CONSTRUCTION OF IDLEWILD AIRPORT *

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I AM very glad to be here this afternoon to talk on Idlewild for at least one reason. The work of collecting information for such a talk is one of the best ways we have of keeping before us the enormous size of the project and the many problems this airport presents.

Being associated exclusively with this one field for four years, it is inevitable that the engineering personnel reach a "so what" attitude toward its complexities, and an occasional review helps to keep us on our toes.

Less than two years after the opening of LaGuardia Field, which was in 1939 hailed as the "airport of the future", it became quite apparent that the growing traffic of the various air line companies could not continue to be handled by LaGuardia alone. Consequently, a search was started for a suitable tract within the City limits which would provide sufficient area and the proper freedom from obstructions on all sides. The Idlewild location in the extreme southeast corner of the Borough of Queens was finally picked and the acquisition of 1,200 acres started. The site is presently 35 minutes from mid-town Manhattan and will be only 25 minutes away upon the completion of arterial connections presently being planned and very soon to be constructed.

Subsequently, as the air lines suddenly realized that the City was actually going to build a new airport, the various companies began traffic studies to show their future requirements. These studies indicated that the 1,200 acres, with its original 8-runway parallel pattern would be far from sufficient to provide for future required facilities. As a result, the site has been increased by stages until it has reached its present size. Fortunately, the location permitted this increase without any compromise as to the required flight clearances on all sides. It is, undoubtedly, safe to say that this is the only location within City limits where such a condition would be possible; where 50 to 1 flight angles from the end of each runway can be maintained; and where no major obstructions, such as chimneys, gas tanks or tall buildings occur in any flight zone.

Idlewild went through severe growing pains during the process of this expansion. The field was originally laid out with 8-dual parallel runways and with the administration building, loading, and hangar facilities located

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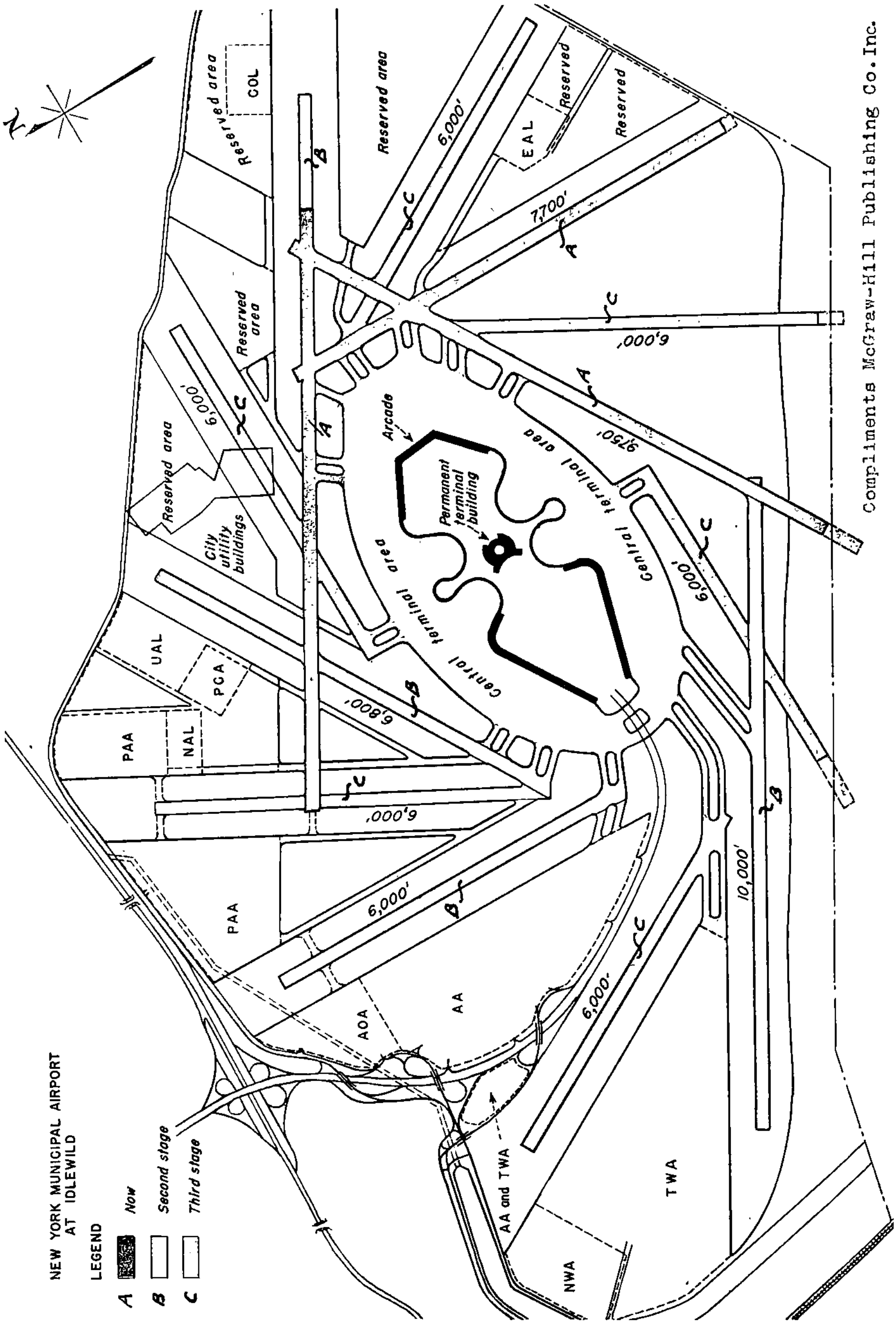

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at the westerly end. Such a layout meant extremely long taxiing distances for the planes, and, furthermore, the capacity of the runways was not sufficient to take care of the anticipated traffic. The next logical step was the further development of this parallel pattern, in which the loading apron was pushed toward the center of the field and the runways increased to 11, thus shortening the distances planes were obliged to taxi and increasing the allowable number of takeoffs and landings. Still in some wind directions we were unable to take care of the traffic requirements as outlined by the air companies. About this time, the so-called tangent pattern was suggested in which the administration building and loading apron formed the hub from which the runways sprayed off like a pinwheel. This plan was finally adopted and is today being built. It is designed in three stages, the first of which consists of three runways with a temporary apron and administration area, and which goes into operation this year. According to the lease agreements with the air lines, the next stage of 6-runways with the permanent administration building, hangar areas, and other facilities must be installed and in use by 1949. The final stage will be developed as traffic requirements rise. With 12 runways in use, three adjacent ones will be used simultaneously for takeoffs and the three opposite for landings with the takeoffs diverging away from the center and the landings converging toward it. As wind direction changes, operations will be stepped around the center from runway to runway so that all planes will come in or leave within 37½ degrees of the prevailing wind. This layout gives a theoretical hourly plane capacity of 360 arrivals and departures after radio aids presently in use by the Armed Forces are released and installed. The expected traffic at the field will be greater than 900 operations per day. This does not mean, however, that all planes in and out of New York will be handled by Idlewild. Newark presently carries approximately 85 flights per day and LaGuardia more than 600. LaGuardia will still be used for the so-called "commuter traffic" travelling distances as far away as Chicago. Idlewild is designed for the longer distances—trans-continental, trans-Atlantic and South American flights.

The first stage of construction provides runways 8,200, 8,000 and 6,500 feet long; the next stage, two of 6,000 feet and one 10,000 feet, while the 12 runway construction adds 6 more each of 6,000 feet. The central terminal area covers 513 acres, about the extent of the present LaGuardia Field. Incidentally, 90% of this area will be paved and so presents a tremendous problem in surface drainage and snow removal.

There are presently within the boundaries of the field some 4,600 acres in an area approximately two miles wide from north to south and three miles long from east to west. In the future more than 300 acres will be added, bringing the total to approximately 5,000. This is almost ten times the size of the existing LaGuardia Field.

On the present site has been pumped 55,000,000 yards of hydraulic fill with another 11,000,000 yards still to be placed. We have put down approximately 500,000 square yards of 12 inch concrete pavement and 275,000 square yards of temporary bituminous macadam pavement. The ultimate pattern calls for 3,000,000 square yards of concrete and 1,000,000 square yards of black top for the shoulders. The black top shoulders serve not only to carry surface water but also to outline the concrete pavement of the runways against the sand.

Of a total of 150,000 lin. ft. of reinforced concrete storm drainage pipe, about 40,000 lin. ft. has been placed, enough to take care of the first three runways. These four items alone demonstrate that it is no ordinary airport New York City is building.

The site was originally marsh land at about high tide elevation with three to five feet of interlaced organic mat covering a variable depth of Galveston clay or mud. This mud varied in depth from two to eight feet, and was of such consistency that when picked up in the hand and squeezed most of it went between the fingers. The water content was very high, somewhere around 75 per cent or 80 per cent. Underneath these materials is firm brown Jamaica Bay sand which gradually rises until the northerly section of the field, where no fill is required, is made of excellent foundation material.

The first hydraulic fill contract for 16,000,000 cubic yards to cover the original 1,200 acre area was let early in 1942 and subsequent contracts have been awarded as more land was acquired. All this hydraulic work has been done by the Gahagan Construction Co., the Atlantic Gulf & Pacific Co., and the Standard Dredging Co., with machines having individual capacities of approximately 1,000,000 cubic yards of placed fill per month. One of the highlights of the dredging was the purchase by the Gahagan people of the dredge *Nebraska,* which was bought in the middle west after its use on the Ft. Peck dam, dissembled, shipped on flat cars to Albany, reassembled, and towed down the Hudson River around New York City to the site. This is an electric machine, presently in use at Boston, of the newest type, and provides tremendous pumping capacity. All of the large dredges used have a 27 inch discharge line and usually a 30 inch intake and were connected to pipe lines up to 17,000 feet in length. At this distance, the pipe line discharged about 15 per cent sand and 85 per cent water. This fill is pumped over the marsh to a depth of about 7 or 8 feet, where its weight compacts the meadow mat and mud—sometimes to half its original thickness. All consolidation takes place in from 3 to 4 months after the fill is placed and plate readings subsequent to that time show a stable material with no settlement.

Borings taken through the sand and meadow mat into the mud indicate that the water has been squeezed from this material, the meadow mat has been forced into it and the whole underlying strata is a dry compact impervious clay.

Grading on the site has been done mostly with 10 to 20 yard tournapulls, carryalls and Euclid wagons, with power provided by D-8 Caterpillars. These have proved economical on hauls up to 5,000 feet and have moved tremendous quantities of sand. There have been as many as 30 of these machines in use at one time, and in the process of the grading, I would estimate that we had probably hauled some five to six million cubic yards of material, with the routes of the various graders between the cut and fill areas established by the engineer so that maximum consolidation would be gained on sections to be paved. The sand, as pumped in, is deficient in fines passing an 80 sieve and also in coarse material retained on a 40. That fact, plus the curse of high ground water, has limited traffic on the field to the equipment just mentioned except when cinder or ash roads were constructed by the contractors. The maintenance problem on all machines at the field is extreme because of blowing sand and the high percentage of time in use.

Drainage at Idlewild has been one of our worst problems. Because of the hydraulic pumping, the vast level area involved, and the slowness of the ground and waste water to seep into the underlying material, the water elevation in the fill has been only about one foot and a half below the surface. This caused much concern and a great deal of research as to possible methods for lowering its elevation.

Experience with the drainage on the first three runways, however, has indicated that as the impervious paved area is increased and the rainfall prevented from reaching the sand the ground water will gradually lower itself, helped by a series of porous subdrains which parallel each side of each runway and which are laid in the same trench as the surface water drains. Present indications are that we can expect ground water elevation from four to five feet below the bottom of paved areas and we believe this to be ample for the prevention of saturation of the subgrade or detrimental frost action.

Most of the pipe lines at Idlewild are reinforced concrete ranging in size from 12 to 72 inches. We have found it economical when we get over the 72 inch size to go into a cast-in-place monolithic box section. The pipe grades are extremely flat, around .15 per cent. All pipes are installed with a bleeder drain in the same trench which connects into sand traps and thence into the adjacent trunk main at frequent intervals. Drainage on the runways is by means of catch basins located off the pavement at intervals of 400 feet in a paved gutter. The edges of the runways being level, all longitudinal grades in the gutter sections on the shoulders have been formed by creating a high point, midway between each pair of catch basins, and sloping the gutter toward each basin. This produces a grade of about .25 per cent along the gutter line and means that extreme care must be taken in placing the shoulder pavement to avoid "bird baths". The apron drainage is a series of continuous scuppers circling the central area and spaced 300 feet apart.

Runways, Taxiways and Apron are 12 inch and 14 inch concrete reinforced with 50 to 60 pounds of mesh per 100 square feet and doweled at the transverse expansion and construction joints. Longitudinal joints, spaced 12½ feet apart are keyed but not dowelled. Transverse expansion joints are placed 120 feet apart with 2 contraction joints at 40 foot intervals between them. Expansion joints are separated by 1 inch of premoulded cork; contraction joints are of the dummy groove type. We have used four types of commercial dowels for load transfer at the joints. Of the four, one proved satisfactory. However, in all future work it has been decided that the joint supports would consist of 1¼ inch round bars 18 inches long and 8 inches at centers with a supporting device to be submitted by the manufacturer and approved by the Engineer. To get back to the runways, these are level with an elevation at the center line of 14 or about 9 feet above mean high tide. They are of 12 inch concrete, 1-1½-3½ mix using 7 sacks of cement per cubic yard and 4½ gallons of water per sack of cement. The slump is roughly 1½ inches. We have been very diligent in our control of the concrete and in our tests of its strength. At the time of placing the pavement, two beams and three compression cylinders were made. One of the beams was broken at 7 days; the second at 28 days. One of the cylinders was broken at 28 days; the second at 90 days, and the third one was held to be broken at the same time as the core taken at the same location. In this way, I feel that we will have a very definite relationship between tensile and compressive strength as indicated by the cores taken directly from the finished job. The comparison of the breaks of the various beams and cylinders show the following results:

Average for 7 day beams was 523 lbs. per sq. in.
Average for 28 day beams was 767 lbs. per sq. in.
Average for 28 day cylinder was 4871 lbs. per sq. in.
Average for 90 day cylinder was 5527 lbs. per sq. in.

and the cylinders broken with the cores average about 5700 lbs. per sq. in., compared with an average of the core breaks of approximately 6,000 lbs. per sq. in. Concrete pavement is designed for 150 ton planes with a factor of safety of 1.6 and is based on subgrade conditions established through plate bearing tests. We arrived at the 12 inch uniform thickness for concrete in the runways by using the Westergaard Analysis and then arbitrarily put on a 25 per cent additional load for the taxiways and apron, making that pavement thickness 14 inches. This is because the greatest stress on the pavement comes when the planes are in a standing position with their motors being warmed up. The 150 ton plane load is distributed over four wheels, making a load of 75,000 pounds per wheel on a tire print area of approximately 800 square inches.

The temporary pavement, of which we have placed a good deal, is composed of 6 inches of lime stone screenings, 3 inches of sand choked stone, 3 inches of penetrated stone, and 3 inches of Asphalt pavement. Theoretically, this will take a 120,000 pound plane with a wheel load of 30,000 pounds.

Concrete was placed by the A. I. Savin Construction Co., of East Hartford, Conn., who used two dual paving units consisting of one double drum paver laying the 8 inch bottom course and one single drum machine laying the 4 inch finishing course above the reinforcing. Each of these units consistently laid over 2,000 feet of 12½ feet lane per day. Cement was hauled from the nearest railroad siding, about two miles away, to bins on the jobs near the aggregate stockpiles. Concrete was batched at this site and then trucked to the mixers with five batches to the truck. Pavement was cured by means of quilted burlap covers which were left in place for a minimum of four days. Traffic was not allowed on any pavement until the flexural strength had reached 500 lbs. per sq. in. as determined by the beam breaks.

One of the worst conditions that we have to contend with at Idlewild is the blowing of sand. This is partially alleviated by the beach grass planting, of which approximately 1,000 acres is in place. We expect that when the planting program is completed, sand drifting will not occur, but in the meantime it fills temporary drainage ditches, permanent drainage structures, and is indeed a costly nuisance to the contractors. At times, on very windy days, the whole field appears as a cloud visible in the air from a distance of many miles.

Lighting at Idlewild will be of the most modern type available. I believe we are the first commercial field in this country to use elevated contact lights along the runways. These are set 15 feet off the edge of the pavement and 24 inches above the ground. The present flush type of light has always presented a maintenance problem from the standpoint of dirt and snow removal and to overcome this our lights are raised, but are still low enough to clear the lowest points on all transport planes either in use or being designed, as long as their wheels do not leave the concrete. On the first three runways, three different types of lights are being tried out. As other runways are added, either the acceptable type already in use will be installed or other makes put in for a test under actual field conditions. Actually, the lights are one of the most important parts of an airport. There is a very brief period between the time when the pilot leaves radio control and before he hits the runway when he depends absolutely on visual recognition of location. On a dark night with fog or rain the lights are the only way he has of doing this.

Contrary to the practice of other airports where one or possibly two runways are equipped with radio aids, all runways at Idlewild will have a compass locater station and glide path beam to provide horizontal and vertical radio control for the incoming pilot. Radar equipment will be installed as fast as it is made available and thoroughly tested.

During the last construction season, contractors at the field had about 1,500 men employed and 400 pieces of equipment in use. These numbers fell off during the winter, of course, but this spring should rise well above those of last year.

At the completion of the 12-runway stage, it is expected that there will be some 40 hangars on the site, a large post office building, a main administration building, and a three mile long arcade, an operations building and over 100 gate positions from which the planes will be loaded.

When completed the airport will be a city in itself with its own fuel storage facilities, steam plants, water system and pumping stations, intramural bus system and restaurants. Approximately 40,000 people will be employed at the field by the air lines and the City. Parking space will be provided for approximately 30,000 cars. Traffic estimates call for 30,000 passengers, 30,000 lbs. of mail and 100,000 lbs. of merchandise to enter or leave the field each day from the 100 gate positions. The complete cost of the field is estimated to be somewhere between $160,000,000 and $200,-000,000, when all facilities are completed. This should be, according to the air lines' traffic estimate, about the year 1954, at which time New York City will have what we hope is the finest airport in the world.

DISCUSSION

Mr. George Nagel: I would like to ask the speaker—he mentioned the lights, especially the contact lights—whether or not he had any experience with the sodium vapor lights and whether they gave a better lighting than the other form.

Mr. Decker: I have had no personal experience with sodium vapor. However, the reports that we have had about it indicate that it does not make a satisfactory contact light. There is too much light diffusion. What the pilot is looking for is a little bright, white spot or green or red, depending on his approach, and I do not think sodium vapor will give that to you.

MR. MUNSON: May I ask if you will be kind enough as to give the dimensions of the thickness of the bituminous runway again?

MR. DECKER: The bituminous pavement consists of six inches of limestone screenings, three inches of sand choked stone, three inches of penetrated stone, and three inches of hot asphalt laid in two courses of one and a half inches each.

MR. MUNSON: And what load is that designed for in pounds per square inch?

MR. DECKER: That is designed for a 120,000 pound plane with a load spread over four wheels making about 30,000 pounds to the wheel. The smallest tire print area, I believe, in use on four wheels is about four hundred square inches, so that you get 30,000 pounds over roughly four hundred square inches.

MR. MUNSON: Well, eighty-some pounds.

MR. DECKER: Eighty-some pounds per square inch taking into consideration the sidewall factor which, I believe, is 1.2 for the tires.

MR. MUNSON: And with your 150,000 pound plane as you had it designed—if I may just follow that out—on the twelve-inch concrete, did you think that that would be much in excess of a hundred pounds?

MR. DECKER: No, that would be less than a hundred pounds. The reason for the apparent discrepancy is that the concrete pavement is permanent. That will be there indefinitely. We figure stress repetition is equal to so much, and a factor of safety of 1.6 which accounts for twelve inches of concrete to the sixteen inches of macadam.

MR. MUNSON: I wonder if I may ask one more question? I would be interested to know how stable that fine sand would be, since you have trouble with the blowing. What do you think of that over a long period of time even with the grass, and what do you suspect may happen with settlement on the runways?

MR. DECKER: Well, over a period of three years, there has been no indication anywhere of any settlement in the sand four months after it was placed. It apparently consolidates the underlying mud within that period of time. We have kept continuous monthly readings on the concrete runways for more than a year now, and have found only two cases of settlement, both in locations above an old stream bed where the mud was excessively soft or exceedingly deep.

The sand, as sand, is not stable. It is short of fines and it is short on coarse material. That is where the screenings help, because they provide the coarse and the fines to go with the sand.

As a matter of fact, our shoulder pavement is designed using fifty per cent sand on site, and fifty per cent crusher run limestone screenings and it gives us a very stable mix, but the sand itself is not stable. It is not graded properly. The grass will keep it down. That has been proven all along the South Shore of Long Island where it has been used for years, but it takes about two years for the grass after it is planted to grow up enough to lift the wind off from the sand surface.