 2-8　Description of a cross section

2-2-3　Terrain Information

Terrain information is the definition of cross-sectional ground lines produced by cross sectioning in route surveying. Since this refers to the cross-section defined in 2-3-2 (2), "Point of Intersection with Ground" can be calculated by superimposing the cross section geometry that connects "constituting points" of the referred cross section with the "Cross-sectional Ground Line" information held for every cross section surveyed.

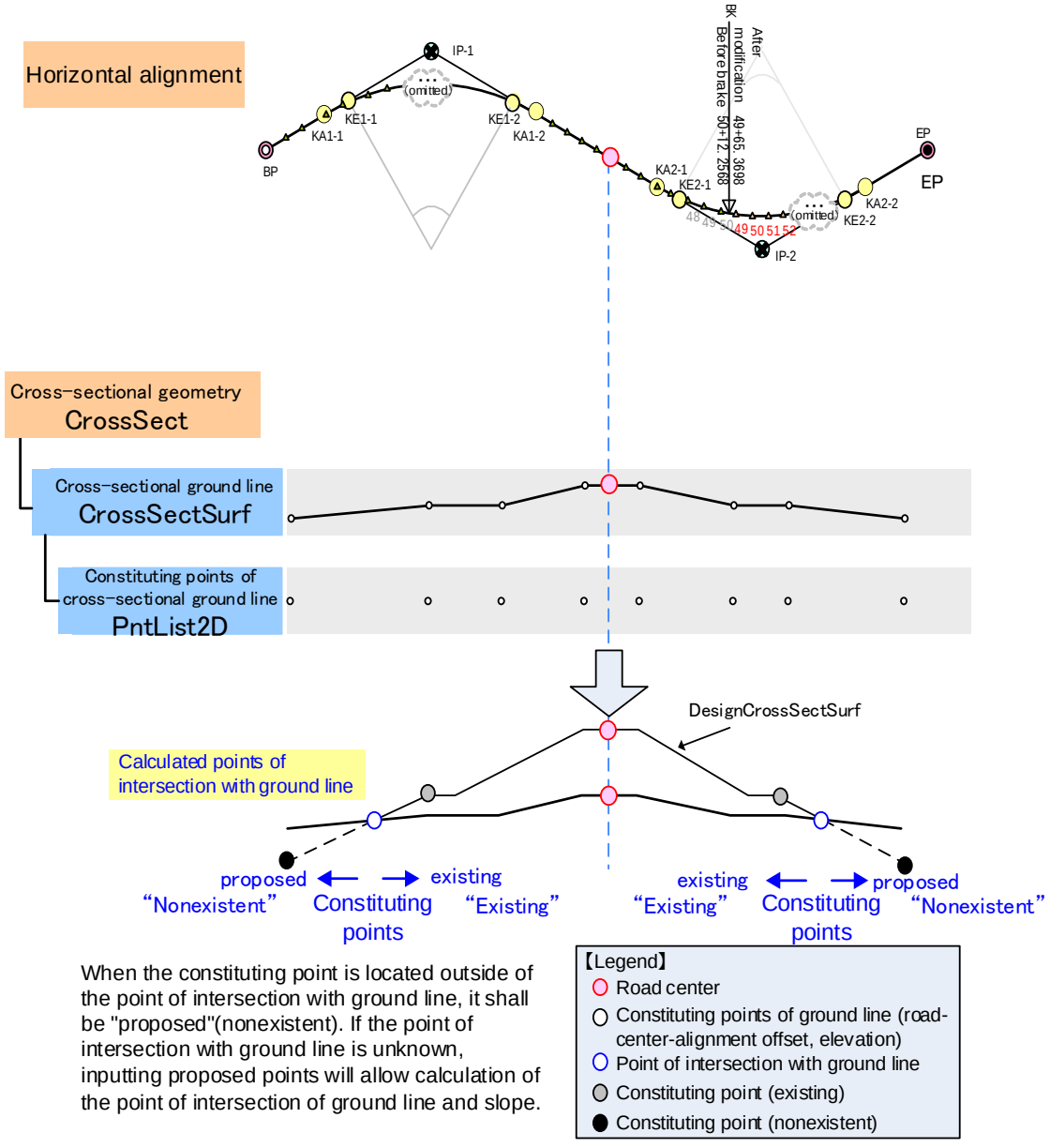



Figure 2-9　Description of terrain information

2-2-4　Pavement information

A pavement structure is composed of several layers (pavement constitutive layers), each of which is classified as a certain type such as surface course, intermediate course, binder course, base course, subbase course etc. Here the layers from the surface course to the base and subbase course are defined.

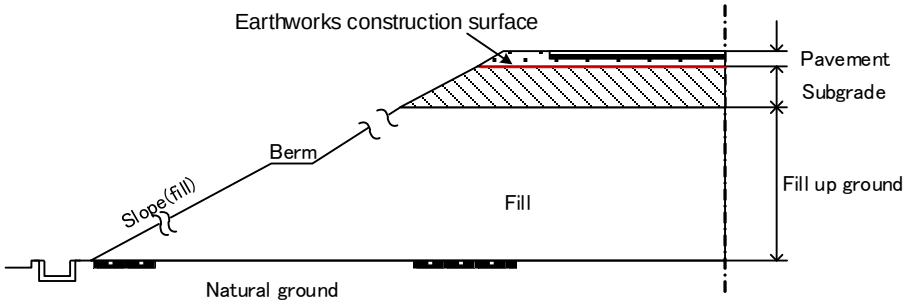



Figure 2-10　Names of the fill section

Source: Commentary and operation of Road Structure Ordinance, Feb. 2004, Japan Road Association

### 2-2-5 Surface data

Surface data of road construction, river structures and the terrain, so as to extend along the Surface specification of LandXML1.2, expressed using the TIN (Triangulated Irregular Network).

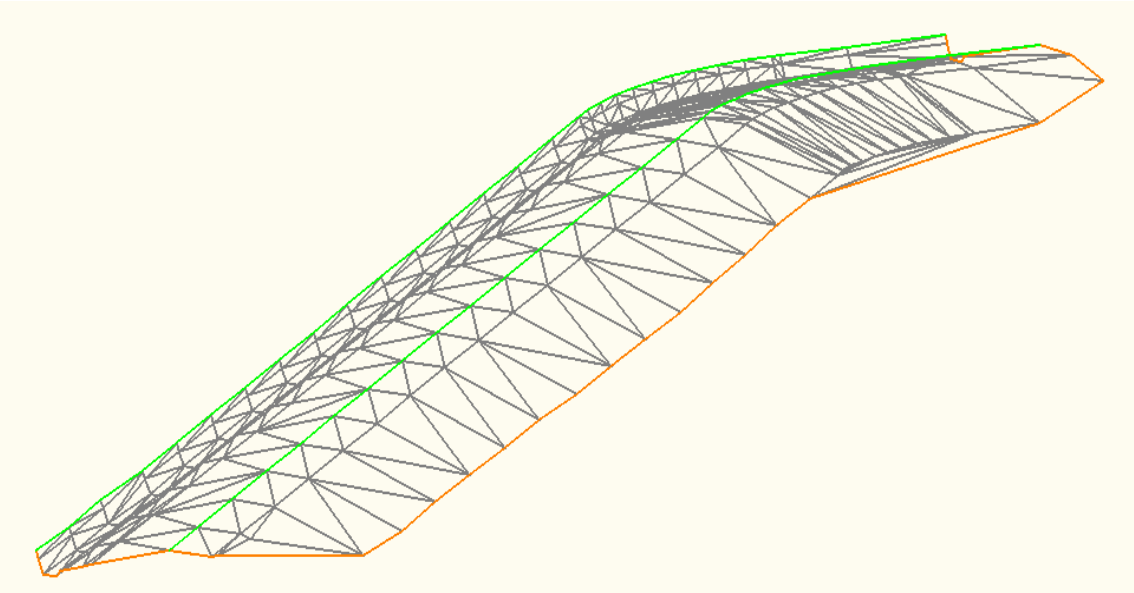


Figure 2-11 Example of surface data

## 2-3 Cross-sectional Geometry treated in this document

Cross-sectional Geometry treated in this document allows the framework of a structure to be represented three-dimensionally by combining it with alignment.

The basic guideline of the cross-sectional geometry defined in this document is as follows.

### (1) Cross-sectional Geometry of Road

・Cross sectional elements covered in this document

The cross sectional elements covered by the cross-sectional geometries of road treated in this document shall include earthworks construction surface, slope, berm, retaining wall, ditch, pavement and so on in addition to the cross-sectional elements prescribed in "Commentary and operation of Road Structure Ordinance". Since the following cross sectional elements are basic elements, more detailed ones shall be added appropriately according to approaches to utilization in the future.

- Carriageway (part of road consisting of lanes etc.)
- Median
- Shoulder
- Stopping lane
- Sidewalk, bicycle and pedestrian track, and bicycle track (the attribute name shall be "sidewalk")
- Planting strip
- Frontage road
- Track lane
- Separator
- Marginal strip
- Subgrade
- Roadbody
- Excavation
- Slope (fill)
- Slope (cut)
- Berm (fill)
- Berm (cut)
- Retaining wall, slope protection work, concrete block work etc. (the attribute name shall be "retaining wall")
- Irrigation and drainage structures such as ditch, gutter, catchment basin, slope drain (the attribute name shall be "ditch")
- Pavement (used in defining pavement section)
- Other (used for the following "other cross-sectional elements")

(2) Cross-sectional Geometry of River

・Cross sectional elements covered in this document

The elements covered by the river levee geometries treated in this document shall be as follows with reference to "Guidelines for Civil Works Design: Part II River (Kyushu Regional Development Bureau). Since the following cross sectional elements are basic elements, more detailed ones shall be added appropriately according to the approaches to utilization in the future.

- Levee crown
- Earthwork surface (fill)
- Slope (fill)
- Berm (fill)
- Retaining wall, revetment, and foot-protection works etc. (the attribute name shall be "retaining wall")
- Other

3. Terminology

The terms referred to in defining XML schema in this document are shown below.

【main station interval】

The interval between adjacent main stations. The main station in this document means a point represented singly by the station number (the point where the additional distance is zero); for example, No.0+00、No.1+00、No.2+00‥‥ in No. representation, STA.0+00, STA.1+00, STA.2+00‥‥ in STA representation, and 0 K000, 1 K000, 2 K000‥‥ in distance-mark representation.

【sub station interval】

The interval between adjacent sub stations. The sub station in this document means the point set between main stations as a reference point for design. Not found in No. representation, the sub station refers to a point represented by the additional distance to the station number at regular intervals; for example, STA.0+20, STA.0+40, STA.0+60, ‥‥in STA representation, or 0K050, 0K100, 0K150‥‥in distance-mark representation.

【point of intersection method】

The method for calculating coordinates by setting IP (point of intersection / intersection point) coordinates and alignment elements to be applied to IP sections (egg shape or S shape etc.).

【element method】

A method to represent an alignment from the coordinates of main points on the horizontal alignment, radius, and transition curve length. Main points that are input shall just be the coordinates of main points of the alignment.

# 4 Commentary on XML-schema

## 4-1 Commentary on the overall organization

Figure 4-1 shows basic elements for XML-schema defined in this document and their organization.

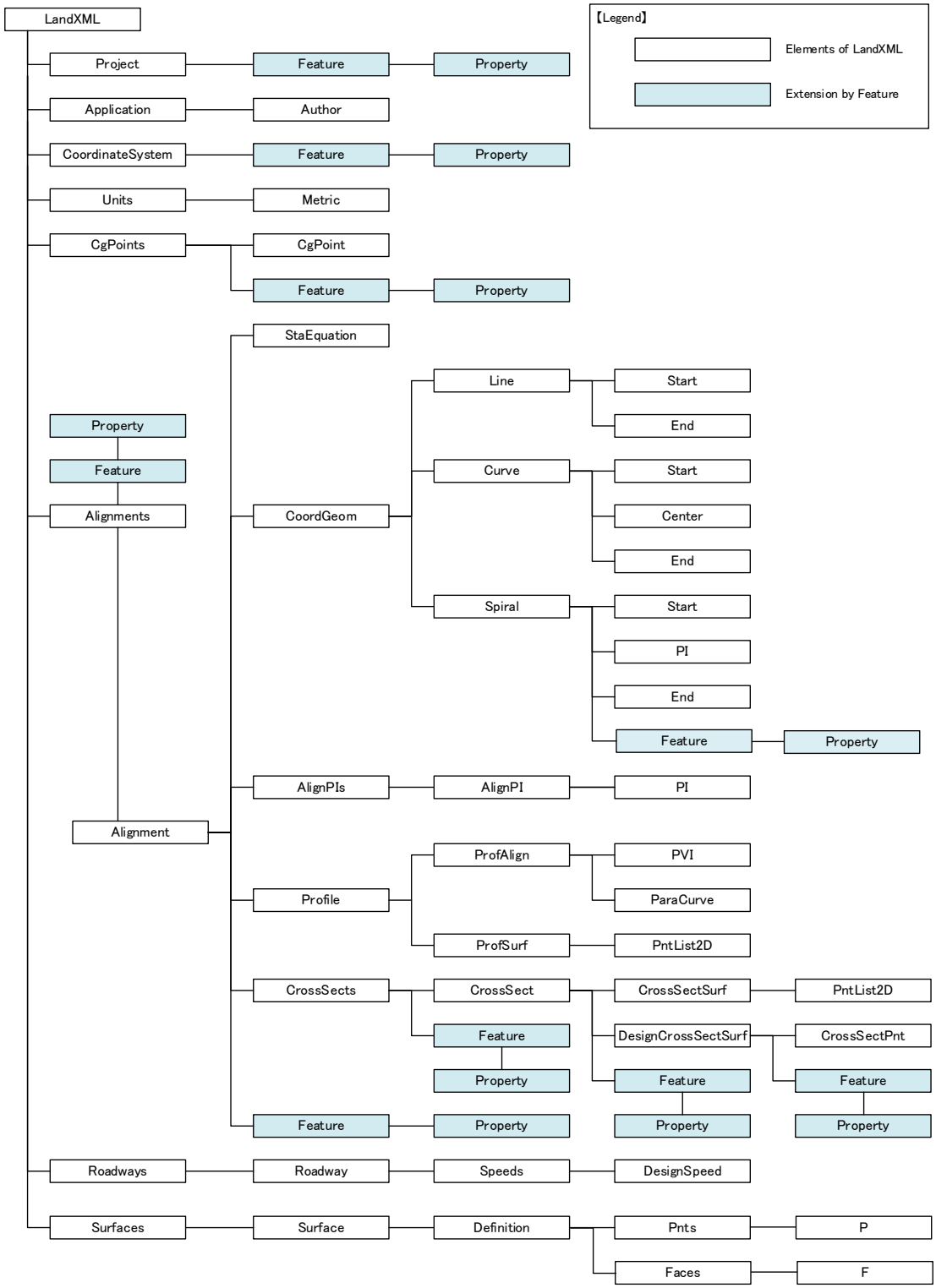



Figure 4-1 Basic elements and organization

4-2　Commentary on elements

This document defines all the elements described in Figure 4-1.

4-2-1　Project information

<table>
<tr><td>element name</td><td colspan="3">Project</td><td>Logical name</td><td colspan="2">Project information</td></tr>
<tr><td>path</td><td colspan="6">/Project</td></tr>
<tr><td>figure</td><td colspan="6"> 
</td></tr>
<tr><td>child elements (children)</td><td colspan="6">Feature</td></tr>
<tr><td>type</td><td colspan="6">—</td></tr>
<tr><td>number of occurrences</td><td colspan="6">0 or 1</td></tr>
<tr><td rowspan="2">attributes</td><td>name</td><td>Name</td><td>xs:string</td><td>Required</td><td colspan="2">Project name</td></tr>
<tr><td>desc</td><td>Notes</td><td>xs:string</td><td></td><td colspan="2"></td></tr>
<tr><td>entry example</td><td colspan="6"><Project name="detailed design of xx Road"><br>　<Feature><br>　　<Property label="projectPhase" value="detailed"/><br>　　<Property label="applicationCriterion" value="MlitLandXmlVer.1.0"/><br>　</Feature><br></Project></td></tr>
</table>

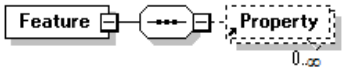
[Project phase, Application criterion]

For Project phase and Application criterion, use Features and Property as the child elements of Project as follows.

Omit name of Feature.
Project phase: enter "projectPhase" for Property label; and the name of project phase for value.
Application criterion: "applicationCriterion" for Property label, and "MlitLandXmlVer.1.0" for value.

*Refers to " Standard for Three-dimensional (3D) Design Data Exchange Conforming to LandXML1.2 (draft), Ver.1.0, Month of March, 2016", MLIT.

### 4-2-2 Feature

| element name | Feature | | Logical name | Feature | |
|---|---|---|---|---|---|
| path | /Project/Feature<br>/CoordinateSystem/Feature<br>/CgPoints/Feature<br>/Alignments/Feature<br>/Alignments/Alignment/Feature<br>/Alignments/Alignment/CoordGeom/Spiral/Feature/<br>/Alignments/Alignment/CrossSects/Feature<br>/Alignments/Alignment/CrossSects/CrossSect/Feature<br>/Alignments/Alignment/CrossSects/CrossSect/DesignCrossSectSurf/Feature | | | | |
| figure |  | | | | |
| child elements | Property | | | | |
| type | － | | | | |
| number of occurrences | 0 or more | | | | |
| attributes | name | Name | xs:string | | |
| description | Add an attribute to the existing element | | | | |

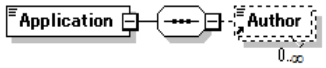
### 4-2-3 Property

| Element name | Property | | Logical name | Property | |
|---|---|---|---|---|---|
| path | /Project/Feature/Property<br>/CoordinateSystem/Feature/Property<br>/CgPoints/Feature/Property<br>/Alignments/Feature/Property<br>/Alignments/Alignment/Feature/Property<br>/Alignments/Alignment/CoordGeom/Spiral/Feature/Property<br>/Alignments/Alignment/CrossSects/Feature/Property<br>/Alignments/Alignment/CrossSects/CrossSect/Feature/Property<br>/Alignments/Alignment/CrossSects/CrossSect/DesignCrossSectSurf/Feature/Property | | | | |
| figure |  | | | | |
| child elements | － | | | | |
| type | － | | | | |
| number of occurrences | 0 or more | | | | |
| attributes | label | Label | | Required | Attribute name |
| | value | Value | | Required | Attribute value |
| content | Attribute Name and Attribute Value defined by Feature | | | | |

List of extension by Feature (* see the section of respective element for more details)

| Element name | Feature name | Property label | Content |
|---|---|---|---|
| Project | – | projectPhase | Project phase |
| | | applicationCriterion | Application criterion |
| CoordinateSystem | – | differTP | Difference in elevation from Tokyo Peil: T.P. (Tokyo Bay mean sea level) |
| CgPoints | IntermediatePnts | alignmentRefs | Reference alignment |
| | (Unique name associated with CgPoint) | sta | Cumulative distance station |
| | | tangentDirectionAngle | Tangential angle |
| | | class | Class of control points and bench marks |
| Alignments | – | designGmType | Structure information |
| | | classification | Standards / classes |
| | | trafficVolume | Design traffic volume |
| | | side | Left or Right bank of the river |
| Alignment | Horizontal | method | Name of design calculation method |
| | Interval | main | Main station interval |
| | | sub | Sub station interval |
| Spiral | – | A | Clothoid parameter |
| CrossSects | – | projectPhase | Project phase |
| | | profAlignRefs | Reference vertical alignment |
| CrossSect | Formation | clOffset | CL offset |
| | | fhOffset | Diiference of elevation from desigh height |
| | xSection | controlSect | Controlled section |
| | | targetPntID | Name of target coordinate |
| | | rounding | Rounding distance |
| | StandardCrossSection | startSta | Start cumulative distance station |
| | | endSta | End cumulative distance station |
| DesignCrossSectSurf | – | xSectType | Type of cross-sectional element |
| | | clearance | Clearance limit |
| | | pavementClass | Type of pavement |
| | | heightType | Type of height in vertical direction |

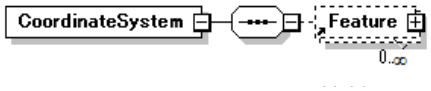
### 4-2-4 Application information

| element name | Application | | Logical name | Application information | |
|---|---|---|---|---|---|
| path | /Application | | | | |
| figure |   | | | | |
| child elements | Author | | | | |
| type | ― | | | | |
| number of occurrences | 0 or more | | | | |
| attributes | name | Name | xs:string | Required | Application name |
| content | Information on the application with which LandXML data were created | | | | |
| entry example | <Application name="xx CAD Ver.10"><br><Author createdBy="taro_yamada" company="yy Design Co., Ltd."/><br></Application> | | | | |

### 4-2-5 Creator information

| element name | Author | | Logical name | Creator information | |
|---|---|---|---|---|---|
| path | /Application/Author | | | | |
| figure |   | | | | |
| child elements | ― | | | | |
| type | ― | | | | |
| number of occurrences | 0 or more | | | | |
| attributes | createdBy | Name of the creator | xs:string | | |
| | Company | Company name | xs:string | | |

4-2-6　Coordinate reference system

<table>
<tr><td>element name</td><td colspan="3">CoordinateSystem</td><td>Logical name</td><td colspan="2">Coordinate reference system</td></tr>
<tr><td>path</td><td colspan="6">/CoordinateSystem</td></tr>
<tr><td>figure</td><td colspan="6"> 
</td></tr>
<tr><td>child elements</td><td colspan="6">—</td></tr>
<tr><td>type</td><td colspan="6">—</td></tr>
<tr><td>number of occurrences</td><td colspan="6">0 or 1</td></tr>
<tr><td rowspan="6">attributes</td><td>Name</td><td>Name</td><td>xs:string</td><td></td><td colspan="2"></td></tr>
<tr><td>horizontalDatum</td><td>Horizontal datum</td><td>xs:string</td><td></td><td colspan="2">Criterion name of horizontal datum</td></tr>
<tr><td>verticalDatum</td><td>Vertical Datum</td><td>xs:string</td><td></td><td colspan="2">Criterion name of the main river</td></tr>
<tr><td>horizontalCoordinateSystemName</td><td>Horizontal coordinate</td><td>xs:string</td><td></td><td colspan="2">Criterion name of the horizontal coordinate system</td></tr>
<tr><td>desc</td><td>Note</td><td>xs:string</td><td></td><td colspan="2"></td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>entry example</td><td colspan="6"><CoordinateSystem<br>name="CRS1"<br>horizontalDatum="JGD2000"<br>verticalDatum="O.P"<br>horizontalCoordinateSystemName="9(X,Y)"<br>desc="9th system"/><br><Feature><br><Property label="differTP" value="-1.3000"/><br></Feature></td></tr>
</table>

[Difference in elevation between the main river standard and Tokyo Bay mean sea level]
For the difference in elevation between the main river standard and Tokyo Bay mean sea level (T.P.), use Feature and Property as follows as the child elements of CoordinateSystem.

Omit the name of Feature.

Difference in elevation from T.P.: "differTP" for Property label; the value of difference in elevation from T.P for value.

Reference names of Horizontal datum

| Reference name | content |
|---|---|
| JGD2000 | Japan Geodetic System 2000 |
| JGD2011 | Japan Geodetic System 2011 |
| TD | Japan Geodetic System |

Reference names of main rivers and difference in elevation from T.P.

| River name | Reference name | Difference in elevation from T.P. (m) |
|---|---|---|
| Tokyo Bay mean sea level | T.P | |
| Kitakami river | K.P | -0.8745 |
| Naruse river | S.P | -0.0873 |
| Tone river | Y.P | -0.8402 |
| Ara, Naka, and Tama rivers | A.P | -1.1344 |
| Yodo river | O.P | -1.3000 |
| Yoshino river | A.P | -0.8333 |
| Watari river | T.P.W | +0.113 |
| Lake Biwa | B.S.L | ＋84.371 |

Reference names of horizontal coordinate systems

| Standard name | content |
|---|---|
| 1(X,Y) | Plane rectangular coordinate systems, system I |
| 2(X,Y) | Plane rectangular coordinate systems, system II |
| 3(X,Y) | Plane rectangular coordinate systems, system III |
| 4(X,Y) | Plane rectangular coordinate systems, system IV |
| 5(X,Y) | Plane rectangular coordinate systems, system V |
| 6(X,Y) | Plane rectangular coordinate systems, system VI |
| 7(X,Y) | Plane rectangular coordinate systems, system VII |
| 8(X,Y) | Plane rectangular coordinate systems, system VIII |
| 9(X,Y) | Plane rectangular coordinate systems, system IX |
| 10(X,Y) | Plane rectangular coordinate systems, system X |
| 11(X,Y) | Plane rectangular coordinate systems, system XI |
| 12(X,Y) | Plane rectangular coordinate systems, system XII |
| 13(X,Y) | Plane rectangular coordinate systems, system XIII |
| 14(X,Y) | Plane rectangular coordinate systems, system XIV |
| 15(X,Y) | Plane rectangular coordinate systems, system XV |
| 16(X,Y) | Plane rectangular coordinate systems, system XVI |
| 17(X,Y) | Plane rectangular coordinate systems, system XVII |
| 18(X,Y) | Plane rectangular coordinate systems, system XVIII |
| 19(X,Y) | Plane rectangular coordinate systems, system XIX |

### 4-2-7 Unit system

| element name | Units | Logical name | Unit system |
|---|---|---|---|
| path | /Units | | |
| figure |   | | |
| child elements | Metric | | |
| type | ― | | |
| number of occurrences | 1 | | |
| content | Setting of units used for LandXML | | |
| entry example | <Units><br><Metric areaUnit="squareMeter"<br>LinearUnit="meter"<br>volumeUnit="cubicMeter"<br>temperatureUnit="celsius"<br>pressureUnit="HPA"<br>angularUnit="decimal dd.mm.ss"<br>directionUnit="decimal dd.mm.ss" /><br></Units> | | |

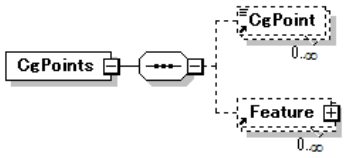
### 4-2-8 Metric system

| element name | Metric | | Logical name | Metric system | |
|---|---|---|---|---|---|
| path | /Units/Metric | | | | |
| figure |   | | | | |
| child elements | ― | | | | |
| type | ― | | | | |
| number of occurrences | 1 | | | | |
| attributes | areaUnit | Unit of area | metArea | Required | Fill in squareMater |
| | linearUnit | Unit of length | metLinear | Required | Fill in meter |
| | volumeUnit | Unit of volume | metVolume | Required | Fill in cubicMeter |
| | temperatureUnit | Unit of temperature | metTemperature | Required | Fill in celsius |
| | pressureUnit | Unit of pressure | metPressure | Required | Fill in HPA |
| | angularUnit | Unit of angle | angularType | | Choose from the following.<br>・radians<br>・grads<br>・decimal degrees<br>・decimal dd.mm.ss |

| | | | | | |
|---|---|---|---|---|---|
| | directionUnit | Unit of direction | angularType | | Choose from the following.<br>・radians<br>・grads<br>・decimal degrees<br>・decimal dd.mm.ss |
| content | Setting of units of the metric system | | | | |

* About decimal dd.mm.ss
Separate the degree and minute with a period "."; do not separate the minute and second and input them continuously.
Example: in the case of 10°25’ 35” -> 10.2535

4-2-9　Coordinate point set

| element name | CgPoints | | | Logical name | Coordinate point set |
|---|---|---|---|---|---|
| path | /CgPoints | | | | |
| figure |  | | | | |
| child elements | CgPoint Feature | | | | |
| type | ― | | | | |
| number of occurrences | 0 or more | | | | |
| attributes | name | Name | xs:string | (Required) | Name of the coordinate point set |
| | desc | Notes | xs:string | | |
| content | Sets of coordinate points such as the intermediate points, target coordinate points, control points, bench marks, and width-pile coordinates.<br>The following names shall apply to the intermediate points, the target coordinate points, the control points, and the bench-marks.<br>・For the intermediate points: IntermediatePnts<br>・For the target coordinated points: TargetPnts<br>・For the control points: ControlPnts<br>・For the bench marks: BenchMarks | | | | |
| entry example | <CgPoints name="TargetPnts" desc=" List of the target coordinated points "><br><CgPoint name="T-5">-134713.643982 22106.715939</CgPoint><br><CgPoint name="T-6">-134704.988287 22088.646203</CgPoint><br><CgPoint name="T-7">-134696.125401 22070.530393</CgPoint><br><CgPoint name="T-8">-134686.499748 22052.745064</CgPoint><br></CgPoints> | | | | |

* Though the items with "(required)" are optional in LandXML, for 3D design they are necessary in design, thus they are made required.

* For those points other than the intermediate points, target coordinate points, control points, and bench marks, enter the name that represents an optional set of points for "name". Then put description of the coordinate points for desc.

4-2-10　Coordinate points

| element name | CgPoint | | | Logical name | Coordinate points |
|---|---|---|---|---|---|
| path | /CgPoints/CgPoint | | | | |
| figure |  | | | | |
| child elements | － | | | | |
| text node | Data type: List of double | Input coordinate values in the order X Coordinate, Y Coordinate, and elevation. Separate the values with spaces. Elevation is omissible. | | | |
| number of occurrences | 0 or more | | | | |
| attributes | name | Name | xs:string | (Required) | Unique name |
| | desc | Notes | xs:string | | |
| | featureRef | Reference feature | featureNameRef | | String data to associate with Feature name |
| | timeStamp | Date and time | xs:dateTime | | Measurement date and time in the case of target coordinate points |
| content | The coordinate points related to alignment geometric elements such as intermediate points, as well as the coordinate points such as target coordinate points, control points, bench marks, and width-pile coordinates | | | | |

[Name of the intermediate point]

For the name of the intermediate point, it is assumed to input "station number + additional distance" or "the name of the main point" etc. It shall also be a unique name among the reference alignment.

[Reference alignment for the intermediate point]

For the alignment that an intermediate point refers to, Features and Property are used as the child elements of CgPoints as follows. When having intermediate points, reference alignment is required.

Enter "IntermediatePnts" for Feature name.
Reference alignment: "alignmentRefs" for Property label; the name of alignment for value.

[Distance mark and tangential angle of the intermediate point]

The cumulative distance station and tangential angle of each intermediate point shall be associated with featureRef of CgPoint and Feature name. When establishing intermediate points, cumulative distance stations are required.

Specify Feature name to a unique name to associate with CgPoint.
Cumulative distance station: "sta" for Property label; the value of cumulative distance station for value.
Tangential angle: "tangentDirectionAngle" for Property label; the value of tangential angle for value.

Entry example

```
<CgPoints name="IntermediatePnts">
  <CgPoint name="No.0+0.0000" featureRef="1">
    -134492.609300 -31243.259760 108.016
  </CgPoint>
  <CgPoint name="No.1+0.0000" featureRef="2">
    -134486.259302 -31224.294594 109.348
  </CgPoint>
  <Feature name="IntermediatePnts">
    <Property label="alignmentRefs" value=" alignment 1"/>
  </Feature>
  <Feature name="1">
    <Property label="sta" value="0.0000"/>
    <Property label="tangentDirectionAngle" value="71.29175309"/>
  </Feature>
  <Feature name="2">
    <Property label="sta" value="20.0000"/>
    <Property label="tangentDirectionAngle" value="71.29175309"/>
  </Feature>
</CgPoints>
```

[Class of control points and bench marks]

For the class of control points and benchmarks, use Features and Property as the child elements of CgPoints as follows. Make association using featureRef of CgPoint and Feature name.

Specify Feature name as a unique name to associate with CgPoint.
Class: "class" for Property label, and the class of control point or bench mark for value
(See the table of the Class of control points and bench mark).

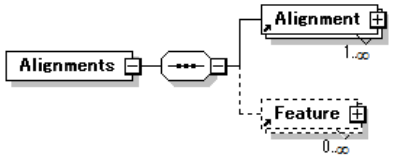
Class of control points

| Class | content |
|---|---|
| Electronic control point | For the electronic control point |
| First-order triangulation station | For the first-order triangulation station |
| Second-order triangulation station | For the second-order triangulation station |
| Third-order triangulation station | For the third-order triangulation station |
| Fourth-order triangulation station | For the fourth-order triangulation station |
| First-class control point | For the first-class control point |
| Second-class control point | For the second-class control point |
| Third-class control point | For the third-class control point |
| Fourth-class control point | For the fourth-class control point |

Class of bench marks

| Class | content |
|---|---|
| First-order bench mark | For the first-order bench mark |
| Second-order bench mark | For the second-order bench mark |
| Third-order bench mark | For the third-order bench mark |
| First-class bench mark | For the first-class bench mark |
| Second-class bench mark | For the second-class bench mark |
| Third-class bench mark | For the third-class bench mark |
| Fourth-class bench mark | For the fourth-class bench mark |
| Simplified bench mark | For the simplified bench mark |

4-2-11　Alignment set

<table>
<tr><td>element name</td><td colspan="3">Alignments</td><td>Logical name</td><td>Alignment set</td></tr>
<tr><td>path</td><td colspan="5">/Alignments</td></tr>
<tr><td>figure</td><td colspan="5"> 
</td></tr>
<tr><td>child elements</td><td colspan="5">Alignment Feature</td></tr>
<tr><td>type</td><td colspan="5">－</td></tr>
<tr><td>number of occurrences</td><td colspan="5">0 or more</td></tr>
<tr><td rowspan="2">attributes</td><td>name</td><td>Name</td><td>xs:string</td><td></td><td>Enter the name, such as human beings can be grasped.</td></tr>
<tr><td>desc</td><td>Notes</td><td>xs:string</td><td></td><td></td></tr>
<tr><td>content</td><td colspan="5">Collection of alignments<br>Information on 3D structures of roads or rivers</td></tr>
<tr><td>entry example</td><td colspan="5">[For roads]<br><Alignments name="route xx""><br>・・・<br>・・・<br><Feature><br><Property label="designGmType" value="road"/><br><Property label="classification" value="type 1, class 2"/><br><Property label="trafficVolume" value="28400"/><br></Feature><br></Alignments><br><br>[For rivers]<br><Alignments name="xx river"><br>・・・<br>・・・<br><Feature><br><Property label="designGmType" value="river"/><br><Property label="classification" value="Class A"/><br><Property label="side" value="left bank"/><br></Feature><br></Alignments></td></tr>
</table>

[The structure information, standards and classes, and design traffic volume of roads]

For the structure information, standards and classes, and design traffic volume of roads, Features and Property shall be used as the child elements of Alignments as follows.

Omit Feature name.
Structure information: enter "designGmType" for Property label, and "road" for value.
Standards / classes: enter "classification" for Property label, and select the value from the following.
"type 1, class 1", "type 1, class 2", "type 1, class 3", "type 1, class 4"
"type 2, class 1", "type 2, class 2"
"type 3, class 1", "type 3, class 2" ,"type 3, class 3", "type 3, class 4", "type 3, class 5"
"type 4, class 1", "type 4, class 2", "type 4, class 3", "type 4, class 4"

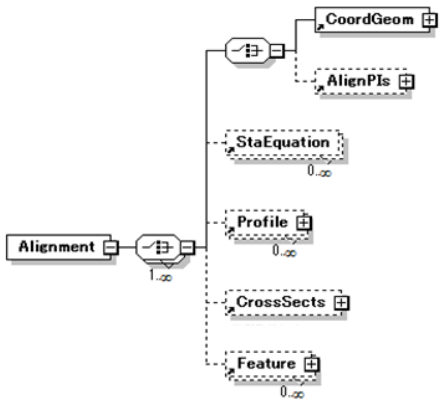
Design traffic volume: enter "trafficVolume" for Property label, and the value for value (unit: vehicle/day).

[The structure information, standards and classes, and left/right bank of river]
For the structure information, standards and classes, and left/right bank of river, Use Features and Property as the child elements of Alignments as follows.

Omit Feature name.
Structure information: "designGmType" for Property label, and "river" for value.
Standards / classes: "classification" for Property label, and the class of river for value.
Left or right bank: "side" for Property label, and "left bank" or "right bank" for value.

* Data about the shape of river levees shall be created by dividing data into the levee on the left bank and the one on the right. In order to distinguish the left and right banks, entry of left / right banks shall be required.

4-2-12　Alignment

<table>
<tr><td>element name</td><td colspan="3">Alignment</td><td>Logical name</td><td colspan="2">Alignment</td></tr>
<tr><td>path</td><td colspan="6">/Alignments/Alignment</td></tr>
<tr><td>figure</td><td colspan="6"> 
</td></tr>
<tr><td>child elements</td><td colspan="6">CoordGeom AlignPIs StaEquation Profile CrossSects Feature</td></tr>
<tr><td>type</td><td colspan="6">－</td></tr>
<tr><td>number of occurrences</td><td colspan="6">1 or more</td></tr>
<tr><td rowspan="5">attributes</td><td>name</td><td>Name</td><td>xs:string</td><td>Required</td><td colspan="2"></td></tr>
<tr><td>length</td><td>Total length</td><td>xs:double</td><td>Required</td><td colspan="2"></td></tr>
<tr><td>staStart</td><td>Cumulative distance station of the start point</td><td>xs:double</td><td>Required</td><td colspan="2">Distance to the location on the basis of the control point(the cumulative distance station of the start point in the following figure)</td></tr>
<tr><td>desc</td><td>Notes</td><td>xs:string</td><td></td><td colspan="2"></td></tr>
<tr><td colspan="5"></td></tr>
<tr><td>content</td><td colspan="6">Information about alignments</td></tr>
<tr><td>entry example</td><td colspan="6"><Alignment name="alignment 1" length="553.357221" staStart="0."><br>・・・<br>・・・<br><Feature name="Horizontal"><br><Property label="method" value="IPmethod"/><br></Feature><br><Feature name="Interval"><br><Property label="main" value="100."/><br><Property label="sub" value="20."/><br></Feature><br></Alignment></td></tr>
</table>

[Alignment calculation method]
　For the calculation method of the horizontal alignment, use Features and Property as the child elements of Alignment as follows.

Horizontal alignment: enter "Horizontal" for Feature name.
Name of the alignment calculation method: enter "method" for Property label, and "IP method" or "element method" for value.

[Station interval]
　For the station interval, use Features and Property as the child elements of Alignment as follows.

Station interval: "Interval" for Feature name.
Main station interval: "main" for Property label, and the value of main station interval for value.
Sub station interval: "sub" for Property label, and the value of the sub station interval for value.

* Station numbers and additional distance are not registered into LandXML. They are obtained from the station interval and the cumulative distance stations as needed.
* When there is no sub station, the data of the sub station interval can be omitted.
* The data about the representation of stations such as No., STA, are not covered for data exchange. They shall be entered using software as needed.

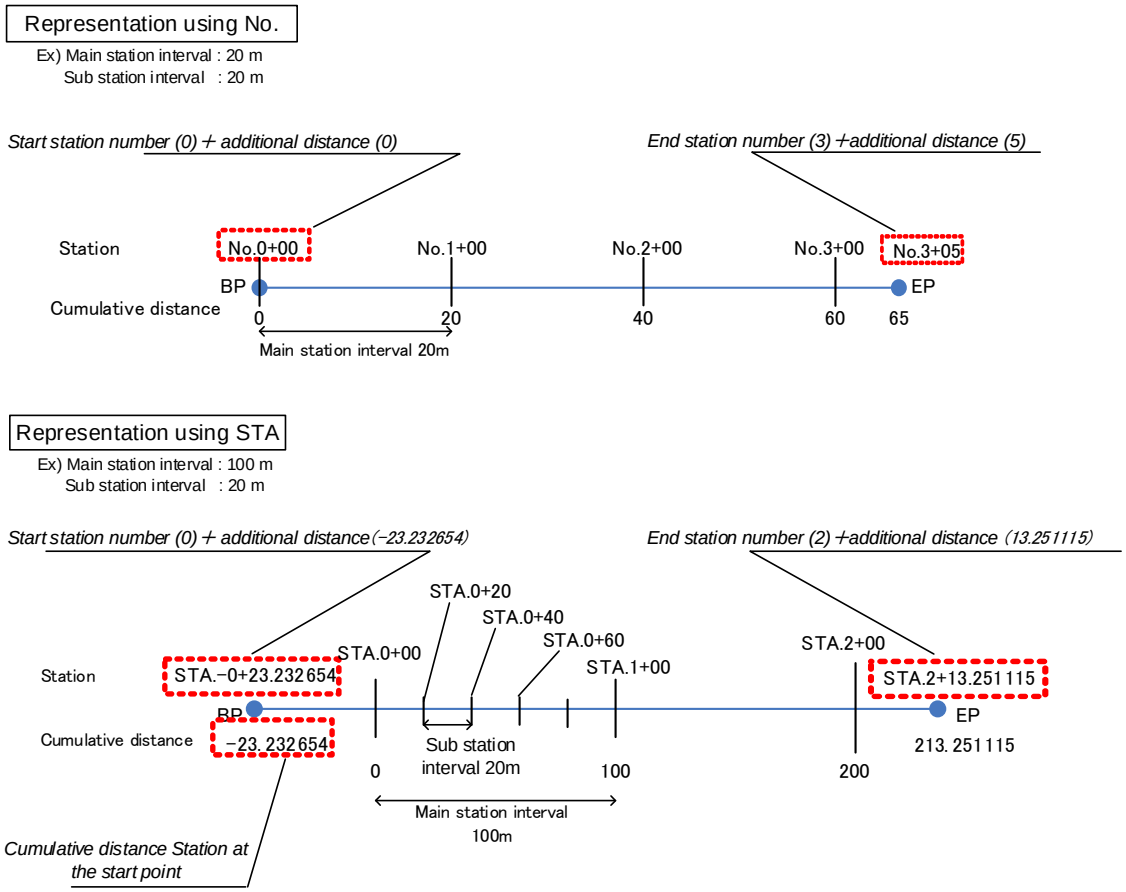



Figure 4-2 Relationship between stations (station number + additional distance) and cumulative distance stations

4-2-13　Definition of stations

| element name | StaEquation | | Logical name | Definition of stations | |
|---|---|---|---|---|---|
| path | /Alignments/Alignment/StaEquation | | | | |
| fgure | StaEquation | | | | |
| child elements | — | | | | |
| type | — | | | | |
| number of occurrences | 0 or more | | | | |
| attributes | staBack | Cumulative distance station of the station before the brake | xs:double | | |
| | staInternal | Cumulative distance station of the station on the brake position | xs:double | Required | Distance to the position on the basis of the start point |
| | staAhead | Cumulative distance station of the station after the brake | xs:double | Required | |
| content | Information about the definition of stations regarding station brake | | | | |
| entry example | <StaEquation staAhead="287.345948" staInternal="339.25" staBack="339.25"/> | | | | |

* The cumulative distance station after the brake shall be the value converted from "the station number + the additional distance" of the station after the brake.

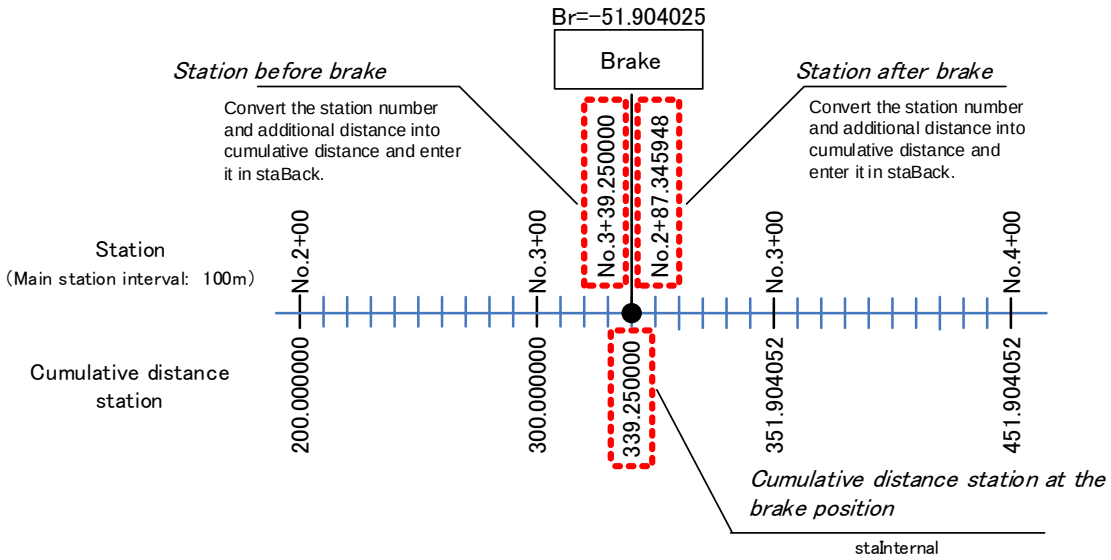
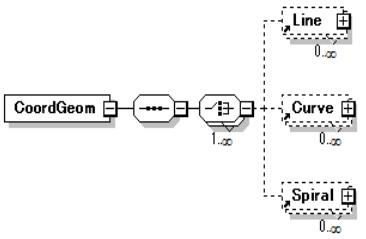


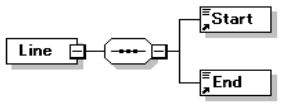

Figure 4-3　Relationship between the station number before and after the brake and cumulative distance station of brake position

4-2-14　Geometric element

| element name | CoordGeom | Logical name | Geometric element |
|---|---|---|---|
| path | /Alignments/Alignment/CoordGeom | | |
| figure |  | | |
| child elements | Line Curve Spiral | | |
| type | ― | | |
| number of occurrences | 1 | | |
| content | Information about the geometric elements that compose the horizontal alignment. Any of the straight line, the circular curve, or the transition curve shall be put in order continuously from the beginning point of the alignment. | | |
| entry example | <CoordGeom><br><Line length="94.906"><br><Start name="BP">-134492.609300 -31243.259760</Start><br><End name="KA1-1">-134462.476634 -31153.264299</End><br></Line><br><Spiral length="37.5" radiusEnd="150." radiusStart="INF"<br>rot="ccw" spiType="clothoid"><br><Start name="KA1-1">-134462.476634 -31153.264299</Start><br><PI>-134454.532630 -31129.538410</PI><br><End name="KE1-1">-134449.108977 -31118.255675</End><br></Spiral><br><Curve rot="ccw" radius="150."><br><Start name="KE1-1">-134449.108977 -31118.255675</Start><br><Center>-134313.917658 -31183.242652</Center><br><End name="KE1-2">-134408.933782 -31067.173982</End><br></Curve><br>・・・<br>・・・<br></CoordGeom> | | |

* They are elements that constitute a horizontal alignment, put continuously in order from the side of beginning point (BP).
* The end point of a geometric element and the beginning point of the adjacent element should be connected (share the same coordinate values).
* For Name of the beginning point and end point of the element, input the name of the main element point (e.g. name of the start and end points of elements such as BC, EC, KA1-1, KE1-1, KE2-1, or KA2-1).

### 4-2-15 Straight line

| element name | Line | | Logical name | | Straight line |
|---|---|---|---|---|---|
| path | /Alignments/Alignment/CoordGeom/Line | | | | |
| figure |  | | | | |
| child elements | Start End | | | | |
| type | — | | | | |
| number of occurrences | 0 or more | | | | |
| attributes | name | Name | xs:string | | Name of straight line |
| | length | Length | xs:double | | Length of the straight line |
| content | Information about the straight line | | | | |

### 4-2-16 Start point

| element name | Start | | Logical name | | Start point |
|---|---|---|---|---|---|
| path | /Alignments/Alignment/CoordGeom/Line/Start<br>/Alignments/Alignment/CoordGeom/Curve/Start<br>/Alignments/Alignment/CoordGeom/Spiral/Start | | | | |
| figure |  | | | | |
| child elements | — | | | | |
| text node | Data type<br>List of double | Input coordinate values in the order X Coordinate, Y Coordinate, and elevation. Separate the values with spaces.<br>Elevation is omissible. | | | |
| number of occurrences | 1 | | | | |
| attributes | Name | Name | xs:string | （Required） | Name of the start point (Note 1) |
| content | Information about the start point of the straight lines, circular curves, and transition curves | | | | |

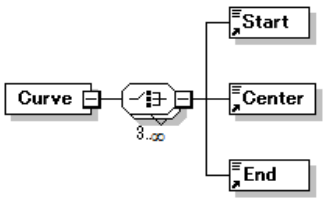
### 4-2-17 End point

| element name | End | | Logical name | | End point |
|---|---|---|---|---|---|
| path | /Alignments/Alignment/CoordGeom/Line/End<br>/Alignments/Alignment/CoordGeom/Curve/End<br>/Alignments/Alignment/CoordGeom/Spiral/End | | | | |
| figure |  | | | | |
| child elements | — | | | | |
| text node | Data type<br>List of double | Input coordinate values in the order X Coordinate, Y Coordinate, and elevation. Separate the values with spaces.<br>Elevation is omissible. | | | |

| | | | | | |
|---|---|---|---|---|---|
| number of occurrences | 1 | | | | |
| attributes | Name | Name | xs:string | （Required） | Name of the end point (Note 1) |
| content | Information about the end point of the straight lines, circular curves, and transition curves | | | | |

Notes 1: Names of the start and end points shall be the name of main points.

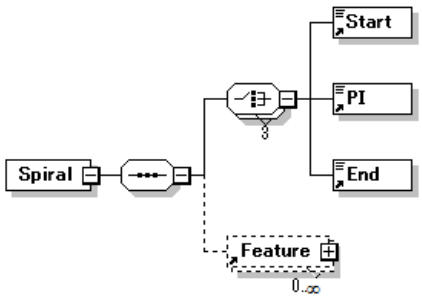
4-2-18　Circular curve

| element name | Curve | | Logical name | Circular curve | |
|---|---|---|---|---|---|
| path | /Alignments/Alignment/CoordGeom/Curve | | | | |
| figure |  | | | | |
| child elements | Start Center End PI | | | | |
| type | － | | | | |
| number of occurrences | 0 or more | | | | |
| attributes | rot | direction | clockwise | Required | Clockwise (cw) / counter clockwise (ccw) to the direction of movement. Choose from the following.<br>cw<br>ccw |
| | name | Name | xs:string | | Name of circular curve |
| | radius | Radius | xs:double | | Radius of circular curve |
| | length | Length | xs:double | | Curve length |
| content | Information about the circular curve | | | | |

4-2-19　Center point

| element name | Center | Logical name | Center point |
|---|---|---|---|
| path | /Alignments/Alignment/CoordGeom/Curve/Center | | |
| figure |  | | |
| child elements | － | | |
| text node | Data type<br>List of double | Input coordinate values in the order X Coordinate, Y Coordinate, and elevation. Separate the values with spaces.<br>Elevation is omissible. | |
| number of occurrences | 1 | | |
| content | Information about the center point | | |

4-2-20　Transition curve

| element name | Spiral | | Logical name | | Transition curve |
|---|---|---|---|---|---|
| path | /Alignments/Alignment/CoordGeom/Spiral | | | | |
| figure |  | | | | |
| child elements | Start PI End | | | | |
| type | — | | | | |
| number of occurrences | 0 or more | | | | |
| attributes | name | Name | xs:string | | Name of transition curve |
| | length | Length | xs:double | Required | Length of transition curve |
| | radiusStart | Radius at the start point | xs:double | Required | INF in the case of straight line |
| | radiusEnd | Radius at the end point | xs:double | Required | INF in the case of straight line |
| | Rot | Direction | clockwise | Required | Clockwise (cw) / counter clockwise (ccw) to the direction of movement. Choose from the following.<br>cw<br>ccw |
| | spiType | Type of transition curve | spiralType | Required | Enter clothoid |
| content | Information about the transition curve | | | | |

[Clothoid parameter]

For the clothoid parameter, use Features and Property as the child elements of Spiral as follows.

Omit Feature name.

"A" for Property label, and the value for value.

When there is no value of clothoid parameters, obtain it from the length of transition curve and the radius.

4-2-21　Point of intersection

| element name | PI | | | Logical name | Point of intersection |
|---|---|---|---|---|---|
| path | /Alignments/Alignment/CoordGeom/Spiral/PI<br>/Alignments/Alignment/ AlignPIs/AlignPI/PI | | | | |
| figure |  | | | | |
| child elements | — | | | | |
| text node | Data type<br>List of double | Input coordinate values in the order X Coordinate, Y Coordinate, and elevation. Separate the values with spaces.<br>Elevation is omissible. | | | |
| number of occurrences | 1 | | | | |
| attributes | name | Name | xs:string | | |
| | desc | Notes | xs:string | | |
| content | The coordinates of point of intersection of the tangent for Spiral; the coordinate data of the IP for AlignPI | | | | |

[Point of intersection of Spiral Lines]

The point of intersection of Spiral lines is the point of intersection of two tangents of a transition curve.

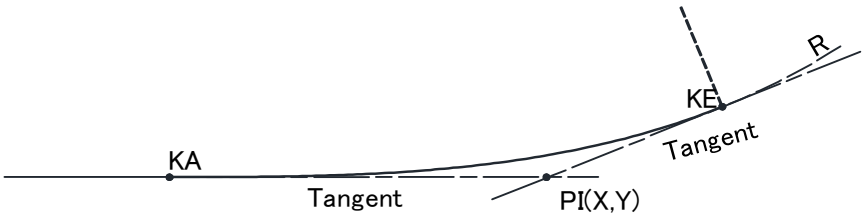
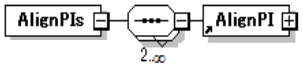


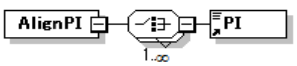

Figure 4-4　Point of intersection of Spiral Lines

4-2-22　Intersection Point list

| element name | AlignPIs | Logical name | IP List |
|---|---|---|---|
| path | /Alignments/Alignment/ AlignPIs | | |
| figure |   | | |
| child elements | AlignPI | | |
| type | － | | |
| number of occurrences | 0 or 1 | | |
| content | Information about the list of IP (intersection points) | | |
| entry example | <AlignPIs><br>　<AlignPI><br>　　<PI name="BP"> -134492.609300 -31243.259760</PI><br>　</AlignPI><br>　<AlignPI><br>　　<PI name="IP-1" desc="KA1-1～KA1-2"><br>　　-134439.455520 -31084.508490<br>　　</PI><br>　</AlignPI><br>　<AlignPI><br>　　<PI name="IP-2" desc="KA2-1～KA2-2"><br>　　-134260.046870 -30971.780270<br>　　</PI><br>　</AlignPI><br>　<AlignPI><br>　　<PI name="EP"> -134172.474970 -30814.085110 </PI><br>　</AlignPI><br></AlignPIs> | | |
| content | The IP list includes Beginning Points (BP) and End Points (EP). | | |

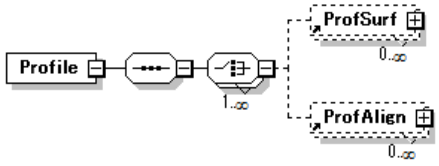
* The IP list is omissible.

4-2-23　IP (Intersection point)

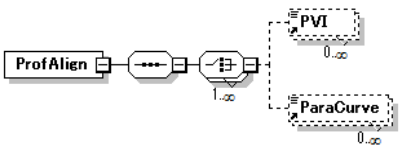
| element name | AlignPI | Logical name | Point of intersection |
|---|---|---|---|
| path | /Alignments/Alignment/ AlignPIs/AlignPI | | |
| figure |   | | |
| child elements | PI | | |
| type | － | | |
| number of | 2 or more | | |

| | |
|---|---|
| occurrences | |
| content | Information about points of intersection |

4-2-24 Profile

| element name | Profile | | Logical name | | Profile |
|---|---|---|---|---|---|
| path | /Alignments/Alignment/Profile | | | | |
| figure |  | | | | |
| child elements | ProfSurf ProfAlign | | | | |
| type | — | | | | |
| number of occurrences | 0 or more | | | | |
| attributes | name | Name | xs:string | | |
| | staStart | Cumulative distance station | xs:double | | Distance from the start point to the position |
| content | The parent element of the vertical alignment and ground profile | | | | |
| entry example | <Profile name="Profile" staStart="12.8495"><br>  <ProfAlign name="Vertical alignment 1"><br>  <PVI>-912.8495 204.589</PVI><br>  <ParaCurve length="200.">451.405 184.125</ParaCurve><br>  ・・・<br>  </ProfAlign><br>  <ProfSurf name=" Ground profile 1"><br>  <PntList2D><br>  -912.8495 200. 128.6091 190. 610.0461 180. ・・・<br>  </PntList2D><br>  </ProfSurf><br></Profile> | | | | |

4-2-25 Vertical alignment

| element name | ProfAlign | Logical name | Vertical alignment |
|---|---|---|---|
| path | /Alignments/Alignment/Profile/ ProfAlign | | |
| figure |  | | |

| | | | | | |
|---|---|---|---|---|---|
| child elements | PVI ParaCurve | | | | |
| type | — | | | | |
| number of occurrences | 0 or more | | | | |
| attributes | name | Name | xs:string | Required | |
| | desc | Notes | xs:string | | |
| content | Information about vertical alignments or design water level for rivers | | | | |

4-2-26 Intersection point of vertical tangent(changing point of grade without vertical curve)

| | | | |
|---|---|---|---|
| element name | PVI | Logical name | Changing point of vertical gradient |
| path | /Alignments/Alignment/Profile/ProfAlign/PVI | | |
| figure |  | | |
| child elements | — | | |
| text node | Data type: List of double | Enumerate cumulative distance and elevation separated with a space. | |
| number of occurrences | 0 or more | | |
| content | Grade transition points without a vertical curve, such as start or end points. | | |

4-2-27 Intersection point of vertical tangent (changing point of grade with a vertical curve)

| | | | | | |
|---|---|---|---|---|---|
| element name | ParaCurve | | Logical name | Vertical curve | |
| path | /Alignments/Alignment/Profile/ProfAlign/ParaCurve | | | | |
| figure |  | | | | |
| child elements | — | | | | |
| text node | Data type: List of double | Enumerate cumulative distance and elevation separated with a space. | | | |
| number of occurrences | 0 or more | | | | |
| attributes | length | Vertical curve Length | xs:double | Required | |
| content | Grade transition points with a vertical curve, such as intermediate points. | | | | |

* The vertical curve radius is obtained from the vertical curve length.
* When setting a vertical curve at the place where the vertical gradient changes, use ParaCurve element. For the point of changing without a set vertical curve or the start or end points of an alignment, use PVI element. The coordinates of a vertical changing point are represented by the cumulative distance station and elevation of the horizontal alignment. Enumerate the coordinates of intersection points of vertical tangent in order from the beginning point to the end point.

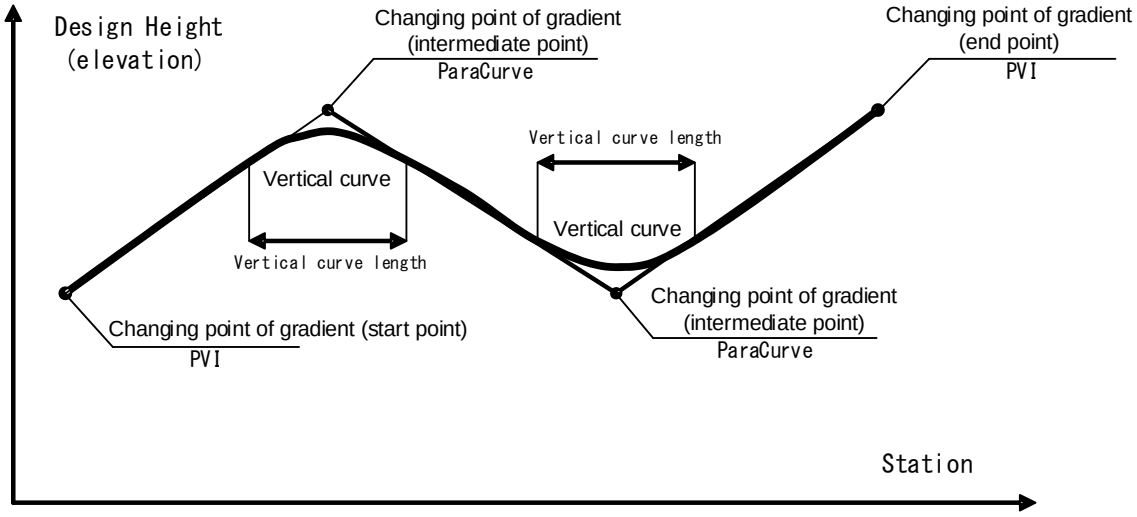
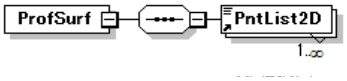



Figure 4-7　Relationship between vertical alignment and intersection points of vertical tangent

4-2-28　Ground profile

| element name | ProfSurf | | Logical name | Ground profile | |
|---|---|---|---|---|---|
| path | /Alignments/Alignment/Profile/ProfSurf | | | | |
| figure |  | | | | |
| child elements | PntList2D | | | | |
| type | － | | | | |
| number of occurrences | 0 or more | | | | |
| attributes | name | Name | xs:string | Required | |
| | desc | Notes | xs:string | | |
| content | Information about the ground profile (vertical surface line) | | | | |
| entry example | <ProfSurf name=" Ground profile 1"><br><PntList2D><br>584.2955 24.456<br>584.5618 25.753<br>584.6342 26,289<br></PntList2D><br></ProfSurf> | | | | |

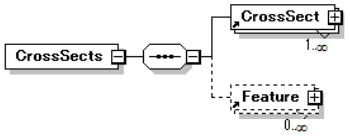
* The ground profile represents the ground level at the position of the horizontal alignment. The coordinates of point are represented by the cumulative distance station of the horizontal alignment and elevation. Basically, they are enumerated in order from the beginning to end points of the alignment.

4-2-29　Two-dimensional (2D) coordinate list

| element name | PntList2D | | Logical name | 2D coordinate list |
|---|---|---|---|---|
| path | /Alignments/Alignment/Profile/ProfSurf/PntList2D<br>/Alignments/Alignment/CrossSects/CrossSect/CrossSectSurf/PntList2D | | | |
| figure |  | | | |
| Child elements | － | | | |
| text node | Data type | For the ground profile, enumerate the cumulative distance station and elevation separated with a space.<br>For the cross-sectional terrain information, enumerate the horizontal distance from the road center line and elevation separated with a space. | | |
| | List of double | | | |
| number of occurrences | 1 or more | | | |

4-2-30　Cross-sectional geometry set

| element name | CrossSects | Logical name | Cross-sectional geometry set |
|---|---|---|---|
| path | /Alignments/Alignment/CrossSects | | |

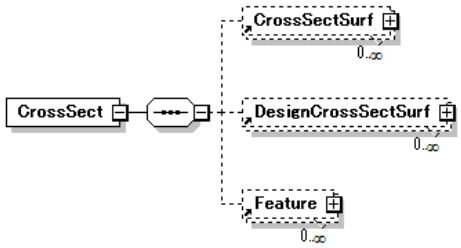
<table>
<tr><td>figure</td><td colspan="5"> 
</td></tr>
<tr><td>child elements</td><td colspan="5">CrossSect Feature</td></tr>
<tr><td>type</td><td colspan="5">—</td></tr>
<tr><td>number of occurrences</td><td colspan="5">0 or 1</td></tr>
<tr><td rowspan="2">attributes</td><td>name</td><td>Name</td><td>xs:string</td><td></td><td>Name of the cross sectional element</td></tr>
<tr><td>desc</td><td>Notes</td><td>xs:string</td><td></td><td></td></tr>
<tr><td>content</td><td colspan="5">Information on the cross section profile of roads or rivers</td></tr>
<tr><td>entry example</td><td colspan="5"><CrossSects name="Cross sectional geometry set 1"><br><CrossSect name="No.0+0.00" sta="0."><br><CrossSectSurf name="Present topography 1"><br>・・・<br></CrossSectSurf><br>・・・<br><DesignCrossSectSurf name="SlopeFill" side="left"><br>・・・<br></DesignCrossSectSurf><br>・・・<br></CrossSect><br><Feature><br><Property label="projectPhase" value="detailed"/><br><Property label="profAlignRefs" value="vertical alignment 1"/><br></Feature><br></CrossSects></td></tr>
</table>

[Project phase, reference vertical alignment]

For project phase and reference vertical alignment, use Features and Property as the child elements of CrossSects as follows.

Omit Feature name.
Project phase: "projectPhase" for Property label, and the name of project phase for value.
Reference vertical alignment: "profAlignRefs" for Property label, and the name of vertical alignment for value.

4-2-31　Cross section

<table>
<tr><td>element name</td><td colspan="3">CrossSect</td><td>Logical name</td><td colspan="2">Cross section</td></tr>
<tr><td>path</td><td colspan="6">/Alignments/Alignment/CrossSects/CrossSect</td></tr>
<tr><td>figure</td><td colspan="6"> 
</td></tr>
<tr><td>child elements</td><td colspan="6">CrossSectSurf DesignCrossSectSurf Feature</td></tr>
<tr><td>type</td><td colspan="6">－</td></tr>
<tr><td>number of occurrences</td><td colspan="6">1 or more</td></tr>
<tr><td rowspan="5">attributes</td><td>name</td><td>Name</td><td>xs:string</td><td></td><td colspan="2">Order to ensure the correspondence between the cross-section and the intermediate point, Enter the name of the station number + additional distance.</td></tr>
<tr><td>sta</td><td>cumulative distance station</td><td>xs:double</td><td>Required</td><td colspan="2">Input the position of the cross section using the cumulative distance station</td></tr>
<tr><td>angleSkew</td><td>Direction angle</td><td>angle</td><td></td><td colspan="2">Input the cross-sectional direction angle.</td></tr>
<tr><td>desc</td><td>Notes</td><td>xs:string</td><td></td><td colspan="2"></td></tr>
<tr><td colspan="5"></td></tr>
<tr><td>content</td><td colspan="6">Information about the positions of controlled cross sections and about other cross sections. For those cross sections in which cross sectional elements change, such as from a Fill cross section to a Cut cross section, each of the cross sections on the sides of start point and end point is created with DesignCrossSectSurf.</td></tr>
<tr><td>entry example</td><td colspan="6"><CrossSect name=" No.10+0.0000" sta="200."><br><DesignCrossSectSurf ・・・><br>・・・<br></DesignCrossSectSurf><br><Feature name="Formation"><br><Property label="clOffset" value="0.7"/><br><Property label="fhOffset" value="0.2"/><br></Feature><br></CrossSect></td></tr>
</table>

[Direction angle]

In road design, some cross sections, which are created in the form of crossing the road alignment of the main line at right angles such as a ramp, may cross the alignment diagonally; for example, crossing the road alignment of the frontage road diagonally. Also in river design, since a cross section drawing is created in the way that crosses the survey center line, a section view that crosses the levee alignment diagonally may be created.

For these kinds of cross sections, the cross section shall be defined by selecting the direction angle or the name of the target coordinates. For the direction angle, define the cross section with an optional direction angle to the alignment shown in the figure below. The direction angle shall be the angle that the alignment from the side of start point forms with the cross section, which is a clockwise angle contained by the line segment that constitutes the alignment and the cross section. When obtaining the direction angle of B.P. (start point), it shall be an angle that the extension of the alignment containing B.P. forms with the cross section. The alignment may be on the right or left edge of pavement. The unit of the direction angle shall follow the definition of Units.

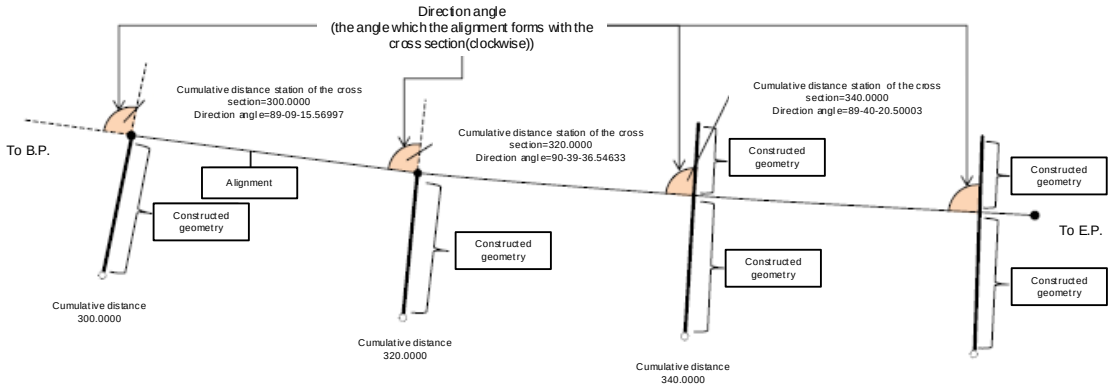



Figure 4-8　Outline of direction angles

[Controlled cross sections, names of target coordinates, and rounding distance]

When setting controlled cross sections, names of target coordinates, and rounding distance, use Feature and Property as the child elements of CrossSect as follows.

"xSection" for Feature name.
Controlled section: "controlSect" for Property label, and "true" for value if it is a controlled cross section.
Name of target coordinates: "targetPntID" for Property label, and the name of CgPoint for value.
Rounding distance: "rounding" for Property label, and the value of the rounding distance for value.

* Name of target coordinates

The cross section in this case shall be defined by the coordinates defined by the name of target coordinates and the point of intersection obtained by the cumulative distance on the alignment. The name of target coordinates are defined by referring to Cgpoint registered in the coordinate set that are grouped as "TargetPnts".

When both of the direction angle and the name of target coordinates are contained, the name of target coordinates shall be given priority over the other and used to define the direction of the cross section.

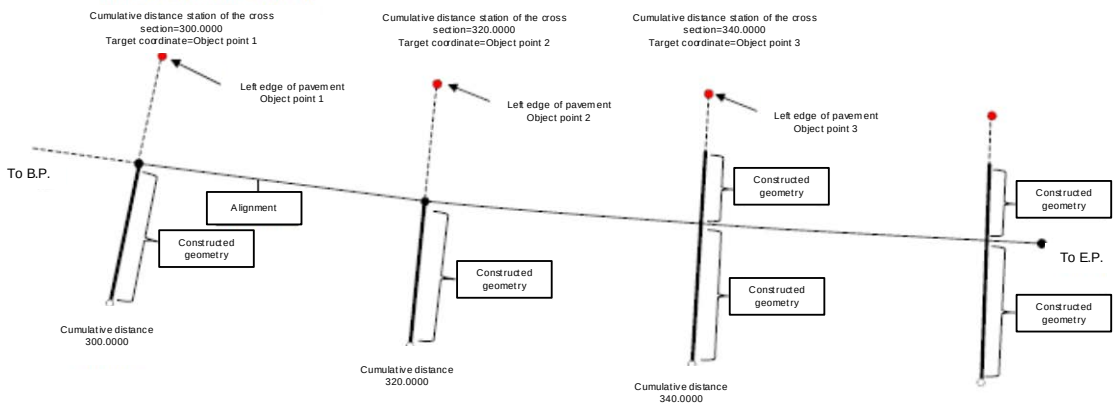



Figure 4-9 Illustration of the name of target coordinates

* Rounding distance

Rounding is to round the edge of the artificial terrain produced by land development. The starting position of rounding and the distance to the intersection point of the extended tangents of slope and ground are defined.

For the intersection point of the extended tangents of slope and berm, state of the constitutive point (CrossSectPnt) is treated as a proposed point.

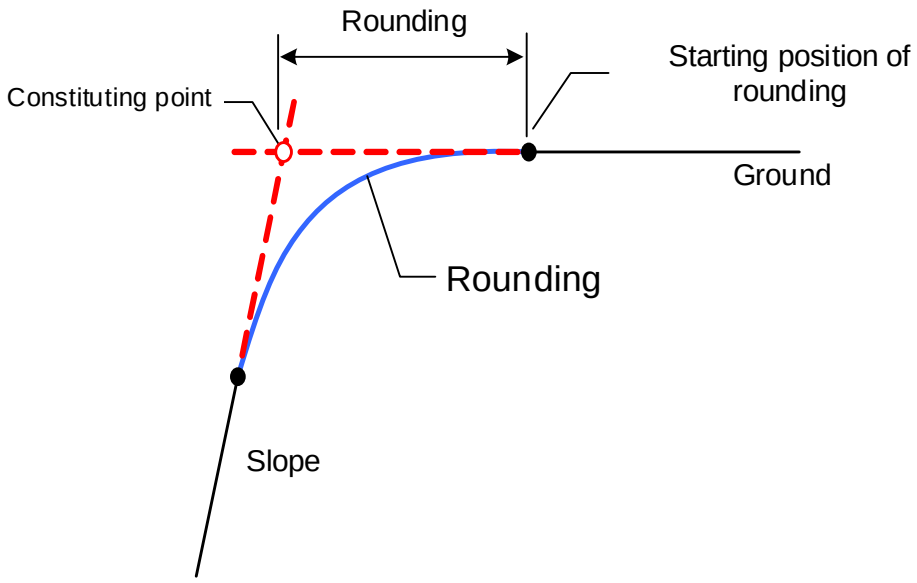



Figure 4-10　How to define rounding

[Formation center]

For roads, it is required to create data of the formation center(formation center　is the center　of constituting elements of road surface). When the road center line and the center line of road formation agree with each other, data on the formation center should also be created. For setting the formation center, use Features and Property as the child elements of CrossSect as follows.

Formation center: "Formation" for Feature name.
CL offset: "clOffset" for Property label; the value of the horizontal distance from the center line for value.
Elevation difference from the design height: "sta" for Property label; the value of elevation difference for value.

[Standard cross section]

The standard cross section shows the standard settings of width and gradient of the constituting elements of road surface, gradient and relative height of slope, and width and gradient of berm. Basically it shall be created for the fill and cut sections

respectively. Basically, they are created for a fill section and cut section respectively. The typical cross section is specified as a standard cross section, and the segments to which the standard cross section is applied are specified using cumulative distance stations.

When setting the cross section defined according to CrossSect, use Feature and Property as the child elements of CrossSect as follows.

Standard cross section: "StandardCrossSection " for Feature name.
Starting cumulative distance station: "startSta" for Property label; the value of cumulative distance station at the start of applying the standard cross section for value.
Ending cumulative distance station: "endSta" for Property label; the value of cumulative distance station at the end of applying the standard cross section for value.

In defining the standard cross section, cut and fill can be set in advance by registering the slopes and berms as proposed points (See Figure 4-11).

For the proposed (nonexistent) points of slopes or berms, register the state of constituting points (CrossSectPnt) as "proposed".

When the definition of slope or berm ends up with a slope, create a slope extended with the gradient of the last slope (See Figure 4-12). When it ends up with a berm, repeat a combination of the last berm and the slope registered before it to represent geometries of slope and berm (Figure 4-13).

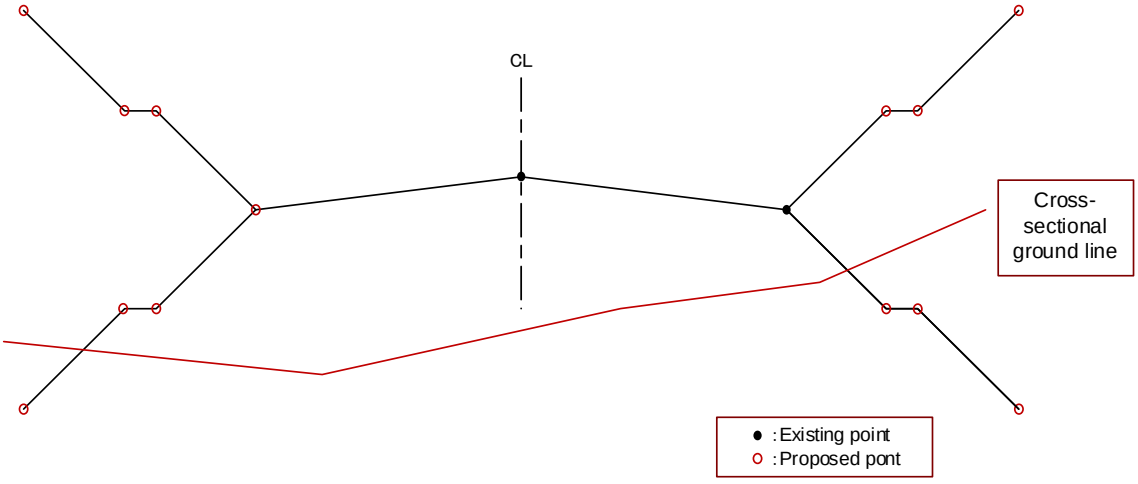



Figure 4-11　How to define the standard cross section

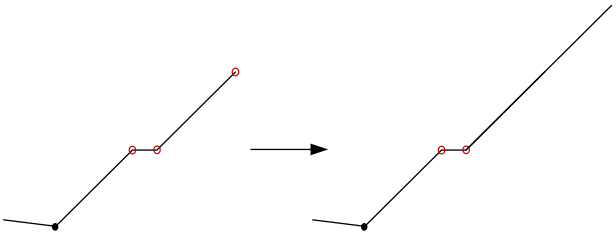


Figure 4-12　How to define slope and berm (when ending up with a slope)

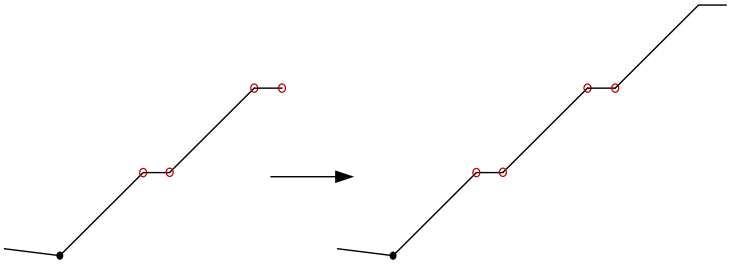
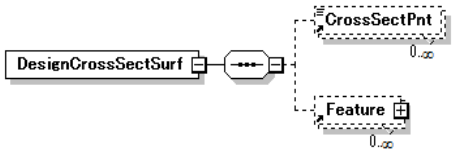


Figure 4-13　How to define slope and berm (when ending up with a berm)

4-2-32　Cross-sectional geometry

| element name | DesignCrossSectSurf | | Logical name | Cross-sectional geometry | |
|---|---|---|---|---|---|
| path | /Alignments/Alignment/CrossSects/CrossSect/DesignCrossSectSurf | | | | |
| figure |  | | | | |
| child elements | CrossSectPnt Feature | | | | |
| type | — | | | | |
| number of occurrences | 0 or more | | | | |
| attributes | name | Name | xs:string | (Required) | Name of element type |
| | desc | Notes | xs:string | | Choose from the following. Road Surface, Subgrade Surface, Embankment Surface, Excavation Surface, Design Levee, Extra Bannking, River Wall |
| | side | Position of the constituting point | sideofRoadType | (Required) | Right if the constituting point is located on the right side of the formation center line; left if on the left side. |
| | material | Material | xs:string | | Input the material in the case of pavement. |
| | typicalThickness | Thickness | xs:double | | Input the thickness in the case of pavement. |
| | closedArea | Closed flag | xs:boolean | | "true" if the constituting points are closed as a plane such as a pavement surface or a structure |
| content | The cross-sectional geometry represented by aligned constituting points. (A fill and cut section of earthworks is represented by one cross section, with divided cross-sectional | | | | |

| | |
|---|---|
| | geometries for the fill section and the cut section respectively). |
| entry example | <DesignCrossSectSurf name="SlopeFill" side="left" desc=”Road Surface”><br><CrossSectPnt code="L1n1">8.1660 119.415</CrossSectPnt><br><CrossSectPnt code="L1n2">12.9855 116.202</CrossSectPnt><br><Feature name="Formation"><br><Property label="heightType" value="elevation"/><br></Feature><br></DesignCrossSectSurf> |

* When the carriageway and pavement etc. overlap with each other on the same spot in the sequence of elements, another model is created in addition to the road surface and pavement.

[Sequence of describing constituting points]

The constituting points are entered continuously in the order from the formation center in the outward direction (see Figure 4-14 (a)). For rivers, the levee alignment is the basis for separating the left and right sides; the constituting points are input continuously in the order from the levee alignment in the outward direction.

The constituting points of a closed cross section are registered as continuous CrossSectPnt; the cross section is closed by returning to the first constituting point. For the closed area on the right side of the formation center, they are defined clockwise from a constituting point. For the closed area on the left side of the formation center, they are defined counterclockwise (see Figure 4-14 (b)).

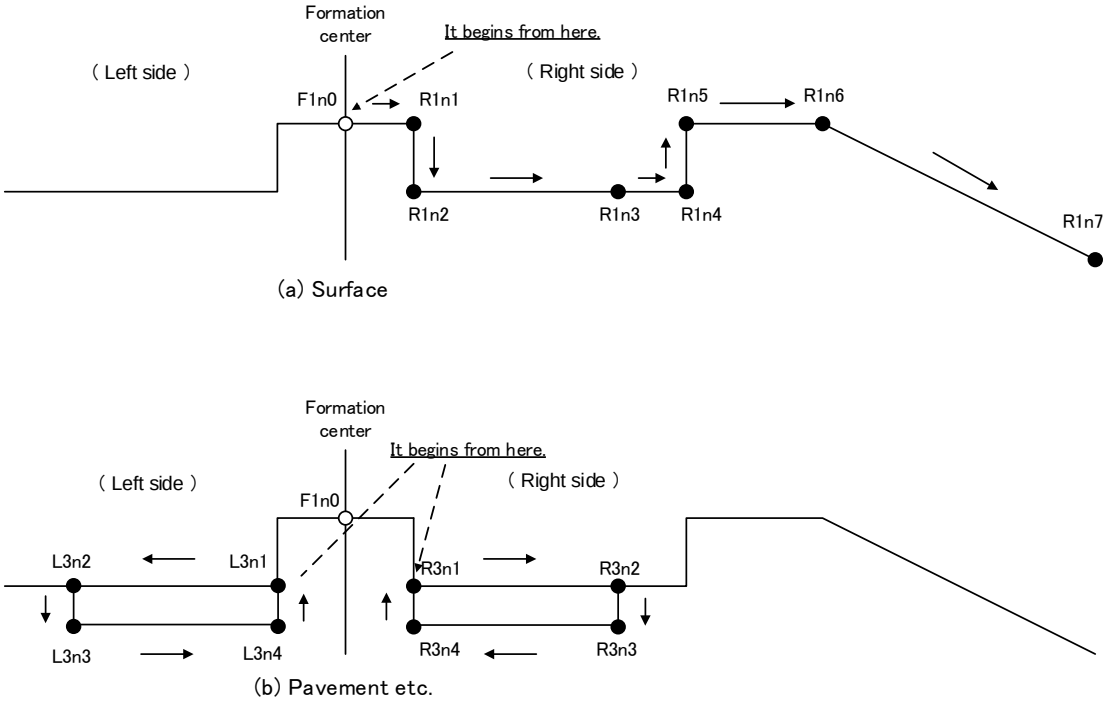



Figure 4-14　Sequence of describing constituting points (with sample code numbers)

[Type of element]

The following table shows options of element type to enter for the name and their corresponding Japanese names.

Table 4-2 Types of element and corresponding Japanese names (for roads)

| Type of element (option) | Type of element (Japanese name) |
|---|---|
| Carriageway | Carriageway |
| CenterStrip | Median |
| RoadShoulder | Shoulder |
| StoppingLane | Stopping lane |
| SideWalk | Side walk |
| PlantingZone | Planting zone |
| FrontageRoad | Frontage road |
| Track | Track |
| Separator | Separator |
| MarginalStrip | Marginal strip |
| SubBase | Subgrade surface |
| SubGrade | Embankment surface |
| Excavation | Excavation(digging) |
| SlopeFill | Slope (fill) |
| SlopeCut | Slope (cut) |
| BermFill | Berm (fill) |
| BermCut | Berm (cut) |
| RetainingWall | Retaining wall |
| Drainage | Ditch (Drainage) |
| Pavement | Pavement |
| Other | Other(turnouts, vehicle-specifications measurement facilities, parking lots, bicycle parking lots, emergency parking bays, and places for putting on and removing tire chains etc.) |

Table 4-3 Types of element and corresponding Japanese names (for rivers)

| Type of element (option) | Type of element (Japanese name) |
|---|---|
| Crown | Levee crown |
| EarthWorkBaseLineFill | Earthwork surface (Fill) |
| SlopeFill | Slope (Fill) |
| BermFill | Berm (Fill) |
| RetainingWall | Retaining wall |
| Other | Other |

[Positions of the constituting points]

For roads, constituting points shall be constructed separately between the left and right sides of the center of the road width. When creating elements on the left-hand side of the width center, the position of the constituting points shall be "left"; when creating those on the right-hand side, their positions shall be "right".

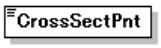
For river levees, constituting points shall be constructed separately between the left and right sides of the levee alignment. Although the cross section drawing is created by looking from the upper reaches towards the lower reaches, it is common to create a levee alignment from the lower reaches to the upper reaches. Note that this makes the separation of the constituting points between left and right to be opposite to the cross section drawing.

[Types of cross sectional element, clearance limit, and types of pavement]

For types of cross sectional element, clearance limit, and types of pavement, use Feature and Property as the child elements of DesignCrossSectSurf as follows.

Omit Feature name.
Type of cross sectional element: "xSectType" for Property label; the type of works of the progress control of working form by TS for value. This entry is made at the stage of the progress control of working form by TS, but is unnecessary at the design phase.
Clearance limit: "clearance" for Property label; height of clearance limit for value. This entry is made when the type of element is Carriageway, Shoulder, or Sidewalk.
Type of pavement: enter "pavementClass" for Property label; surface course, binder course, base course, or subbase course etc. for value.

4-2-33　Constituting point

| element name | CrossSectPnt | | Logical name | Constituting point | |
|---|---|---|---|---|---|
| path | /Alignments/Alignment/CrossSects/CrossSect/DesignCrossSectSurf/CrossSectPnt | | | | |
| figure |   | | | | |
| child elements | — | | | | |
| text node | Data type: List of double | If the data format is OffsetElevation, input the constituting point with the road- center-alignment (levee alignment) offset and elevation or vertical offset separated with a space. In describing the road-alignment offset of each constituting point, describe it as a negative number (-) if it is located on the left side of the location of the road alignment set to the origin, and as a positive number (+) if it is on the right side.<br><br>If the data format is SlopeDistance, input the constituting point with the gradient (%) and distance separated with a space. Describe the downward gradient as a negative number (-), and the upward one as a positive number (+). Describe the distance in the left direction as a negative number (-), and in the right direction as a positive number (+). | | | |
| number of occurrences | 0 or more | | | | |
| attributes | code | Constituting point cord | xs:string | (Required) | |
| | dataFormat | Data format | dataFormatType | | Choose the data format of the Text node from the following:<br>Offset Elevation<br>Slope Distance<br>When omitted:<br>Offset Elevation |
| | state | State | stateType | | When the constituting point is existing within the cross section, (when it is inside the point of intersection with the terrain), input "existing".<br>When it is nonexistent, input "proposed". If unknown, omit it. |
| content | The constituting points that constitute the constructed geometry | | | | |

[Coordinates of the constituting point]

A constituting point specifies its location using CL offset (horizontal offset in the cross-sectional direction of the road center line (levee alignment for a river)) and elevation or vertical offset (difference in elevation from design height). CL offset of a constituting point specifies the right side of road alignment (levee alignment) as positive (+). The vertical offset define the upper side of design height position as positive (+), and the lower side as negative (-).

[Constituting point code]

In order to define constituting points as the continuous points over two successive cross sections, the same code of constituting point shall be given. When the constituting points change between cross sections, for example, if a cross-sectional geometry changes from cut to fill or from ordinary fill to a retaining wall, the cross sections on the side of the start point and on the side of the end point are defined with the same station on the changing section.

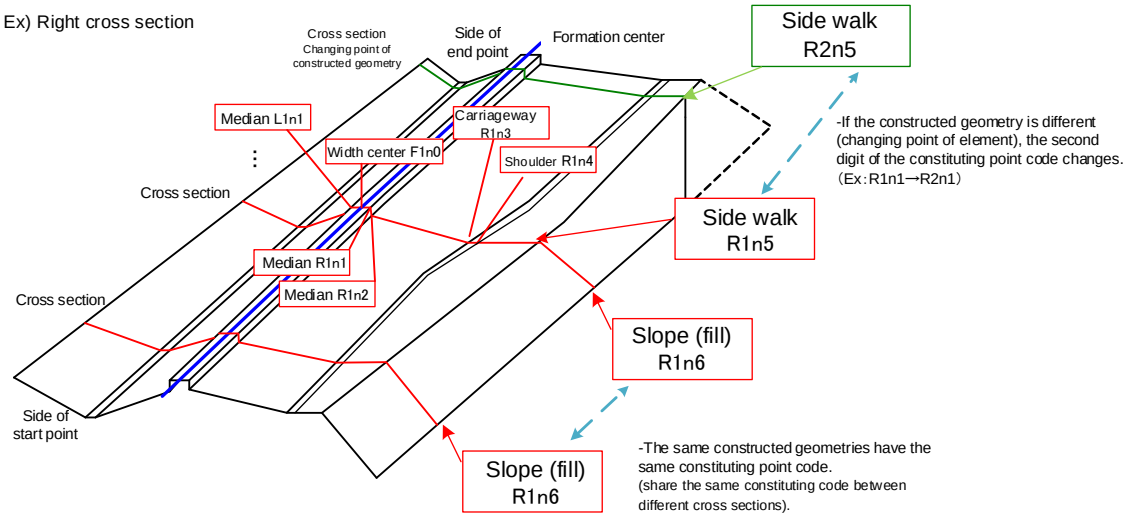



Figure 4-15　Concept of the constituting point code

[Data Format]

A data format is chosen from two types of options: OffsetElevation, which is specified with offset from the road center (horizontal distance) and elevation or vertical offset, and SlopeDistance, which is specified with gradient (%) and distance (OffsetElevation is a usual choice).

When the data format that indicates the method of specifying the size of cross-sectional geometry is OffsetElevation, it is also allowed to input the height of the constituting point using "vertical offset from the road alignment". In this case, choose vertical offset (fhOffset) using Feature and Property as below as the child elements of CrossSectPnt.

Enter "heightType"Property for label; "elevation" for value for elevation; and "fhOffset" for vertical offset. Enter "elevation" when omitted.

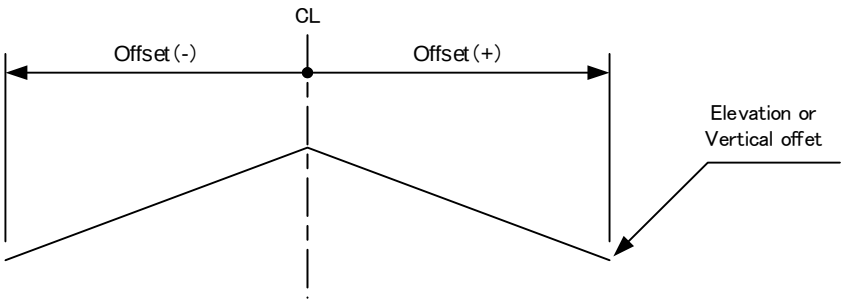



Figure 4-16　Offset and elevation or vertical offset (OffsetElevation)

[How to create Median]

A mount-up geometry is created for a median (center strip).Geometries to create shall be only the width of median and the part of mount-up.

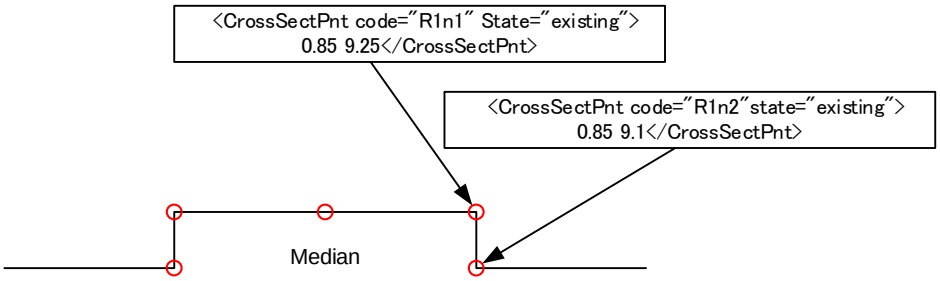



Figure 4-18　　How to create Median

[How to create structures]

For the drainage ditch or retaining wall, detailed representation of geometries is not necessary; however, use Drainage（Drainage）or Retaining wall (RetainingWall) by element type of DesignCrossSectSurf, separating them from Shoulder and Slope. Create only the surface as Figure 4-18, or create the perimeter of a structure as a plane as Figure 4-19.

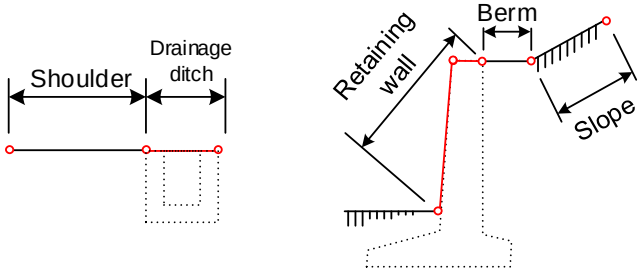



Figure 4-19　How to create "Surface" of a structure (left: drainage ditch, right: retaining wall)

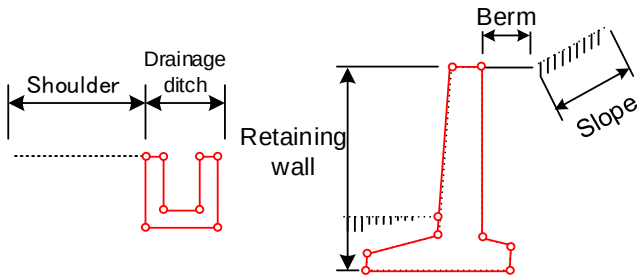
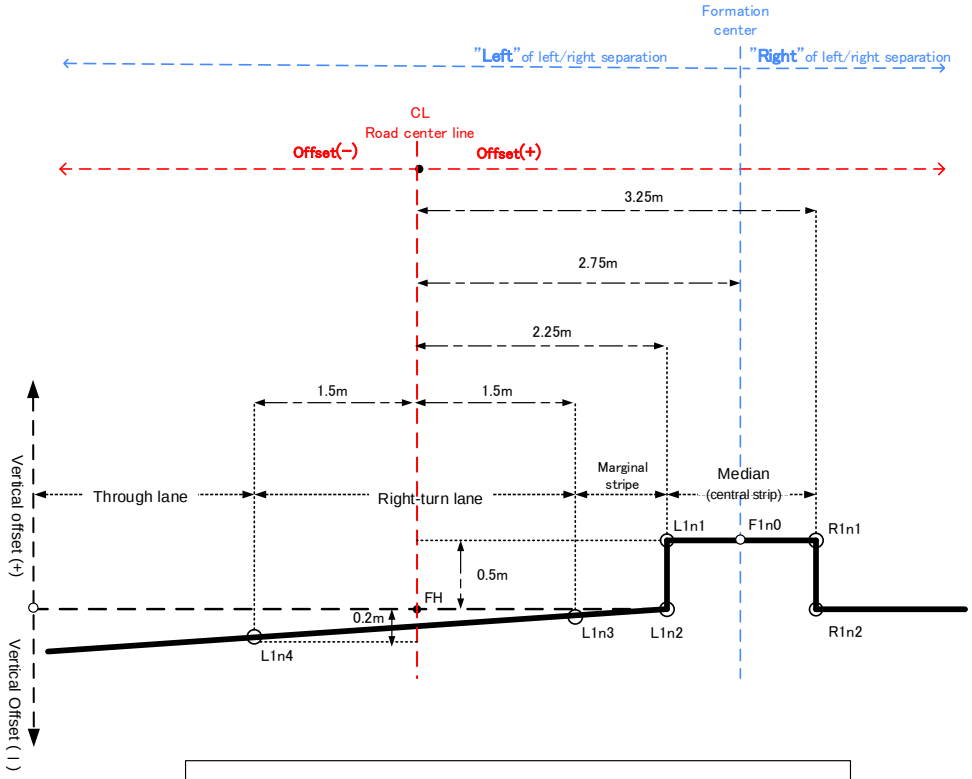



Figure 4-20　How to create "Perimeter" of a structure (left: drainage ditch, right: retaining wall)

[Method of creation when the formation center is different from the road center line]

When the formation center is different from the road center line, for a constituting point located on the right side of the road center line though it is on the left lane, input the value of offset from the road center line as right (the sign is "+").

When choosing the vertical offset from the road alignment for the attribute of height type (heightType), enter the offset from the road alignment (levee alignment) and vertical offset separated by a space. Describe the upward vertical offset as positive (+), and the downward offset as negative (-) based on the road alignment set to the origin.




```
<CrossSects>
   ⋮
   <CrossSect name="No.0+0.00" sta="0.0">
      <DesignCrossSectSurf name="CenterStrip" side="left" desc="Road Surface">
         <CrossSectPnt code="F1n0">2.750 0.500</CrossSectPnt>
         <CrossSectPnt code="L1n1">2.250 0.500</CrossSectPnt>
         <CrossSectPnt code="L1n2">2.250 0</CrossSectPnt>
         <Feature>
            <Property label="heightType" value="fhOffset"/>
         </Feature>
      </DesignCrossSectSurf>
      <DesignCrossSectSurf name="MarginalStrip" side="left" desc="Road Surface">
         <CrossSectPnt code="L1n2">2.250 0</CrossSectPnt>
         <CrossSectPnt code="L1n3">1.500 -0.020</CrossSectPnt>
         <Feature>
            <Property label="heightType" value="fhOffset"/>
         </Feature>
      </DesignCrossSectSurf>
      <DesignCrossSectSurf name="Carriageway" side="left" desc="Road Surface">
         <CrossSectPnt code="L1n3">1.500 -0.020</CrossSectPnt>
         <CrossSectPnt code="L1n4">-1.500 -0.200</CrossSectPnt>
         <Feature>
            <Property label="heightType" value="fhOffset"/>
         </Feature>
      </DesignCrossSectSurf>
      ⋮
      <DesignCrossSectSurf name="CenterStrip" side="right" desc="Road Surface">
         <CrossSectPnt code="F1n0">2.750 0.500</CrossSectPnt>
         <CrossSectPnt code="R1n1">3.250 0.500</CrossSectPnt>
         <CrossSectPnt code="R1n2">3.250 0</CrossSectPnt>
         <Feature>
            <Property label="heightType" value="fhOffset"/>
         </Feature>
      </DesignCrossSectSurf>
      ⋮
      <Feature name="Formation">
         <Property label="clOffset" value="2.750"/>
         <Property label="clOffset" value="0.500"/>
      </Feature>
   </CrossSect>
   ⋮
</CrossSects>
```

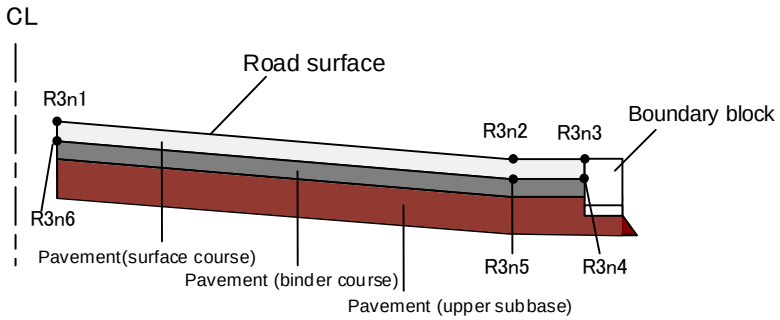
Figure 4-21　Method of creation when the formation center is different from the road center line

[How to create Pavement]

When creating a surface course as the figure below, register 6 constituting points as successive CrossSectPnt, returning to the first point to close the Pavement cross section. For the closed area on the right side of the formation center, define them clockwise from a constituting point. For the closed area on the left side of the formation center, define them counterclockwise.

Designate the element type of DesignCrossSectSurf (name)" as pavement (Pavement), and the closed flag (closedArea) as "true".

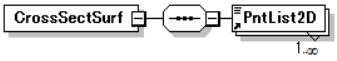
Besides, register the type of pavement (Feature), location of the constituting point (side), material (material), and thickness (typicalThickness).




```
<CrossSect name=" No.0+0.0" sta="0.0000" >
  <DesignCrossSectSurf name="Pavement" side="right"
       material="asphalt" typicalThickness="0.05" closedArea="true">
    <CrossSectPnt code="R3n1">1.000 -0.050</CrossSectPnt>
    <CrossSectPnt code="R3n2">4.000 -0.300</CrossSectPnt>
    <CrossSectPnt code="R3n3">4.500 -0.300</CrossSectPnt>
    <CrossSectPnt code="R3n4">4.500 -0.600</CrossSectPnt>
    <CrossSectPnt code="R3n5">4.000 -0.600</CrossSectPnt>
    <CrossSectPnt code="R3n6">1.000 -0.350</CrossSectPnt>
    <CrossSectPnt code="R3n1">1.000 -0.050</CrossSectPnt>
    <Feature>
      <Property label="pavementClass" value="surface course"/>
      <Property label="heightType" value="fhOffset"/>
    </Feature>
  </DesignCrossSectSurf>
  ・・・
</CrossSect>
```

Figure 4-22　How to create Pavement

4-2-34　Terrain information

| element name | CrossSectSurf | | Logical name | Terrain information | |
|---|---|---|---|---|---|
| path | /Alignments/Alignment/CrossSects/CrossSect/CrossSectSurf | | | | |
| figure |   | | | | |
| child elements | PntList2D Feature | | | | |
| type | — | | | | |
| number of occurrences | 0 or more | | | | |
| attributes | name | xs:string | Required | | |
| | desc | xs:string | | | Enter "GroundLine" to discriminate terrain information. |
| content | Information about each cross-sectional ground line | | | | |
| entry example | <CrossSectSurf name="Cross section 1-1" desc="GroundLine"><br><PntList2D>-30. 35. -20. 22 ・・・</PntList2D><br></CrossSectSurf> | | | | |

* See 4-3-7 for the two-dimensional (2D) coordinates list.
Enter the constituting points of the ground line with offset from the road alignment (levee alignment) and elevation separated with a space. Describe the road-alignment offset of each cross-sectional point of ground line as a negative number (-) if it is located on the left side of road alignment set to the origin, and as a positive number (+) if it is on the right side. For roads, enumerate them from the start point to the end point, in order from left to right.

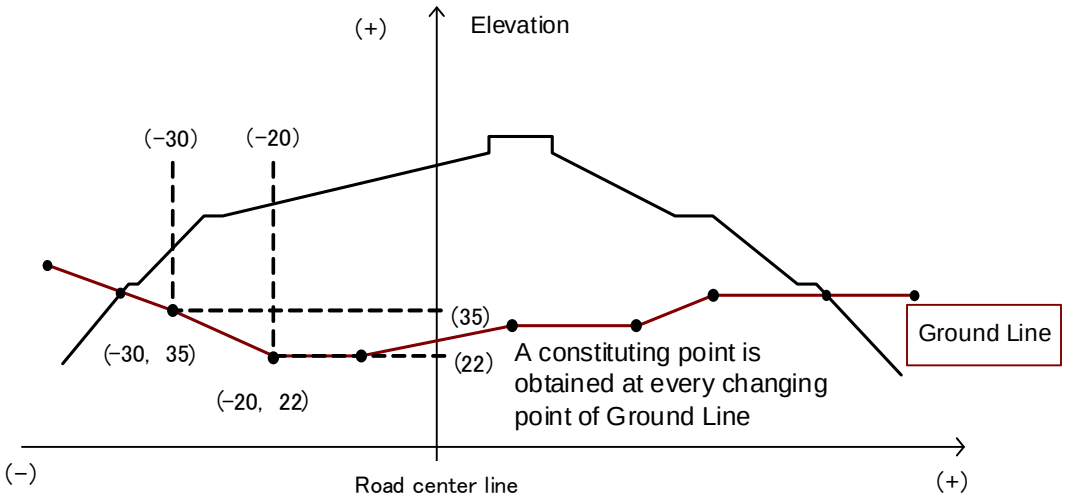



Figure 4-23　Terrain information and how to define the 2D coordinates list

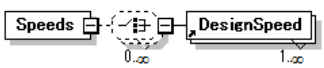
### 4-2-35 Roadways

| element name | Roadways | Logical name | Roadways |
|---|---|---|---|
| path | /Roadways | | |
| figure |   | | |
| child elements | Roadway | | |
| type | ― | | |
| number of occurrences | 0 or more | | |
| Entry example | <Roadways><br><Roadway name="Design condition" alignmentRefs="alignment 1" ><br><Speeds><br><DesignSpeed speed="60."/><br></Speeds><br></Roadway><br></Roadways> | | |

### 4-2-36 Roadway

| element name | Roadway | | Logical name | Roadway | |
|---|---|---|---|---|---|
| path | /Roadways/Roadway | | | | |
| figure |   | | | | |
| child elements | Speeds | | | | |
| type | ― | | | | |
| number of occurrences | 1 or more | | | | |
| attributes | name | Name | xs:string | Required | |
| | alignmentRefs | Reference alignment | alignmentNameRefs | Required | string data to associate with Alignment name |

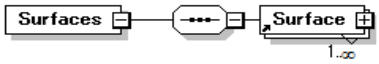
### 4-2-37 Speeds

| element name | Speeds | Logical name | Speeds |
|---|---|---|---|
| path | /Roadways/Roadway/Speeds | | |
| figure |   | | |
| child elements | DesignSpeed | | |
| type | ― | | |
| number of occurrences | 0 or more | | |

4-2-38　DesignSpeed

| element name | DesignSpeed | | Logical name | | Design Speed |
|---|---|---|---|---|---|
| path | /Roadways/Roadway/Speeds/DesignSpeed | | | | |
| figure |   | | | | |
| child elements | — | | | | |
| type | — | | | | |
| number of occurrences | 1 or more | | | | |
| attributes | speed | design speed | speed | | Choose from the following. 120, 100, 80, 60, 50, 40, 30, 20 (km/h) |

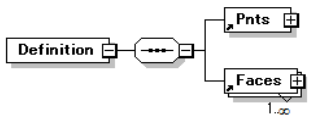
4-2-39　Element type surface set

| element name | Surfaces | | Logical name | | Element type surface set |
|---|---|---|---|---|---|
| path | /Surfaces | | | | |
| figure |   | | | | |
| child elements | Surface | | | | |
| type | — | | | | |
| number of occurrences | 0 or more | | | | |
| attributes | name | Name | xs:string | (Required) | Name of element type |
| | desc | Notes | xs:string | | |
| content | It is a collection of the surface to be expressed by TIN (Scalene triangle). This can be expressed the three-dimensional shape of the terrain of the plan or current state. | | | | |
| entry example | <Surfaces name=”SubBase”><br><Surface name=”1”><br>・・・<br></Surface><br><Surface name=”2”><br>・・・<br></Surface><br>・・・<br></Surfaces><br><Surfaces name=” SubGrade”><br>・・・<br></Surfaces><br><Surfaces name=” Excavation”><br>・・・<br></Surfaces><br>・・・ | | | | |

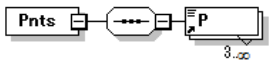
### 4-2-40 Element type surface

| element name | Surface | | Logical name | Element type surface | |
|---|---|---|---|---|---|
| path | /Surfaces/Surface | | | | |
| figure |  | | | | |
| child elements | SurfaceData Definition | | | | |
| type | ― | | | | |
| number of occurrences | 1 or more | | | | |
| attributes | name | Name | xs:string | <Required> | Serial number |
| | desc | Notes | xs:string | | |
| content | If more than one face with the same element type is present, it is managed by the serial number in the name. | | | | |

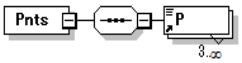
### 4-2-41 Definition of surface

| element name | Definition | | Logical name | Definition of surface | |
|---|---|---|---|---|---|
| path | /Surfaces/Surface/Definition | | | | |
| figure |  | | | | |
| child elements | ― | | | | |
| type | ― | | | | |
| number of occurrences | | | | | |
| attributes | SurfType | Type of surface | xs:string | Required | TIN |

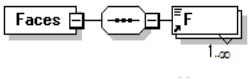
### 4-2-42 Point set

| element name | Pnts | | Logical name | Point set | |
|---|---|---|---|---|---|
| path | /Surfaces/Surface/Definition/Pnts | | | | |
| figure |  | | | | |
| child elements | ― | | | | |
| type | ― | | | | |
| number of occurrences | 1 | | | | |

### 4-2-43 Point

| element name | P | | Logical name | Point | |
|---|---|---|---|---|---|
| path | /Surfaces/Surface/Definition/Pnts/P | | | | |
| figure |  | | | | |
| child elements | ― | | | | |
| text node | Data type<br>List of double | Enter coordinate values which are arranged in the order of x-coordinate, y-coodenate and elevation with the space-separated. | | | |
| number of occurrences | 3 or more | | | | |
| attributes | Id | ID of point | xs:integer | Required | |

### 4-2-44 Face set

| element name | Faces | Logical name | Face set |
|---|---|---|---|
| path | /Surfaces/Surface/Definition/Faces | | |
| figure |  | | |
| child elements | ― | | |
| type | ― | | |
| number of occurrences | 1 | | |

### 4-2-45 Face

| element name | F | | Logical name | Face |
|---|---|---|---|---|
| path | /Surfaces/Surface/Definition/Faces/Fa | | | |
| figure |  | | | |
| child elements | ― | | | |
| text node | Data type<br>List of double | Enter the three points that make up the surface with the space-separated. | | |
| number of occurrences | 1 or more | | | |