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Project Summary

Organization
Sotepa Ltda

Solution
Roads

Location
Blumenau, Santa Catarina, Brazil

Project Objectives

- Design an extension to Humberto De Campos Street to connect between inner and outer ring roads to improve mobility within Blumenau.
- Enhance public transportation through provision of dedicated bus lanes.
- Define alignment within 30-meter right-of-way constrained by the narrow river valley, rugged topography, and unstable soils.

Products Used

MicroStation, PowerCivil for Brazil

Fast Facts

- Sotepa's design accommodated three lanes in each direction, pedestrian sidewalks, and a bicycle lane.
- Sotepa used PowerCivil for Brazil to efficiently design a single alignment with multiple independent grades, and grade adjustments for intersections and access ramps.
- PowerCivil corridor modeling tools enabled designers to quickly and easily optimize the horizontal alignment and vertical intersections.

ROI

- Sotepa completed the design in 6.5 months, with design taking 25 percent less time than similar projects.
- The BRL 25 million extension will pay for itself in 2.2 years in the form of savings to society.

PowerCivil for Brazil Shifts Sotepa's Focus from Software to Solutions

Sotepa Takes 25 Percent Less Time for Design of Six-lane Connector Road Using Bentley's Powerful Civil Software

A Blumenau 2050 Project

The City of Blumenau, Santa Catarina, Brazil, retained Sotepa Ltda. as consulting engineer on the 2050 Blumenau Project for Urban Infrastructure. The firm was tasked with designing the Humberto de Campos Street Extension, a southwest radial connection between the city's inner and outer ring roads intended to improve mobility in the narrow river valley. Sotepa defined a cross section that accommodated three lanes in each direction, pedestrian sidewalks, and a bicycle lane. PowerCivil for Brazil was used to design the 1.8 kilometer extension, which required a distinct grade for each lane as well as grade adjustments at intersections and access ramps. Compared to similar projects, the design took 25 percent less time to complete using PowerCivil for Brazil.

Connecting Neighborhoods

Situated in the Itajaí-Açu River Valley, where disastrous floods and landslides are commonplace, the City of Blumenau was challenged to improve mobility for its more than 300,000 citizens. The road infrastructure had been adapted to the geography, but the lack of space resulted in narrow roads with few connections between neighborhoods. The city's transportation planners identified a potential solution as early as 1970, when a plan for inner and outer ring roads with radial streets was first idealized. In 1978, the city envisioned a new connector in



PowerCivil enabled Sotepa to meet the project's fast-paced production schedule and deliver the required 3D models.

a then undeveloped section between Marechal Deodoro and General Osorio streets. Subsequently, the city began acquiring right-of-ways along the proposed route for the southwest radial known as Humberto de Campos Street Extension.

In 2008, the 2050 Blumenau Project was introduced to establish planning and design guidelines for the city's infrastructure. The goal was to promote public transportation, accommodate pedestrian and bicycle traffic, maintain ecological sustainability, integrate with the landscape, and not exacerbate extreme flood events. The Humberto de Campos Street Extension received BRL 25 million in funding with the aim to connect downtown Blumenau to the outskirts of the city via the previously envisioned route.

Narrow Right-of-way

As a pioneer of infrastructure solutions for Brazil since 1972 and a consulting engineer on the 2050 Blumenau Project, Sotepa was selected to execute this challenging project. The scope of work was to provide survey and mapping; geotechnical and geological investigations; environmental assessment and planning; road, bridge, and overpass design; and public hearing presentation. Three-dimensional models were required deliverables.

Sotepa had 6.5 months to complete the design, but the contractor required 30-day progress reports. Significant challenges emerged almost immediately. The project required crossing a now densely populated residential district subject to a daily traffic volume of 50,000 vehicles. The geometric design was restricted by the city's early vision and land acquisition. The total available width was just 30 meters; deviations from the original layout had significant cost impacts, given the limited budget for additional right-of-ways.

The history of severe flooding made stormwater management and drainage another critically important factor. The valley was bisected by the Itajaí-Açu River and riddled with tributaries. Geotechnical investigations revealed poor soils, resulting in the need to borrow material for the site. Environmental protection also factored into the design, including mitigating impacts on vegetation and wildlife.

“PowerCivil for Brazil helped us build this project more efficiently and focus on quality. The intelligent templates gave us rapid solutions and easy clearance reports. We were able to absorb more contracts and deliver them on time.”

— Andrei de Figueiredo, agronomy engineer, Sotepa Ltda

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Adjusting Alignment and Grading

Sotepa's design took into account all of these factors while adapting the project to meet 20-year traffic demand forecasts. The selected route ultimately resulted from a series of adjustments to the original layout based on topographic surveys, geotechnical studies, environmental studies, and traffic studies.

With improved mobility as the primary guideline for the 2050 Blumenau Project, accommodating public transit was a clear mandate. The final design provided a 30-meter wide roadway with three lanes in each direction including a dedicated outer lane for transit buses in each direction, two traffic-lighted intersections, three flyover intersections, and one bridge. Pedestrians and cyclists were provided safe passage with sidewalks and bicycle lanes, respectively.

To work out the complex geometry for grading and intersections, the firm chose Bentley's PowerCivil for Brazil, a complete 3D modeling and civil engineering design application with powerful mapping tools. Sotepa used PowerCivil for Brazil to create an intelligent template for the alignment. The template allowed designers to make changes to the horizontal layout, and have the software automatically adjust the points of vertical intersection.

Due to the site constraints, rugged topography, and unstable soils, the final design was comprised of two grades working independently for the single horizontal alignment. Sotepa also developed smart templates to try alternatives with dividing walls, Jersey barriers, central flowerbeds, and other options. PowerCivil for Brazil accelerated the rate at which various options could be evaluated, so the team could find the optimal solution in less time.

Drainage Solution Data

During the survey phase, the firm had access to a database in Blumenau's Department of City Planning that enabled the project team to develop vector data for the drainage system, flood stage contours, residential land use, and city zone map. The updated map provided crucial information for planning and designing the drainage system, and for formulating landslide mitigation solutions in residential areas. This data also helped the firm in preparing necessary documents for evaluating costs and procedures for the project.

PowerCivil for Brazil's GIS tools enabled the project team to propose optimal solutions for the street extension. As Sotepa Agronomy Engineer Andrei de Figueiredo said, "The company was able to overcome the challenges of acquiring thousands of houses, dealing with high levels of floods, differentiating residential areas from the area reserved for road extension, etc., with the help of GIS technology. By utilizing GIS solutions, Sotepa was able to obtain precise information, which helped in optimizing the design for this project. The timely availability of up-to-date and accurate data from the city planning department thus greatly helped the project."

Powerful Productivity Tool

PowerCivil for Brazil helped Sotepa to develop a workflow that significantly improved productivity. The tools for determining geometric coordinates allowed the designers to understand the problems, find solutions, and rapidly achieve the goal. Signaling an intersection, for example, took just two days. With each lane following a distinct grade, tools for calculating grade adjustments at intersections and access ramps to the main road allowed designers to explore options and quickly arrive at the optimal grading. "We could change the vertical and horizontal alignments on-screen with one click. So as we studied the intersections and the design we could easily experiment to see what fit the best," explained de Figueiredo.

Using the PowerCivil for Brazil georeferencing tools, Sotepa was able to import existing COGO points, which accelerated the production process without sacrificing precision and quality. Modeling the earthworks to achieve the horizontal and vertical alignments yielded final quantities for the borrow pit in just one day.

The firm also made rapid progress in the presentation of the project to inspectors and contractors using MicroStation's 3D visualization tools. The 3D images and video simulations of the finished work enhanced their understanding of the design intent.

One-fourth Less Design Time

Compared to similar projects undertaken with other software programs, the Humberto de Campos Street Extension project required fewer resources and 25 percent less time to complete the geometric design. Using PowerCivil for Brazil for iterative design allowed Sotepa to concentrate less on making changes and more on designing for quality and client satisfaction.

Productivity gains and the agility with which PowerCivil for Brazil handled geometric coordinates prompted Sotepa's designers to begin using the software for the design of signage, relocation of poles, passenger shelters, and other similar works. As the Sotepa project director said, "We don't worry about the tools now, but instead focus on solutions."

Construction of the Humberto de Campos Street Extension started in the beginning of 2014 and is expected to be completed within two years. As a critical element in the 2050 Blumenau Project, the extension will contribute to a web of ring and radial roads that will help to regulate city traffic, reduce traffic jams on existing roads and bridges, and allow growth in the northern region of the municipality. Improved public transportation made possible by the dedicated bus lanes will also enhance accessibility in the area.

The City of Blumenau estimated that the capital invested in the Humberto de Campos Street Extension will take 2.2 years to be recovered in the form of savings to society, yielding a 37.1 percent Internal Rate of Return.