

## **Experiences in Construction Engineering at Kiewit**

Kiewit is a company that has been around since 1884 and is one of the largest construction and mining organizations in North America. In 2005 Kiewit's revenues totaled \$4.15 billion. Kiewit has more than 1,700 active employees and their workforce includes almost 5,000 core staff and more than 10,000 skilled craft workers. Kiewit has different divisions or units that are called districts. Every district operates as a separate business unit with each focusing on specific types of work. For instance, the Pacific Structures district mainly focuses on building bridges and the Northwest district does mostly heavy earthwork like building roads. Even though districts operate as separate businesses, they often help each other out in supplying expertise, equipment and workforce.

### **Kiewit Districts:**

- Bibb and Associates
- Continental Fire Sprinkler
- Denver
- Eastern
- Eastern Canada
- General Construction
- Industrial
- Kiewit Building Group
- Kiewit Energy
- Kiewit Engineering
- Kiewit Federal Group
- Kiewit Mining Group
- Kiewit Offshore Services
- Mass. Electric
- Northern California
- Northwest
- Pacific Structures
- Phoenix
- Southeast
- Southern California
- Texas
- Underground
- Western Canada

The Kiewit Pacific Structures District is a leader in heavy construction. Since 1985, they have specialized in building some of the most modern and technically challenging bridges in North America. In addition to their bridge work, they also construct projects related to:

- Marine and port facilities
- Highways and bridges (Kirkland I-405, Tacoma Narrows)
- Dams and reservoirs
- Hydro plants
- Mass transit, light rail and heavy rail (Sound Transit )

### **What type of work should you expect as a new hire?**

As an entry level construction employee you can expect to be involved in any of the following areas:

- Planning

- Estimating
- Scheduling
- Progress reporting and cost control
- Material and equipment management
- Surveying
- Quantity tracking
- Temporary structure design
- Field operation supervision
- Subcontractor coordination
- Ordering
- Traffic control (MOT)
- Document control

The following sections expand on each of these tasks and give specific examples of each. These examples are specific to Kiewit Pacific Structures in job definitions, terminology, etc.

## **Planning**

Jobs must be carefully planned for productivity, cost, scheduling and safety reasons. Usually the whole project is broken down into smaller sections which are called DFOW “Definable Feature of Work” and every DFOW is broken down into smaller sections. For instance, In the I-405 Kirkland project which was about adding one lane to each direction and replacing a bridge with a bigger and taller one the project was broken down into DFOW of roadway, bridge, Noise wall, etc. The roadway DFOW was further broken down into different tasks of paving, striping, drainage, and grading. Construction engineers come up with a plan for every one of these tasks that considers safety, quality, environment, production, schedule, material, drawings and a fall-back plan, which stand for a secondary plan if the main plan did not work. After work plan is done, it’ll be checked by the construction manager and after it’s revised, it’ll be presented in a meeting to the owners and supervisors and the foremen and superintendents that are involved in the project. Everybody has to fallow the work plan and failure to do so can lead into an accident or poor quality.

## **Estimating**

Accurately forecasting the cost of future projects is vital to the survival of any business. Construction engineers develop the cost information that business owners or managers need to make a bid for a contract or to decide whether a proposed new product will be profitable. They also determine which endeavors are making a profit. Estimators compile and analyze data on all of the factors that can influence costs, such as materials, labor, location, and special machinery requirements, including computer hardware and software. Most of the estimates are based on the previous similar experience of the company and its accuracy, which makes Kiewit a valuable candidate.

## **Scheduling**

Scheduling does not just assign dates to project activities; rather, it is intended to match the resources of equipment, materials and labor with project work tasks over time. Good scheduling can eliminate problems due to production bottlenecks, facilitate the timely procurement of necessary materials, and otherwise insure the completion of a project as soon as possible. In contrast, poor scheduling can result in considerable waste as laborers and equipment wait for the availability of needed resources or the completion of preceding tasks. Delays in the completion of an entire project due to poor scheduling can also create havoc for owners who are eager to start using the constructed facilities. Every Kiewit project has an overall schedule that covers the major activities for the whole project. The I-405 project has a 90 days schedule that covers the next 3 months as well as a more detailed 5 weeks schedule that is usually up on a 9x15ft board and is updated weekly. Typically, each part of the project has someone in charge of it and that person is usually in charge of updating the schedule as well. The schedule helps engineers, project managers and construction managers coordinate efforts and solve conflicts. An example of a 5 week schedule can be seen in Appendix A1 & 2.

## **Progress Reporting and Cost Control**

Cost control helps construction companies make money. In Kiewit every activity has a cost code associated with it that gets billed to. For example when Kiewit bids on a project like Kirkland 405, they may figure the cost to remove the existing pavement to be \$10/SY. If you are responsible for this task at the end of the day you need to calculate how much it actually cost you to remove pavement. If it is higher than the estimated number you need to find a way to reduce it. Imagine what would happen if every task on the project went over the original estimate? In the KirklandI-405 project we realized that the material we were placing for the roadway was costing too much compared to the original bid, and knowing this helped us to look for cheaper material.

## **Material and Equipment Management**

Good equipment management begins with proper equipment selection. This means selecting the equipment that matches job conditions and gives the lowest total cost. Lowest total cost is a combination of production and operating cost. Total cost can be expressed per unit of time or per unit of production. Since most jobs are bid on the basis of yards of dirt moved, pounds of steel erected, or yards of concrete placed, the most meaningful cost for the selection is based on production units. As an engineer you need to make sure you don't have equipment sitting on the site without it being used. The rent for these equipments can be really expensive. Although Kiewit owns most of its equipment, not operating equipment efficiently (for instance, letting it sit around on a jobsite without using it) costs money. The more use a piece of equipment gets, the more money it can make for the company. In the Kirkland 405 job we had a board that had a list of all the equipments and whoever needed a particular equipment would write their name on the board and that way we could share equipment with different parts of the job.

## **Surveying**

Surveying is a measurement of dimensional relationships among points, lines, and physical features on or near the Earth's surface. Basically, surveying determines horizontal distances, elevation differences, directions, and angles. These basic determinations are applied further to the computation of areas and volumes and to the establishment of locations with respect to some coordinate system. Surveying is typically used to locate and measure property lines; to lay out buildings, bridges, channels, highways, sewers, and pipelines for construction; to locate stations for launching and tracking satellites; and to obtain topographic information for mapping and charting. Surveying can be really expensive and during the construction time most of the surveying companies are busy. Usually general contractors like Kiewit hire a sub contractor to lay out a few baseline points (called controlling points) and then Kiewit engineers will lay out the other points based on these controlling points. For instance, I helped some engineers to lay out the location of about 10 soil nails using only one point from the original surveyor subcontractor. Also having this knowledge helped me to be able to check our surveyors to make sure their points were accurate.

## **Quantity Tracking**

You always need to keep track of how much material is being placed for the purpose of cost control, production and quality control and many other reasons. According to Washington Department of Transportation specifications, a certain amount of testing is required for certain amount of material placed. For example we were required to sample the aggregate and sand for the concrete for every 1000 yd<sup>3</sup> placed on the job and were required to take a sample of hot mix asphalt for every 800 tons placed. Usually if the contractor cannot show that they have taken the proper types and number of tests, the owner may not have to pay full price. An Excel sheet of quantity tracking can be seen in appendix B1 & B2.

## **Temporary Structure Design**

Although Kiewit Pacific Structures is a construction company, we still do design. Our engineers need to be able to design with things like temporary structures (cofferdams, scaffolding, formwork, etc.) to be used during the construction. As a good example at the Kirkland job Kiewit engineers had to come up with a temporary structure design to support the existing freeway while we were digging 40 feet down right next to the live traffic.

## **Field Operation Supervision (Field Engineer)**

If you are assigned to be a field engineer for a particular part of a project, you are required to make sure all the work is done with accordance to the plan and your crew have what they need to compete the assignment. You will be doing quantity tracking, surveying, planning, equipment management and etc. Last summer I was responsible for our paving contractor. Whenever they were going to pave I had to be out in the field to

count all the trucks coming on the site, check the thickness of hot mix asphalt placed (it could not be more than 0.3 ft thick) and temperature (a minimum of 230°F when placed). Also I had to check the hot mix asphalt density after compaction using a nuclear density gauge.

### **Subcontractor Monitoring**

If you are assigned to monitor a subcontractor you will be the person calling them and scheduling them for work. They will always contact you first if they have any questions. When they bill the company you are the person verifying the bill prior giving them the money. This can be a complex work. For example, at the Kirkland job we didn't have anybody to monitor our surveying request and our surveying subcontractor was receiving many surveying requests each day for surveying and they were not able to prioritize these requests and, as a consequence, fell behind schedule. In order to solve this problem, the project manager came up with a person responsible for this subcontractor and all the requests were routed through this person.

### **Ordering**

You might be responsible for ordering small tool and supply "STS" or permanent material "PM". You usually chose the material you need and then need to get at least three bids from which you chose the best deal and get an approval form your business manager or your supervisor. Ordering permanent material can be a little tricky. For instance: whatever we were ordering as a permanent material in the Kirkland 405 project had to get an approval from our quality manager. WSDOT has a qualified product list "QPL" and as long as we order things that were on that list we did not have to do any testing on them. However if we had to order something that is not on that list, we had to test the material and prove to WSDOT that the material was good and met the specifications. A print screen of the QPL is in the appendix C.

### **Traffic Control or Maintenance of Traffic (MOT)**

Depending on the job site you might need to do some traffic control. Kirkland I-405 job required a lot of traffic control because we were working next to live traffic and had both night and weekend closures. The bridge was built in three different phases because we were not allowed to close the freeway and this made the traffic control a very complex work. We had one employee just working on the traffic control and nothing else. He had to schedule and get an approval for all the closures we had from WSDOT and the City of Kirkland. He was in charge of our subcontractor for moving temporary barrier, temporary striping and signage.

### **Document Control**

Document control can be a very complex work; new hires and interns usually start with some form of document control work to understand the importance of it. Plus, you can be productive here quickly and you get to learn about all the documents. You need to

come up with an organization system to file the paper work and be able to find them in the least amount of time. These document could include drawings, cost reports, design change request.

### **My Internship Experience at Kirkland Kiewit I-405 Projects:**

My internship with Kiewit allowed me to use some of my previous experience with hot mix asphalt and quality control while giving me even more knowledge in these areas. I worked in the quality assurance department for Kirkland 405 job and was assistant to the quality assurance (QA) manager. I worked during the summer of 2006 (about 50 hours/week on average) and have continued working part time during the fall of 2006. I have also accepted Kiewit's offer of employment and will start working in January 2007.

I mainly worked on document control and creating a system to find the needed documents as quickly as possible. I also did a lot of quantity tracking and checking the number of tests for the material being placed such as pavement base material (called crushed surfacing base course or CSBC), HMA, pipe backfill, Mechanically Stabilized Earth, MSE, wall backfill and concrete. I was also responsible for reporting all the tests and daily reports form our technicians to the owner (WSDOT) so they can figure out our pay factor. Another assignment I was responsible for was to post the entire quality assurance documents and data in a database so Kiewit and WSDOT could access it. I was made the field engineer for paving because of my experience with hot mix asphalt, and I had to be out on the field to collect the tickets form trucks and indicate every load's location and check its temperature and compaction. This allowed me to be able to train our technicians in asphalt testing and help them get qualified through the WSDOT materials laboratory. In addition, I did some off site inspection for our pre cast concrete panels, pipes and manholes since WSDOT requires all the major items like bridge girders, MSE wall panels, noise walls, sign posts and pre cast pipe and manholes to be stamped by the QA personal before shipment. I also gained some experience in surveying by helping out our field engineers. Typically we would locate structures by having a control point or just double check the work of our surveyor subcontractors.

I would drive around the job site to make sure we had enough inspectors for different activities and would often check key dimensions to make sure they were in accordance with plans. For example I checked the depth of a shaft, amount of rebar in the structure and the width and thickness of the pavement. I also did concrete quantity take off for the bridge for the whole structure. This would include pile shafts, pile caps, abutment walls, architectural corners, grout pads, girders, bridge deck and finally bridge barriers. This took me about 16hours of work and helped me understand the plans and drawings. It also enabled our engineers to order their concrete in advance. Every cubic yard of concrete costs about \$100 and if somebody orders more than it is needed, it can be a big lost to the project. I attended the daily meeting to get information on next day's work, and prepare myself for the number of inspector needed. I also attended the quality assurance meetings that was a combination of WSDOT managers and Kiewit manager and would answer any questions for the part of the QA department that I was responsible for.

In sum, I performed a variety of tasks in several different engineering areas including quality assurance, cost control, etc. I would consider this a typical intern experience and expect my experience as a construction engineer with Kiewit to be very exciting and informative.







Appendix B-2 (Quantity Tracking)

WSDOT Test Verification									
Common Embankment 9-03.14(3)									
Kirkland I-405									
Week Ending	Week Quantity	To Date Quantity	Unit	Field Density Test	Compaction Test	Gradation Test	Sand Equivalent Test		
4/16/2006	2,191	2,191	CY	1555	7571, 7572, 7574	7571, 7571, 7574			
4/23/2006	720	2,911	CY	7099, 10005, 10008	7591	7591			
4/30/2006	1,168	4,079	CY	10004					
5/7/2006	600	4,679	CY	10012					
5/14/2006	1,152	5,831	CY		7612, 7613	7612, 7613	7612, 7613		
5/21/2006	0	5,831	CY						
5/28/2006	0	5,831	CY						
6/4/2006	176	6,007	CY						
6/11/2006	0	6,007	CY	10051	7629	7629	7629	7629	
6/18/2006	0	6,007	CY		7646	7646	7646	7646	
6/25/2006	3,464	9,471	CY	10073					
7/2/2006	4,944	14,415	CY	10077, 10083	7671	7669.1, 7671	7669.1, 7669.2		
7/9/2006	4,060	18,475	CY	8-Jul					
7/16/2006	8,240	26,715	CY	10099, 10102	7682, 7676	7676, 7680	7676		
7/23/2006	7,904	34,619	CY	10116	7687	7686, 7687, 7688			
7/30/2006	10,216	44,835	CY	10127, 10131, 10135, 10136, 10139	7709-P	7694, 7700, 7709-P			
8/6/2006	7,224	52,059	CY	7902, 10142, 7717, 10149, 10139, 81, 82, 83		7711-P, 7715-P	7715-P		
8/13/2006	5,600	57,659	CY	7904, 10155, 7906, 10157	7747-P, 7754-P	7722, 7747-P, 7754-P	7722		
8/20/2006	1,899	59,558	CY	7909, 7910					
8/27/2006	2,152	61,710	CY	6362, 6363, 6367	7773P	7773P	7773P		
9/3/2006	1,744	63,454	CY	6368, 6369, 6370, 6372	7801-P, 7794-P, 7801-P, 7804P	7794-P, 7801-P, 7804P	7801-P, 7794-P, 7801-P, 7804P		
9/10/2006	216	63,670	CY	6374, 6377					
9/17/2006	872	64,542	CY	6380, 9-12, 6381, 6382, 9-15					
9/24/2006	2,156	66,698	CY	10139					
10/1/2006	256	66,954	CY	9-27, 8158					
10/15/2006	123	67,077	CY						
10/22/2006	256	67,333	CY						
10/29/2006	32	67,365	CY	6744					
11/5/2006	0	67,365	CY						
11/12/2006	0	67,365	CY						
11/19/2006	575	67,940	CY						

Quantity Tracking Sheet for Soil

# Appendix C (Ordering)

The screenshot shows a Microsoft Internet Explorer browser window displaying the Washington State Department of Transportation's Qualified Product List (QPL) website. The browser's address bar shows the URL: <http://www.wsdot.wa.gov/biz/mats/QPL/QPL.cfm>. The website header includes the WSDOT logo and navigation tabs for TRAFFIC & ROADS, PROJECTS, BUSINESS, ENVIRONMENTAL, and MAPS & DATA. The main content area is titled "STATE MATERIALS LABORATORY" and "Qualified Product List". It features a search bar, a list of applications (ASA, QPL, RAM, ROM, SAM, EPG, FWD, PassCool, New Product), and a list of divisions (Construction Materials, Geotechnical Services, Pavements). The text explains that the QPL is compiled by WSDOT Environmental & Engineering Programs Division, Materials Laboratory and published by WSDOT Engineering Publications. It also includes a disclaimer that WSDOT is not responsible for errors or omissions in the QPL and that products may be removed if they do not perform or are found to be non-compliant with WSDOT Specifications. The footer contains copyright information for WSDOT © 2006 and navigation links for Traffic & Roads, Site Index, Contact WSDOT, WSDOT Business, and WSDOT Home. The Windows taskbar at the bottom shows several open applications, including Yahoo! Mail, Adobe Reader, and various spreadsheets.

## Washington State Department of Transportation Qualified Product List