new construction equipment and techniques for airports

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This paper discusses some of the new techniques and equipment used to construct the mammoth Dallas/Fort Worth Airport. As a background to this discussion, the author gives some of the advantages and disadvantages in using new equipment. To give an indication of the magnitude of the Dallas/Fort Worth Airport project, the author relates some of the quantities of materials used on the project. He goes on to mention some of the problems in meeting the contract specifications and tells how they were resolved.

•Contractors have three basic tools: men, machinery, and methods. The successful contractor is the one who makes the best mix of these three m's. Some may wonder why some contractors have modern equipment and others are still using older machines and methods. There are of course advantages and disadvantages affecting the decision of any contractor on whether he should purchase new equipment. It is not always a question of whether he has the money to spend, but a question of where he can get the greatest return on his investment.

ON USING NEW EQUIPMENT

There are some basic considerations that influence the use of new equipment in the construction industry. In the first place, it must be more economical in either cost, time, or performance. We should not automate something that a man can do more cheaply if the same results are obtained.

Advantages

At the present time there is a lack of manpower skills. This, along with the rising cost of wages (from 5 to 7 percent a year), favors the automation of certain jobs. In addition to rising wages, there has been a continuing decrease in labor productivity, roughly at the rate of 10 percent a year. Invariably, in any crew, the slowest man sets the pace; therefore, when there is a scarcity of skilled people, the overall job incentive is low.

Specifications are becoming stricter, and there are closer control and tolerance requirements. This becomes almost cyclic: As better testing facilities are developed and causes are determined for past failures, it is only natural that closer controls and tolerances result. Also, the manufacturers' competitive position has a terrific influence on whether new equipment is introduced. At the present rate of technology, new equipment appears almost every 2 years, whereas in the past it was usually 5 to 10 years before new pieces of equipment were introduced to the market.

Also, as projects become larger and time limits become shorter, greater production is required. Overhead costs are rising each year and time becomes an even greater factor. Time lost because of weather becomes a major factor in meeting completion schedules; consequently, high production is required when weather conditions are favorable. It is in a contractor's interest to try to organize his men, machinery, and methods such that the overall time on a given project is reduced.

Disadvantages

There are also disadvantages that discourage the use of new equipment. There is sometimes a lack of economic incentive; i.e., short-term use of specialized equipment makes it almost impossible to justify the purchase price unless the need for the equipment is considerable. High investment costs may overrule the labor savings. Also, the obsolescence occurring in today's equipment dilutes the value of the investment. As mentioned before, technology is changing every 2 to 3 years. This technology, along with the steep competition equipment manufacturers are confronted with, forces the introduction of automated equipment and systems into the market before they have been properly tested. The results are sometimes poor. This has caused field people to question the use of highly automated equipment, inasmuch as it results in downtime due to repairs. Repair requires highly specialized skills. It used to be that you could wire something with a piece of bailing wire and get along, but now you almost need an electrician, a mechanic, and a manual on automation.

Severe environmental conditions, e.g., dust, moisture, heat, and vibration, sometimes discourage the use of automated equipment. Field conditions can never be duplicated in the laboratory, and what will work in a closed, airtight building sometimes will not work at all out in the environment.

Another deterrent to using new equipment is owner specifications that limit the use of modern equipment by requiring detailed types of equipment to perform the work. It is very important that engineers keep abreast of modern advancements in equipment designs and capabilities.

Everyone must be willing to gear up for the new equipment pace. Ordinary industry advancement in equipment, even though not always new or revolutionary, has to be adjusted to present-day problems. The construction industry must learn to cope with automation, which is the trend of the times. Costs are going to continue to rise, and we must find ways to maximize the use of cost-saving devices and to properly evaluate the economics involved. It is contractors' responsibility to develop their own systems and make recommendations to the manufacturers. Most new equipment ideas start at the field level. The needs for lower cost, mass productivity, time savings, and so on are again the catalyst for invention. We must train our people to newer skills to use and maintain this type of equipment. Without proper education and training of personnel, the age of machines can soon revert back to stone age methods and the cycle can start all over again.

INNOVATIVE METHODS AND MACHINERY USED ON DALLAS/FORT WORTH AIRPORT

Included in the planning of airport construction are the projection of aircraft of the future, trends in research and development, legislation affecting airports, environmental considerations, and land use planning. In addition, financing larger facilities and engineering management of all this planning become major factors in the operation. This tremendous planning and the design phase become reality only after the airport is actually constructed.

The Dallas/Fort Worth Airport is the largest that has ever been built, with a contract amount of $57 million. It required initial planning of men, machinery, and methods capable of doing a volume of work each month of around $3.2 to $4 million. Because of this, the methods and equipment would not be practical on a smaller project; by the same token, the size of the job made it possible to spend a lot of time, effort, and money devising innovations that would produce the type of volume required.

The quantities of materials used give an indication of the magnitude of this project. Stabilizing the subgrade in the apron areas required 50,000 tons of lime. The cement-stabilized subbase required 770,000 yd^3 of base material and approximately 400,000 barrels of cement. The concrete runways, taxiways, and aprons, varying from 15 to 17 in. thick, required approximately 1,500,000 yd^3 of concrete, approximately 3,000,000 tons of aggregate, 2,250,000 barrels of cement, 450,000 gal of additives, and 18,400 tons of reinforcing steel. The electrical and lighting systems required 250 miles of buried cable and 7,000 lights. The surface of the concrete runways required 5,775,000 ft^2 of nonskid grooving.

The first consideration was how to economically fulfill the specification requirement that the aggregates be stockpiled and used in such a way that they would not be segregated at the time they entered the mixer. The fact that we were purchasing concrete aggregate from four producers created an additional problem in this regard. It would be impossible to keep each producer's stockpile separate and then introduce each into the overall concrete batching operation. The answer was to use mass stockpiling methods and rescreen the materials before they were stored in the aggregate bins that feed the concrete mixers. To ensure adequate amounts of materials, we stockpiled approximately 500,000 yd^3 of aggregate before paving operations were begun.

As soon as the required excavation was accomplished in the apron areas, it was necessary to stabilize the areas with as much as 18 inches of lime. We started the project by depositing dry lime on the surface and then mixing it with the soil-stabilizing equipment. Because of environmental dust, however, we changed to a slurry mix that required mixing the lime with water prior to placement.

The specifications required that cement-stabilized base be placed not only on the apron areas but also on the taxiways and runways. The base material was hauled in from an outside source and mixed through a stabilizing plant with 5 percent cement. Again, we had to stockpile a considerable amount of material before placement.

Most of the automated equipment on today's market requires that a string line be set along the side of the operation so that the sensing devices attached to the equipment have something to follow. This was used for trimming the base and for paving the concrete runways as well.

With the schedule required on slip-forming the concrete runways and taxiways, it would have been impossible to tie and place the reinforcing steel on the site; therefore, we erected a building in a central location where we fabricated the 25- by 50-ft reinforcing mats and then hauled them to the paving spread for placement.

Before the concrete was placed on the runways, the cement-stabilized base had to be sawed to provide trenches for the electrical cables that would eventually supply power to the runway lights. It was also necessary to place the light cans in the runway before the concrete was placed. Dowel baskets had to be inserted at 50-ft spacings prior to placement of the concrete.

Because of the heavy mass of concrete that was to pass over the dowel baskets, we found it necessary to drill steel pins into the stabilized base and tie the dowel baskets to these pins to keep the baskets from moving.

Once most of the preliminary construction was out of the way, we were ready to start the paving operation. We anticipated that we would need at least 10,000 to 12,000 yards a day to meet our schedule. To accommodate this, we employed two 12-yd^3 Rex mixers and one 8-yd^3 plant. To use these large plants required that we employ hauling equipment that would be large enough to carry the concrete away from the mixers to the paving spread. We used Cat 769 hauling units and placed a special ejector bed on them that would eject the concrete without having to raise the truck bed. We placed two 10-yd batches in each truck, which allowed us to haul 20 yards of material at a time. Although paving concrete with slip-form pavers was nothing new, the maximum width that had been tried up to that time was 48 feet. All of this had occurred on highway work but had never been used on airfield paving. We chose to accept the challenge of using a 50-ft slip-form machine to pave the Dallas/Fort Worth runways and taxiways after the Gunnert-Zimmerman manufacturing company guaranteed us that such a machine could be built.

Inasmuch as we started paving in the middle of the summer, temperature was a critical factor. To keep the concrete mix as cool as possible required that a liquid nitrogen system be installed that would cool the water to 32 F.

This paper has presented a thumbnail sketch of the construction methods and equipment that were involved in building the Dallas/Fort Worth Airport. In conclusion, I would like to leave these thoughts with you. The construction industry, including contractors, engineers, and equipment manufacturers, is an industry that must grow with automation, not fight it. We must all have the courage to make new tracks and not follow the ruts of the past. The future will bring greater demands for high-level ingenuity, creative thinking, and advanced education.