CNT
Center of New Technologies

institute of aviation
warsaw, since 1926

AVIATION COMPONENTS AND EQUIPMENT TEST DEPARTMENT

research for future

AVIATION COMPONENTS AND EQUIPMENT TEST DEPARTMENT

The Aviation Components and Equipment Test Department mission is to develop of the new technologies and to propose innovative design and technological solutions including their laboratory verification.

In particular:
- test and design of landing gears for both manned and unmanned aircraft,
- test and design of high energy brakes and Anti-Lock Braking Systems (ABS),
- test and design of shock absorbers, energy absorption systems and mechanical vibration dampers,
- tests of energy absorption materials (high deformation speed),
- maintenance and management, regular and proof test supervision, test program preparation, functional tests and inspections,
- design of test stands and specialized measurement systems,
- structural strength analysis,
- design, preparation and construction of demonstrators.

The Aviation Components and Equipment Test Department consists of a Landing Gear Laboratory which complies with ISO-PN-EN IS/IEC 17025:2005 requirements and is accredited by the Polish Center for Accreditation (certificate number AB 131). Most of the landing gear Polish made airplanes and helicopters were designed in the Aviation Components and Equipment Test Department and tested in the Landing Gear Laboratory.

SCOPE OF ACTIVITY

Design

Design processes are aided by the CAD 3D SOLID EDGE system, fully compatible with the Unigraphics and Catia systems. Strength analysis and stiffness evaluation are performed using the MSC NASTRAN/PATRAN and FEMAP/NASTRAN systems.

Design capabilities
- airplane and helicopter wheel and skid landing gear,
- "shimmy" and anti resonance dampers.
- landing gear shock absorbers (single and double acting),
- test stands,
- ABS for aircraft brake systems,
- actuators and locks,
- wheels and high energy brakes,
- UAV landing gear.

Airplane landing gear

Analyses

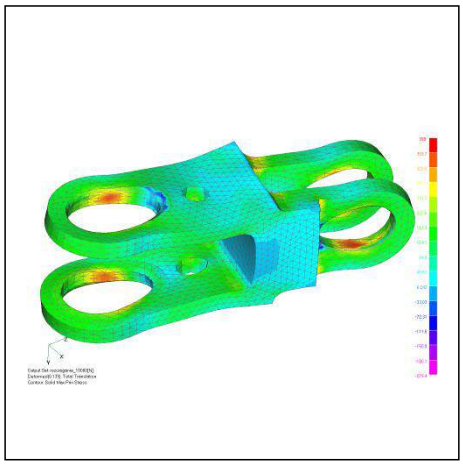
Analyses are made with the use of both advanced FEM packages: Altair HyperWorks, MSC PATRAN/NASTRAN, FEMAP/NASTRAN, and classic computational methods such as AMESim - simulation of intricate mechatronic systems. The analyses cover issues such as: optimization for maximum strength and minimum weight, fatigue wear, contact, friction, heat exchange, flows, vibrations.

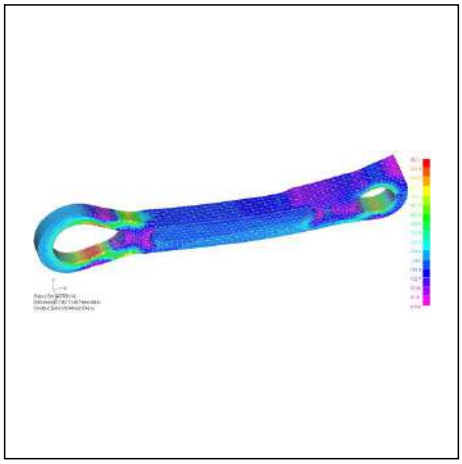
Computational simulation methods for:

- cases of applying a load to aircraft landing gear components and to other energy absorbing structures and materials,
- dynamic load conditions,
- stability simulation with experimental validation,
- shimmy phenomena,
- behavior in extreme conditions,
- computer simulation for aircraft touchdown dynamics for different landing gear concepts,
- braking transients (dynamic, heat transfer and vibration).

Analysis:

- stiffness, strength and flexibility evaluation of subassemblies and complete landing gears,
- optimization and integration of landing gear elements, braking systems, dampers, and control systems,
- evaluation of design process, conformance with quality standards and research methodologies,
- reliability and durability evaluation of landing gear elements using analytical and experimental methods,
- a review of the state of knowledge in the area of helicopter and landing gear technologies.





Computer analysis

Construction of Technology Demonstrators and Prototypes

Implementing projects and filling orders in the area of construction of all types of technology demonstrators, demonstration installations, prototypes, as well as testing and technological instrumentation related to widely understood aviation engineering:

- creating prototypes of components, parts, fuselages, devices and structures:
  - mechanical, static, electrical, automatic, with the use of both aviation and workshop technologies,
- construction of all types of technology demonstrators, iron birds, glass birds, power supply system demonstrators, mechanization system demonstrators, etc.
- implementation of projects in the area of combustion engine adaptation and modification for the purpose of using such engines in newly designed propulsion systems,
- construction and maintenance of testing devices and stations for static and dynamic tests, testing of propulsion systems, framework mechanization systems, and of other systems and subassemblies in the area of widely understood aviation technology,
- complete construction of hovercraft, starting from fuselages built with the use of composite technologies, through design and construction of propulsion systems, to adaptation and installation of engines,
- complete maintenance of combustion engines for aircraft (including certified line and heavy maintenance of ROTAX engines), car engines, inboard and outboard boat engines and other engines.
- aircraft propulsion system and airframe maintenance,
- construction of structures welded with the use of an argon and carbon dioxide blend,
- construction of composite structures with glass, carbon and aramid reinforcement, construction of moulds and instrumentation for fabrication of composite components.

TESTS

The Aviation Components and Equipment Test Department together with the Landing Gear Laboratory are capable of conducting comprehensive tests in accordance with FAR, EASA, MIL and AP standards for helicopters and aircraft with take-off weight of up to 20.000 kg (44.000 lb).
The tests are conducted as tests of complete assemblies and of separate components thereof, in the areas of energy absorption capabilities, static, dynamic and fatigue strength, dynamic and functional characteristics, and resistance to impact load.

Capabilities:
- static and quasistatic tests,
- dynamic tests,
- functional tests.

Measuring and recording parameters:
- time,
- force,
- displacement and deformation,
- pressure,
- temperature,
- rotational speed,
- acceleration,
- voltage and current.

Experimental work is performed using:
- high performance laboratory IBM-PC acquisition systems: max. 333 or 1000 kSamples/s 12 or 16 bit data, configurable for 64 input channels (upgradeable to 256 channels) and mobile system using SPIDER 8 (Hottinger),
- amplifiers (DC or 4.8 kHz carrier frequency plug-in unit); from Hottinger Baldwin, Messtechnik, National Instrument, Peltron, upgradeable to 26 channels,
- transducers and accessories for pressure, acceleration, linear displacement, force, torque, temperature and strain gauges by Hottinger, Keithley, IOtech, NI and Peltron,
- software for data acquisition, control, report generation, applications generated in house using the TestPoint CEC system, NI LabView, IOtech DasyLab and HBM Catman for PC-based Windows and Real-Time machines,
- equipment for calibration, verification, measurement, waveform generation, and control from HBM, Keithley Metrabyte,
- real-time flight recorders with sensors designed for rotating objects,
- LabView software with vision, RT, FPGA modules,
- Soria - a high-speed camera system with original software, 180 fps with a resolution of 2000x2000,
- NI DIAdem for processing large amounts of data and synchronization with video files,

Facilities:
- 10 ton drop test machine,
- 3 ton drop test machine with a drum,
- 40/20 ton press (vertical and/or side load),
- 5 ton automatic drop test machine for functional/fatigue tests of complete landing gear,
- rotary drum for wheel fatigue tests,
- DP test stand for functional and fatigue tests,
- IL 68 - model tests of friction pair materials,
- rotunda field stand for testing rotors and complete helicopters,
- two ILX-27 unmanned helicopter prototypes for flight tests,
- optical strain gauge measurement stand, 64 channels,
- System for thermographic measurements, up to 650°C.

10-Ton Drop Test Machine

Purpose

The 10-Ton Drop Test Machine is capable of doing amortization tests on L/G in conditions similar to real landing. Possible impact tests include dampers, shock absorbers and crash tests.

Drop Test Machine

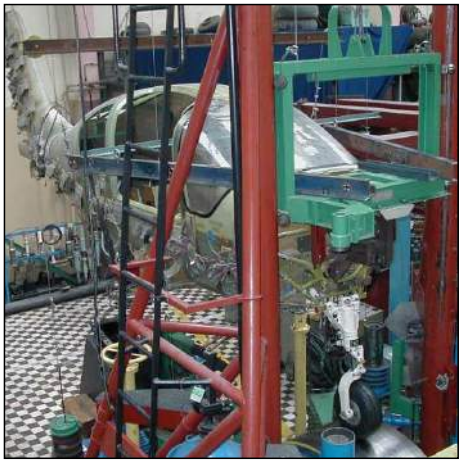
1	Max. weight of tested object including mounting parts	10 T
2	Max. forces during the tests:	
	- Vertical force	392 kN
	- Horizontal force	196 kN
3	Max. buffer pressure	3 MPa
4	Max. spinning wheel velocity	400 km/h (111 m/s)
5	Max. sink speed	28.8 km/h (8 m/s)

3-Ton Drop Test Machine with a Drum

Purpose

The 3-Ton Drop Test Machine with a Drum is used for testing shock absorption capabilities of landing gear in conditions similar to aircraft landing and taxiing, for testing landing gear shimmy, and also for testing brakes, wheels and tires. The test stand enables applying dynamic loads over an obstacle.

The test stand is equipped also with a pressure ramp that enables testing two wheels simultaneously, and is used for testing ABS systems on the stand.



3-Ton Drop Test Machine

1	Max. weight of tested object including mounting parts	3T
2	Max. vertical force during the tests	118 kN
3	Max. buffer pressure	1.96 MPa
4	Drum max. rotational speed	800 rpm (13.3 rps)
5	Drum max. peripheral speed	211 km/h (58.6 m/s)
6	Drum exterior diameter	1400 mm
7	Drum width	530 mm
8	Buffer force	0 - 22.2 kN
9	Drum's moment of inertia	
	I1 = Ib	294 kg•m^2
	I2 = Ib + Il	550 kg•m^2
	I3 = Ib + Ip	588 kg•m^2
	I4 = Ib + Il + Ip	843 kg•m^2

5-Ton Drop Test Machine

Purpose
The 5-Ton Drop Test Machine is capable of performing strength tests of landing gear in conditions similar to landing.

5-Ton Drop Test Machine

1	Max. weight of tested objects including mounting parts	5 T
2	Max. vertical force during the tests	147 kN
3	Max. horizontal force during the tests	74 kN
4	Static load	5 ÷ 50 kN
5	Drop height	0 ÷ 1000 mm
6	Drop frequency	up to 4/min

40/20 - Ton Press

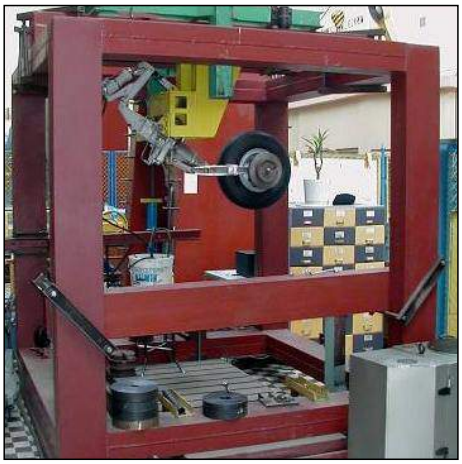
Purpose
The press is capable of doing static and slow inconstant tests of complete sets, as well as of elements such as wheels and shock absorbers. It enables determination of force displacement characteristics under biaxial loads. Non-aircraft object tests are possible, depending on the way objects are mounted on the test stand.

40/20 - Ton Press

1	Vertical force	0 ÷ 392 kN
2	Horizontal force	0 ÷ 196 kN
3	Top deck vertical leap	400 mm
4	Bottom deck vertical leap	400 mm
5	Moving top deck vertical velocity	0 ÷ 300 mm/min
6	Moving bottom deck horizontal velocity	0 ÷ 600 mm/min
7	Bottom deck dimensions	800 x 760 mm
8	Clearance between top and bottom deck	190 ÷ 2000 mm
9	Vertical and horizontal forces increment proportionality assurance in any inclined proportion	
10	Self-activating cycles of vertical load assurance	
11	Reading and recording vertical horizontal loads - leap curves	

Functional and Fatigue Test Stand DP

Purpose
The Test Stand is capable of performing functional and fatigue tests. Hydraulic power systems and data acquisition systems enable static strength, fatigue and wear tests under complex load (multi actuator systems). The stand facilitates, among others tests, investigation of friction damper characteristics, retractable landing gear mechanisms and dynamic characteristics.



Functional and Fatigue Test Stand DP

1	Assembly section dimensions	1900x1800x1900 mm
2	Max. load	19.6 kN
3	Max. load frequency	5 Hz ÷ 15 Hz
4	Adjustable to meet the specific Test requirements	
5	Recording key test parameters	
6	Feedback control	

IL 68 - Model Test of Friction Pair Materials

Purpose
The test stand enables modeling of physical phenomena that occur in brakes during deceleration (vehicles and aircraft) including, in particular, the thermal shock effect. Deceleration down to zero velocity is a rapid process taking between 10-15 s. During this time, heat generated on the brake working surface is transferred inside the friction pair materials. IL 68 - the Model Test of Friction Pair Materials allows recreation of this process on the samples' friction surfaces alongside recording and measuring a range of parameters, such as the maximum power generated per unit of the friction surface, work per unit of the friction surface, slip speed and maximum volumetric temperature. We are also capable of performing thermal resistance tests of brake pad materials.

IL 68 – Model Test of Friction Pair Materials

1	Max. drive shaft rotation velocity	9000 rpm (150 rps)
2	Inertia	0.154 ÷ 1.54 kg•m^2 increased by 0,098 kg•m^2
3	Max. load on the sample surface	5.88 kN

Wheel Fatigue Test Stand

Purpose
The Wheel Fatigue Test Stand is capable of performing fatigue tests of hubs and whole wheels on road vehicles and aircraft.

Wheel Fatigue Test Stand

1	Wheel load on the drum	1.96 ÷ 59 kN
2	Drum diameter	1989 mm
3	Drum width	600 mm
4	Drum Peripheral Speed	5.3 ÷ 53 km/h (1.47 ÷ 14.7 m/s)
5	Testing Wheel Diameter	300 ÷ 1000 mm
6	Single loading time	10 ÷ 60 min
7	Loading Cycle Time	20 ÷ 120 min
8	Self-activating cycles of load assurance	
9	Reading and recording of load, mileage, cycles number and test time	
10	Tire deflection measurement	
11	Constant and adjustable pressure measurement inside the tire	

Compressed-air Cannon for Crash Testing

Purpose
The cannon is used for testing objects in crash conditions, which means impact testing with high collision speeds.

Compressed-air Cannon for Crash Testing

1	Working pressure	11 bar
2	Outlet velocity	40 m/s
3	Projectile diameter	200 mm
4	Remote cannon trigger activation	
5	Possibility to install a device for direct measurement of projectile velocity	
6	Compact structure enabling cannon transportation and field works outside the laboratory	

Universal Static Test Stand

Purpose
The test stand is designed for performing static, strength and functional tests of structure components and whole assemblies.
The test stand can be used also as a universal assembly platform due to the modular character of the utilized technological accessories.

Universal Static Test Stand

1	Platform dimensions	6,6 m x 2,4 m
2	Maximum compressive exciting forces	20 T - 5 lines
3	Maximum tensile exciting forces	20 T - 5 lines
4	Force acquisition	max. 20 T - 5 lines
5	Displacement acquisition	max. 1 m - 5 lines

Stand for Charging Shock Absorbers

Purpose
The stand is used for filling shock absorbers and other assemblies in which pressurized gas must be used, with gas.

Stand for Charging Shock Absorbers

1	Number of charging ranges	3
2	Range 1	5 - 15 MPa
3	Range 2	1 - 5 MPa
4	Range 3	0 - 1 MPa

Our Projects and Applications

- Landing gears for:
  - 2 seat piston trainer PZL TS-8 Bies,
  - 2 seat jet trainer PZL TS-11 Iskra,
  - combat jet trainer PZL I-22 Iryda,
  - medium helicopter PZL W-3 Sokol,
  - 4 seat airplane PZL 104 Wilga.
- Nose and main L/G for 2 seat military - trainer PZL 130TC Orlik,
- modernization of L/G to military trainer - PZL I-22 M93 IRYDA (take-off mass increased to 8940 kg),
- steerable tail L/G for 6 seat airplane PZL 105 Flaming,
- nose and main L/G for 4 seat composite airplane I-23,
- nose and main L/G for the 2 seat small airplane I-25 (prototype),
- dynamic and fatigue tests of landing gear of aircraft (Bryza),
- dynamic tests of I-23 landing gear,
- tests of brake lining of Iskra and Orka aircraft,
- landing gear damper of the SW-4 helicopter,
- technical project of nose and main retractable landing gear for the airplane Bryza (sea patrol),
- conceptual project for Sokół helicopter landing gear (marine version),
- conceptual project for main retractable landing gear for Skytruck PLUS aircraft,
- fatigue analysis of fixed landing gear for Bryza aircraft,
- strength analysis of fixed landing gear for Bryza, aircraft in the MSC NASTRAN system,
- strength analysis of retractable landing gear for the composite airplane I-23,
- nose & main landing gear retraction systems for Bryza aircraft,
- nose and main L/G for EM-11 Orka aircraft,
- main L/G for Skytruck aircraft with improved impact absorption - the ADLAND project,
- UAV electrically controlled L/G, take off mass of 100 kg, the NACRE project,
- UAV electrically controlled L/G, take off mass of 230 kg,
- landing gear for the ILX-27 unmanned helicopter - 1.100 kg,
- "Unmanned helicopter - robot for special tasks" - tests,
- design, construction and testing of landing gear for an autogyro built as a part of the "Technology of introducing a new type of rotorcraft into business practice" project,
- "Efficient Systems and Propulsion for Small Aircraft",
- a modern unpowered rotor,
- design, construction and testing of landing gear for an unmanned helicopter prototype built as a part of a development project named "Unmanned helicopter - robot for special tasks" implemented in a consortium with ITWL and WZL-1,
- design for modernization of brakes for the "Dzik" armored vehicle.

I-23 Manager

PZL-104 Wilga

Certificates and Norms

The Institute of Aviation is a leading center for design and testing of landing gear in Poland. The landing gear of most airplanes and helicopters produced by Polish manufacturers have been designed and tested by the Institute's Department of Examination of Aviation Equipment in compliance with the quality standards of ISO - PN - EN ISO/IEC 17025:2001 and is certified by the Polish Center for Accreditation (Certificate No. AB 131). The Department of Examination of Aviation Equipment offers design, analysis and test services of landing gear with the use of modern devices and measurement instrumentation.

PN-EN OSO 9001-2009, WSK KONCESJA MSWiA nr B-003/2010, AQAP 2110:2009.

PCA
POLSKIE CENTRUM AKREDYTACJI
BADANIA

AB 131

International and Domestic Cooperation

International cooperation

- CESA CESA - COMPAÑIA ESPAÑOLA DE SISTEMAS AERONÁUTICOS, S.A. - testing of landing gear for an unmanned aerial vehicle - ATLANTE project.
- ASTRIUM SAS - crash tests of energy absorbing materials.
- ADLAND - Adaptive Landing Gears for Improved Impact Absorption - STREP.
- Specific targeted research project: "Development of steerable landing gear with the aim to improve energy absorption upon touchdown".
- DRESS - Distributed and Redundant Electro-mechanical Nose Gear Steering System - Design and integration of a test stand for testing an electrical system for steering the nose landing gear of the Airbus A320 airplane. The test stand was developed as a part of participation in an European project coordinated by the Messier-Bugatti company. The test stand has been used since 2010 in France by the Messier-Bugatti company, *www.dress-project.eu.*
- RASTAS SPEAR - Radiation-Shapes Thermal Protection Investigations for High-Speed Earth Re-entry - selection and crash testing of energy absorbing materials - *www.rastas-spear.eu*

Domestic cooperation:

AUGUSTA WESTLAND "PZL-Swidnik" S.A.:

- landing gear for the W-3 SOKOL helicopter,
- landing gear for the I-23 aircraft.

SIKORSKY PZL - Mielec Sp. z o.o.:

- landing gear for the PZL I-22 IRYDA aircraft,
- landing gear for the M28 SKYTRUCK aircraft,
- landing gear for the BRYZA aircraft.

AIRBUS MILITARY EADS PZL "Warszawa-Okecie" S.A.:

- landing gear for the PZL-104 WILGA aircraft,
- landing gear for the PZL-111 KOLIBER 235 aircraft,
- landing gear for the PZL-106 KRUK aircraft,
- landing gear for the PZL-130TC ORLIK aircraft.

Margański & Mysłowski Zakłady Lotnicze Sp. z o. o.:

- landing gear for the EM11 - ORKA aircraft.

Delphi Poland:

- tests of automotive shock absorbers.

Projects:

- Unmanned helicopter - robot for special tasks ILX-27,
- Technology of introducing a new type of rotorcraft into business practice,
- Modern unpowered rotor,
- Butterfly Wing,
- Efficient Systems and Propulsion for Small Aircraft,
- PKAERO - Modern material technologies used in the aviation industry.

Norms

FAR 23	MIL-L-8552C	CS-25
EASA PART 23	MIL-A-8867C	CS-27
FAR 27	MIL-S-8698	CS-VLA
EASA PART 27	MIL-B-8075D	CS-ET30
FAR 29	MIL-B-8584C	STANAG
EASA PART 29	MIL-STD-810	CS-VLR
AP 970	MIL-T-8679	CS-23
TSO-C 26	MIL-W-5013L	JAR-22
TSO-C 62	MIL-C-6021	JAR-23
MIL-A-8866 (ASG)	MIL-H-8775	JAR-25
MIL-STG-1290A	MIL-A-5503	JAR-VLA
MIL-T-6053C		

Head of Aviation Components and Equipment Test Department
Andrzej Tywoniuk, M.Sc. Eng.
phone: (+48) 22 846 00 11 ext. 219
fax: (+48) 22 846 37 52
e-mail: andrzej.tywoniuk@ilot.edu.pl

Institute of Aviation
al. Krakowska 110/114
02-256 Warsaw
phone: (+48) 22 846 00 11
fax: (+48) 22 846 44 32
e-mail: ilot@ilot.edu.pl

www.ilot.edu.pl
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