The a320 is the first launched engineering essay

In this assignment, I was selected one civil aircraft which is A320-200. Generally, the family of A320 consists are A318, A319, A320 and A321. I would like to prefer A320-200 because of the aircraft is better than other variants. This aircraft was manufactured as commercial passengers jet airliner by Airbus. The A320 is best-selling aircraft since launched and received a lot of order around the world especially from Europe and Asia. The aircraft was designed a short body and narrow compared to another variants. It also is able to accommodate up to 220 passengers which are consists 150 seating in two class cabin and up to 180 seating in high density layout for a low cost. The advantage is this aircraft used digital fly-by-wire control systems. This system used electronic interface to replaces the manual flight control. The replacement of the control systems are for protected airframe structural to obtain higher safety, to reduce pilot workload and also to make aircraft stability and smoothness during flight.

The A320 is the first launched among the A320 family in March 1984. The first flight in 22 February 1987 and introduce by Air France in 28 March 1988. The A320 families typically used digital fly-by-wire control systems and control the aircraft by joystick at side-stick usually on right hand side, in commercial aircraft. Since the introduction A320 family, Airbus industry gets many order form airliners in total 5 323 aircraft that have been delivered before August 2012. The first faster selling aircraft in the world had been recorded from 2005 to 2007. The development A320 by airbus industries are able to compete with latest aircraft such as Boeing 737, 717, 757 and McDonnell Douglas MD-80.

The range A320-200 usually is about 3 300 nautical miles with 150 passengers on board. It is can accommodate up to 220 passengers and the capacity of cargo is about 37. 41 m3. The aircraft length and wingspan which are 37. 57 m and 34. 01 m. A320-200 offered with a maximum takeoff weight (MTOW) of 73 500 kg, maximum landing weight of 64 500 kg, maximum zero fuel weight of 61 000 kg and empty operating weight 42 100 kg. The two engines used are CFMI CFM56-5s or IAE V2500s and the thrust between 113 to 120 kN. The minimum cruise speed that the aircraft can fly is about 811 km/h and the maximum cruise speed is 875 km/h. The maximum capacity of fuel that able to accommodate is 53 699 kg. The more specification and performance of this aircraft it shows in the table below.

A320-200

Fuselage width:

3. 96 m

Fuselage height:

6 m

Fuselage length:

37. 57 m

Cabin length:

27. 51 m

Cabin width:

3. 7 m

Cabin height:

2. 13 m

Empty operating

42 100 kg

Max Zero Fuel

61 000 kg

Max Takeoff Weight

73 500 kg

Max Landing Weight

64 500 kg

Max fuel capacity

53 699 kg

Normal cruise

811 km/h

Max cruise

875 km/h

Max ceiling

12 131 m

Take off field length

2 158 m

Landing field length

1 899 m

Seating capacity

180

Cargo capacity

37. 41 m3

Engines

IAE V2500 series or

CFM International CFM56-5 series

Thrust

111-120 kN

The specification of A320-200

Pre-flight

Preflight is the first phase before they can start a journey. There have several procedures in airport before the aircraft can takeoff. Preflight it also known as push back or taxi out. The aircraft is pushed backward away from the gates by tugs. Tug is vehicles that used to push the aircraft. After the aircraft get out from its gate, then the aircraft move to runway flow by taxiway. The movements of aircraft through taxiway at very slow speed and they require clearance before the aircraft make a movement. Based on this assignment, I have chosen one civil aircraft A320-200 and the destination of flight from origin Kuala Lumpur International Airport to Jakarta Airport. Before flight, the maximum of payload must be calculated. Below is the calculation maximum payload that the A320-200 is able to carry.

Max Takeoff Weight (MTOW) : 73 500 kg

Max Landing Weight (MLW) : 64 500 kg

Max Zero Fuel Weight (MZFW) : 61 000 kg

Dry Operating Weight : 42 100 kg

Flight distance : 1 144 km

Mean speed : 811 km/h

Fuel flow : 2 600 kg/h

Reserve fuel : 13425 kg

The calculation of maximum payload that the aircraft is able to carry

Flight time :

:

Flight fuel :

:

Payload during takeoff :

:

Payload during landing :

:

Payload of MZFW :

:

As the aircraft can operate safely, the lowest total payload based on that calculation is chosen. So, the maximum payload that the aircraft is able to carry is 8 975 kg.

Take-off

After calculated of maximum payload that the aircraft is able to carried, the aircraft will proceed to takeoff. When the pilot ready to takeoff and approved clearance by Air Traffic Control, the aircraft may continue action by release the aircraft brake, forward the throttle and increase slightly. The A320-200 required takeoff distance is about 2 158 m. The lift created because of movement of air through the aerodynamic wings will produce difference pressure which the pressures below the wing get high pressure than above the wings. When the aircraft reached takeoff speed within 180 mph and the higher pressure at below both of wings obtained, then the lift produce will

cause the aircraft can fly (also known as Vr). The aircraft fly until reach initial climb distance 35 feet.

There are lots of factors that can be effect on takeoff performance. Major factor is aircraft weight. The weight of the aircraft will effect on takeoff distance and the takeoff speed. Because of heavier weight, the aircraft require more lift force to attaint fly by increasing the speed to produce high pressure at both wings. The limitation is set to ensure the aircraft is not overweight to operate safely. Before flight, make sure that the weight of aircraft no exceeds the maximum takeoff weight (MTOW). Based on the information of the aircraft, the engineer already set the maximum takeoff weight is 73 500 kg.

Temperature can be affected takeoff performance. This is because the efficiency of engines it is depends on air temperature at surrounding. The high temperature can cause lower thrust generated by an engine. This happen because the totals drag it is more nearly of the total thrust. So, the aircraft need longer takeoff distance to attaint higher speed. At the origin airport, the temperature surrounding is about 30oC. That temperature is not too high so aircraft can takeoff with normal distance and speed.

Flap setting also can be effect on takeoff performance. Because of flap setting give effect to aerodynamic drag. Usually, most of civil aircraft set the flap is about 10 to 15 degree during takeoff. The used of flap can reduce takeoff distance but increase in flap setting due to increase in drag. Increase in drag will decrease the angle of climb. So the aircraft need longer time to reach the level altitude. In addition, increasing takeoff distance will occur if

the airframe contaminated by frost, ice or snow during takeoff and reduce takeoff performance.

Climb

Climb is after takeoff phase. Climb is an operation of aircraft increase the altitude until reach cruising level. Usually, commercial aircraft leaves the ground with rate of climb 257km/h and at 15 degrees angles of climb. To ensure the aircraft climb with the shortest distance and time, the angle of climb and rate of climb must be calculate before flight. This is important to know the angle and rate of climb to ensure the aircraft extremely maintain lift until reach cruising altitude with appropriate time and distance.

The climb gradient is the ratio of height gained to the horizontal distance traveled by aircraft. It is depend on vary thrust, drag and mass of aircraft. To ensure the aircraft climb, the total thrust must be greater than total of drag. That's mean the aircraft can fly if the excess thrust produce. Below is the calculation of climb gradient that I had been made in this aircraft. The thrust, drag and weight of aircraft are 49400 lb, 34580 lb and 162040 lb. Formula for climb gradient is (thrust – drag) / weight

Climb gradient: (49400-34580)/162040

: 0. 091

The angle of climb is the angle between heights gained to the horizontal distance traveled by aircraft during climb. Below is the calculation for angle of climb. The formula of angle of climb

Angle of climb:

= sin-1 (thrust – drag/weight)

= sin-1 (49400-34580)/162040)

= 5. 22

The rate of climb is the vertical component of the speed, expressed in feet per minute. It depends on the airspeed (V) and the angle of climb or climb gradient. The rate of climb is important to ensure aircraft reach cruising altitude in the shortest time. Below is the calculation for rate of climb. The information is same with the calculation in above and the velocity of the aircraft is 438 knots. The formula in this calculation is V x (Thrust – Drag) / Weight.

Rate of climb:

ROC = V – (thrust – drag/weight)

ROC = 438 – (49400-34580)/162040)

ROC = 39. 86

Cruise

Cruise is a phase where the aircraft pass through the climb phase and ends when the aircraft descent for landing is initiated. Cruise also define where the flight journey are between climb and descent phase. Cruising altitude is determine by the pilot refer to flight planned and approved by air traffic control. After aircraft reached cruising altitude, the pilot may decrease the

power to reduce fuel consumption and maintain the flight level. To maintain the flight level, the amount of lift is equal with the amount of weight. Mostly, the large aircraft fly around 35 000 ft and can be vary with the types of aircraft, length of flight, weather conditions, air turbulence and the location of other aircraft in the air. The largest percentages of trip time and trip fuel are consumed typically in cruise phase. The amount of fuel burn and total time can change by speed of aircraft and altitude that pilot selected.

There are three options to identify the best range cruise, speed cruise and the best endurance cruise. Range is defined as distances of journey rely on the amount of fuel available. The maximum range of an aircraft is possible distance depend the maximum amount of fuel can be inserted. Specific range is the range performance of the aircraft at a moment in time. The specific range of this aircraft calculated below: given the total of fuel are 17 091 kg.

Specific range = knot/fuel flow

= 438/2600

= 0. 17

= 0. 17 – 17091

= 2905. 47 km

Endurance is the time that aircraft can remain airborne with the fuel available. It also defines as how long the time of an aircraft in the sky with the fuel available. It will be greatest when the fuel is used at the lowest

possible rate. That mean the fuel flow used is minimum. Below is the calculation of specific endurance.

Specific endurance = flight hours/fuel flow

= 1. 41/0. 72

= 1. 96

Descent

Descent is defined where an aircraft decrease the altitude. Aircraft descent phase begin after an aircraft passed cruising phase and end when the aircraft approaching for landing phase. During descent, the aircraft altitude decrease slightly by reducing the thrust and power. When the aircraft speed decrease will make less of lift. Thus the aircraft will lower their altitude until reach approaching phase. The climb should be thrust greater than drag to produce excess thrust, but fly descent the aircraft drag must be greater than thrust to produce excess drag.

To operated efficiency when descent, the top of descent point must be determine by flight crew to ensure that the aircraft is in correct level to start the descent phase. Top of descent point is a point at which the descent is initiated from the cruising level. Determine for top of descent point is based on the ratio 3: 1 which means aircraft will require three nautical miles distance for every one thousand feet of aircraft altitude above ground. Based on this assignment, the flight level of that journey is 36000 feet. Refer to the ratio, 36000 feet is divided to 1000 equal to 36. Then 36 are multiply by 3 equal to 108. That mean 108 NM is needed for fly descent to the ground.

During descent, pilot must consider of the descent gradient, angle of descent and the rate of descent. This is important to reduce descent distance thus reduce fuel consumptions. Descent gradient is the ratio of height descended to distance travelled by aircraft. The amount of drag must be greater than thrust, thus excess drag is produced. The formula of descent gradient is (drag-thrust)/weight. The drag, thrust, weight of aircraft are 34580lb, 24206lb and 162040 kg.

Descent gradient = (34580 – 24206)/ 162040

= 0. 064

Angle of descent also important to control the descent angle by reducing engine power and pitch angle. The pilot should make sure that the angle is correct by determine the appropriate angle. The formula is sin-1(Drag-Thrust) / Weight.

a = sin-1 (34580 – 24206)/ 162040

= 3. 67

The rate of descent is the vertical component of the speed, expressed in feet per minute.

It depends on the true airspeed (V) and the descent gradient according the formula V – (Drag – Thrust) / Weight. The true airspeed of the aircraft is 438 knots.

Rate of descent = 438 – (34580 – 24206)/ 162040

= 28. 032

Approach

Approach also called final approach or final leg begins several miles from the airport. Final approach starts after the aircraft passed descent and end when the aircraft nearest to the airport for landing. In this phase, the approaching aircraft require from air traffic control to control and separated the aircraft within the same area either other aircraft leaves from airport or comes to airport. The appropriate aircraft speed for approaching about 121 knot to 140 knots to the ground. The operate smoothly when approach, the pilot must set the flap between 10 to 15 degrees and set full flap when the aircraft close to land. This is important to increase the drag so the speed of aircraft will reduce, thus the altitude also reduce. Before aircraft touch down the runway, make sure that the landing gear lowered at about 5nm from the touch down. So that, landing gear will increase the drag and make aircraft slowest.

Approach slope is path of the aircraft follow its final approach till landing on a runway. Approach slope basically as the aircraft path slightly downward slope. A commonly used approach slope is 3° from the horizontal. But they may vary steeper approach paths at every airport where depending on topography, buildings, or other considerations. The term glide slope is often applied to mean approach slope although to be correct it applies to the vertical guidance element of the Instrument Landing System.

Landing

Landing is the last part of the aircraft that return to the ground. It is a phase after an aircraft is passed through final approach. Landing phase begins from certain height around 35 feet to 50 feet to the ground. Mostly, the aircraft landing with the speed around 190km/h relative to the ground until it touch down on runway. The parts of landing consist of airborne segment; touchdown and ground roll which the point of aircraft stop on runway. When the landing gear touch the runway, the pilot may quickly do several actions by pulling back the throttles, deploy the spoilers, applying reverse thrust of the engine and applying the brakes. The spoiler used during landing is for disrupt airflow to reduce lift and create drag, thus the speed will reduce quickly. Where applying brake are to make aircraft stop with efficiently and less landing distance. Before aircraft landing, aircrew must make sure that the minimum landing distance is less than the distance runway available. Also it is important to determine the weight of the aircraft in not exceed the maximum landing weight. Based on this assignment, the minimum landing distance require on this aircraft is about 1899 meter. The research that I have been made, the destination airport, Jakarta Airport has a distance runway 3600 meter on the runway 07R/25L. So, the aircraft is able to land safely on that runway. Other that, the weight of the aircraft is not exceeding maximum landing weight which is the maximum landing weight of this aircraft is 64 500 kg.

There are many factors that can be affected on the landing performance. The distance required for landing is related to aircraft ground speed on landing. Thus increased landing speed will give a significantly increased landing distance requirement. The aircraft mass also can effect of landing

performance. This is because increasing the mass will reduce the deceleration force and thus increases the landing distance. However, the major effect is that the landing distance required will increase with increasing mass.

Conclusion

As a conclusion, mass and performance is related to each other to ensure the aircraft always in safe condition during operation. To generate safety, every flight profile must be a calculation before the aircraft start to fly. In preflight, calculation of maximum payload is very importance to ensure aircraft is not overloaded. Serious problem occurs if the aircraft is overloaded such as need long distance to takeoff, poor performance and also may cause the aircraft stall when climb. In climb phase, calculation for angle of climb and rate of climb is important to get the best angle and speed for climb to be able aircraft reach the level altitude with minimum of time. When the aircraft reached level altitude or cruise, a calculation for range is important to get the best range of aircraft with the minimum of fuel consumption. With minimum of fuel burned, thus the aircraft will get the long distance and could save the economy. In descent and approach phase, require calculation to be determining what the angle and rate for descent and also the distance the destination. Minimum time is necessary to reach the airport and avoid congestion in air traffic while to perform safe operation. The analyzing that I had been made, the higher percentage of aircraft accidents occur due to human error. Thus, precise calculations required in every of flight phase to prevent accidents happens.

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