Gums

Elite 1K

- **Posts:** 1900
- **Joined:** 16 Dec 2003, 17:26

23 Dec 2016, 23:34

Salute!

John-boy can tell us, but only composites I know of for the first blocks were in the tail. Funny, but because of all the carbon fiber and such folks were worried about the tails shorting out the electrical system on the base or downtown!

The block 15's came with aluminum tails, so no more worries.

Personally, and ask some early Viper drivers, but the small tail Block 10 seemed the best combo. Later, I heard from my old wingie that the big mouth block 15 or higher with the GE motor was really good.

Gums tries to remember.....
Gums
Viper pilot '79
"God in your guts, good men at your back, wings that stay on - and Tally Ho!"

johnwill

Elite 1K

- **Posts:** 1872
- **Joined:** 24 Mar 2007, 21:06
- **Location:** Fort Worth, Texas

24 Dec 2016, 07:07

All F-16s have composite skin vertical tails. The skins are bolted to conventional aluminum spars and ribs. Block 1 - 10 horizontal tails are full depth aluminum honeycomb core with bonded composite skins. Near the tail pivot shaft, bolt fasteners help attach the skin to the titanium root rib and shaft.

The block 15 horizontal tail was completely redesigned with a larger area, aluminum root rib and shaft, corrugated aluminum substructure and mechanically fastened composite skins. (Gums - you may be right about aluminum skin, I'm not certain) Another difference, the forward 20% (approx) of the tail was a removable full depth honeycomb core and composite skin structure. It was made removable to make replacement of easily damaged sharp leading edges possible. The original tails were difficult and expensive to repair.

There were several reasons to redesign the tail. Larger area was desired to provide more control at lower airspeeds, primarily breaking the deep stall, but also to have lower takeoff rotation speeds for heavy external stores. Changing from titanium to aluminum for the root rib and pivot shaft was cost saving and losing dependence on the USSR for titanium supply. Use of the stamped understructure corrugation and mechanical fasteners was also cost saving and more reliable compared to bonded honeycomb.

Gums

Elite 1K

- **Posts:** 1900
- **Joined:** 16 Dec 2003, 17:26
- 24 Dec 2016, 23:06
- Salute!

Well, **F-16adf**, looking back over 40 years I would say that John Will and others there came up with a great combo of materials, and then there's the aero folks who blew Northrop away on performance. Oh yeah, that big PW motor was awesome..

The other guys back then could not believe what we could do in that little jet, and do it with lerss gas. We routinely ran the Eagles outta gas and they usually had a big centerline tank. The Hornets were terrible for gas mileage.

A Block 15 today with the new avionics would be a formidable adversary. The F-35 sounds even better.

But what do I know?

Gums opines.....

- Gums
  Viper pilot '79
  "God in your guts, good men at your back, wings that stay on - and Tally Ho!"

johnwill

Elite 1K

- **Posts:** 1872
- **Joined:** 24 Mar 2007, 21:06
- **Location:** Fort Worth, Texas

25 Dec 2016, 03:52

Thanks, Gums.
Let's talk about composites back then. We could have easily designed the F-16 wing skins in composite, but cost and technical risk made aluminum the better choice. Composite positive effects were lighter weight and possible increased stiffness and fatigue resistance. Risk was high because there was little experience in analysis methods, so potential benefits just might not work out. At the same time, the F/A-18 was developed with composite wing skins. Strength met the requirements, but torsional stiffness was much lower than predicted. That resulted in excessive loss of aileron effectiveness in roll at higher airspeeds (above 0.90 mach below 10,000 ft). Roll performance did not meet requirements, so a redesign was required. Thicker wing skins were designed and leading edge flaps were programmed to assist the ailerons in rolling the airplane.

What had happened? The basic composite material stiffness was adequate, but little was known then about fastening composite skins to aluminum spars and ribs. Part the stiffness gains in the basic material was lost in fastener joint effectiveness.

Today, composite analysis methods and better joint effectiveness make composite designs reliable and effective.

However, composite structure is still limited to mostly wing and tail skins with aluminum understructure. So how much weight can composites save? Fighter structure normally weighs around 25 per cent of maximum takeoff weight, with all skins weighing only about 30 percent of structure. So, skin weight is about 8 percent of total weight. If composites save half of skin weight (they don't) they would save only 4 percent of total weight. That is certainly a worthwhile savings, but it is not a dramatic saving.

johnwill

Elite 1K

- **Posts:** 1872
- **Joined:** 24 Mar 2007, 21:06
- **Location:** Fort Worth, Texas

26 Dec 2016, 01:21

f-16adf, don't hesitate to ask technical questions. That's why I'm here.

I'm not sure why you think the Rafale is so light. It's a little bigger than the F-16 and its empty weight is a little more. We don't know the structural weights of either airplane, but empty weight comparison does not show any remarkable "lightness" associated with the Rafale.

Another example is Boeing's claim of 20% savings in the structural weight of the mostly composite 787. but when you add in weight for fuel, engines, systems, furnishings, luggage, and passengers, the savings is only about 5% of maximum takeoff weight.

Again, composites save some weight, but not as much as you might think.

Gums

Elite 1K

- **Posts:** 1902
- **Joined:** 16 Dec 2003, 17:26

26 Dec 2016, 19:20

Salute!

Good stuff from John-boy and some old memories from this dino.

The weight was a biggie for the wing area and I would not give a lotta support for the "body lift", tho it was there. The vortex aero from the strakes was prolly the biggest thing we had for lift, and the LEF's were the biggest thing for directional control/stability plus the drastic reduction in buffet.

Speaking of buffet, I flew the 102,101B, A-7D and then the Viper A/B. No comparison. First ride in a mandatory back seat ride was A2A versus a TopGun Scooter (or Navy aggressor unit). The sustained gee was inpressive, but I was really good shape then. So we eventually got slow and zipping around at 200 kbots or so had so little buffet most folks would not see it. The 102 was about the same, but the buffet was at a higher freq, like a buzz.

A good example of the weight and such is the A-7D. So at over 35,000 pounds GTOW we could still only get maybe 14,500 lb of thrust. Once in combat at really heavy loads we would turn off the A/C and get another pound of turbine outlet pressure. We still rolled all the way to other end of the 9,000 foot rwy, heh heh.

The original Vipers weighed in at almost the same pounds as we had thrust - 25,000. My trusty VooDoo weighed about 48,000 at takeoff and we cranked out about 35,000 pounds from the P&W motors. But that sucker was clean like the Viper and we could easily outclimb everything until the Eagle.
++++++++

Turn radius numbers seem about right for early Vipers. Figure about a quarter mile at 360 knots, which was slowest we could get 9 gees. Was also about 15 deg AoA. The Hornet got better, as did others when slower, but they were bleeding energy like crazy. You could go from 400 to 200 in less than half a turn if your gee allowed. Our advantage was we could sustain higher gee for the same speed as them, so the rule of thumb formula shows smaller radius at higher gee for the

same speed. Nose-pointing is another story, but only happens when really slow. Above 360 knots CAS, the gee limit plays before the AoA limits.

Gums recalls....
Gums
Viper pilot '79
"God in your guts, good men at your back, wings that stay on - and Tally Ho!"

basher54321

Elite 1K

- **Posts:** 1008
- **Joined:** 02 Feb 2014, 15:43

27 Dec 2016, 01:39

Many thanks to John above for the info on the original composite makeup.

*f-16adf wrote:*I'm not trying to beat a dead horse here, but how on earth is Dassault able to make the Rafale C so light? I think it only weighs around 21,800lbs. Even Eurofighter with its giant delta wing only weighs roughly 24,000lbs.

Comparing the figures I have on the F-16XL that added a cranked Delta to some FSD F-16As and added >4000 lbs in weight (they had composite skins according to NASA). The weight and dimensions were:

F-16XL-1
Wing Area = 663sqft
Wing Span = 32ft 5in
Length = 54ft 2in
Height = 17ft 7in
Empty Weight = 19,690 lbs (NASA)
Internal Fuel = 12,750 lbs

Typhoon (BAE/EF figures)
Wing Area = 551sqft
Wing Span = 35ft 11in
Length = 52ft 4in
Height = 17ft 4in
Empty Weight = 24,250 lbs
Internal Fuel = ~11,000 lbs

Obviously no idea how a production F-16XL with the same avionics as Typhoon would have weighed if gone into production (as single seat F-16F).

I think John Will was lead engineer on the XL so will likely know if these are accurate.

sprstdlyscottsmn

Elite 2K

- **Posts:** 2676
- **Joined:** 10 Mar 2006, 01:24
- **Location:** Phoenix, Az

27 Dec 2016, 17:29

*basher54321 wrote:*F-16XL-1
Wing Area = 663sqft
Wing Span = 32ft 5in
Length = 54ft 2in
Height = 17ft 7in
Empty Weight = 19,690 lbs (NASA)
Internal Fuel = 12,750 lbs

Obviously no idea how a production F-16XL with the same avionics as Typhoon would have weighed if gone into production (as single seat F-16F).

Keep this in mind. A Block50/52 weighs more than that XL when empty. THAT is more much avionics and weapon mods weigh.
Attachments

T.O. GR1F-16CJ-1-1

Drag Indexes and Weights — Basic Aircraft

DATA BASIS FLIGHT TEST

AIRCRAFT OPERATING WEIGHT — LB*	F-16C**	F-16D**
BASIC AIRCRAFT	20,000	20,600

*INCLUDES PILOT (D 2), OIL, OXYGEN, UNUSABLE FUEL, AND TIP MISSILE LAUNCHERS.
**ALL WEIGHTS ARE APPROXIMATE. REFER TO INDIVIDUAL AIRCRAFT WEIGHT AND BALANCE HANDBOOK FOR ACTUAL AIRCRAFT WEIGHT.

"Spurts"

-Pilot

-Aerospace Engineer
-Army Medic
-Project Engineer

basher54321

Elite 1K

- **Posts:** 1008
- **Joined:** 02 Feb 2014, 15:43

27 Dec 2016, 21:42

*sprstdlyscottsmn wrote:*Keep this in mind. A Block50/52 weighs more than that XL when empty. THAT is more much avionics and weapon mods weigh.

Fairly certain a lot of the added weight on Block 40 was from the structural redesign with bigger landing gear etc to take the extra loads needed for an AG role. The F-16XL was designed from the start with AG as a primary role and the weights only exist for the 2 mock up / prototypes.

jbgator

Active Member

- **Posts:** 121
- **Joined:** 05 Aug 2009, 01:31
- **Location:** VA

27 Dec 2016, 23:04

You are correct that most of the weight growth has been structural. Especially in empty weight. The addition of new weapons and pods is not reflected there although heavier pylons factors in. Avionics have had little to do with it, in fact, many newer cards, processors, and displays are lighter than the original stuff.

All airplanes, like humans, get heavier as they get older. You would be hard pressed to find an A-model that isn't extremely heavier than it was coming off the factory floor. In the mid 90s, as weapons officer for our squadron, I suddenly had to get familiar with the weight and balance forms for all our F-16A BLK 15s as we added AIM-120 capability to the avionics. Now with AIM-120s and LAU-129s and the recent conversion from JP-4 to JP-8 certain of our combat

loads would exceed the A-model gross weight. So I had to go into the weight and balance forms for all our jets and determine how much fuel we had to take off before we could load MK-84s (for example). I was surprised to find all the jets were heavier than I expected and a big dispersion between heaviest and lightest (These were all 82-83 models). I was told this was due to all the structural modifications required to address cracks and fatigue to meet service life requirements. In 1996 when we converted to F-16C BLK32 I could stop worrying about it as the C-model has a higher gross weigh limit. (BLK40 and 50 are even higher, added strength equals added structural weight), Then we got targeting pods and I was back to the W&B forms as some loads would overgross a BLK32. I found, to my surprise, that many of our lightest BLK32s were lighter than our heaviest A-model had been and our one BLK25 was not our lightest. So that ** at the bottom of the chart is significant. I do not recall the range of weights but we did have to average ~1000 lbs of fuel offload and some jets did not require it so I know it was at least a 1000 lb spread. Later we learned the BLK40 had increased GW due to new wheel/tires and that we now had the same and could use the higher GW (I also became OPSO about that time) and I retired from worrying about W&B.

I am sure the weight growth is similar for all airplanes so comparing original spec weights is probably still fairly valid, but trying to determine the outcome of air combat based on it is nonsense. I challenge any pilot to say he/she can tell the difference between 1100 and 1200 foot turn radius. And radius is an instantaneous value that varies with altitude and speed as well as weight. Since no two aircraft arrive at an aerial engagement at exactly the same set of parameters, even if pilot skill were not considered there would be no way to predict the outcome for sure in closely matched airframes.