# Five Years Operational Experiences with Indonesian Low Speed Tunnel (ILST)

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ABSTRACT

Some experiences of aerodynamics testing have been acquired since the completion of ILST construction in 1987. Most of the work are conducted for the development of Indonesian aircrafts.

The performance of ILST was calibrated by means of measuring a tested model as well as setting up an exploratory model of a commuter aircraft which was mounted using various support system.

The paper reviews some important aspects of experimental experiences of aerodynamics in ILST. Particularly, engine simulation, full and half model test. Also, there is a brief discussion of research activities.

## LIST OF ABBREVIATIONS

| | |
|---|---|
| BPPT | : The Agency for the Assessment and Application of Technology |
| ILST | : Indonesian Low Speed Tunnel |
| IPTN | : Nusantara Aircraft Industries |
| LAGG | : Aero-Gas dynamics and Vibration Laboratory |
| PUSPIPTEK | : Indonesian Research Center for Scientific and Technology |

## 1. INTRODUCTION

The Indonesian Low Speed Tunnel (ILST), is an LAGG facility of the Agency for the Assessment and Application of Technology (BPPT), located at PUSPIPTEK, Serpong, Indonesia.

It is a closed circuit, return type, atmospheric tunnel, and a high quality low speed tunnel which is equipped with computerized measurement systems.

There were three aircraft models have been tested since 1987, namely CN235, Basic and Development of a new commuter aircraft. Also, an experimental aircraft model as a joint cooperation with IPTN and Boeing Company.

On the other hand, some efforts have been done to improve the test quality which were developed under cooperation with theoretical aerodynamics group.

The flow quality was tested during tunnel calibration. Turbulence Level is of about 0.1 %, Flow Angularity ($\Delta\alpha$ and $\Delta\beta$) is < 0.1 , Axial Static Pressure Distributions. (Cp) are ± 0.2 % and Temperature Deviation is ± 0.5 °C.

## 2. ILST FACILITIES

After commissioning and calibration of the tunnel were completed, most of the main facilities were ready to be used. The tunnel has maximum airspeed of about 110 m/sec. It has four interchangeable test sections of 4 m. in width, 3 m. in height and 10 m. in length.

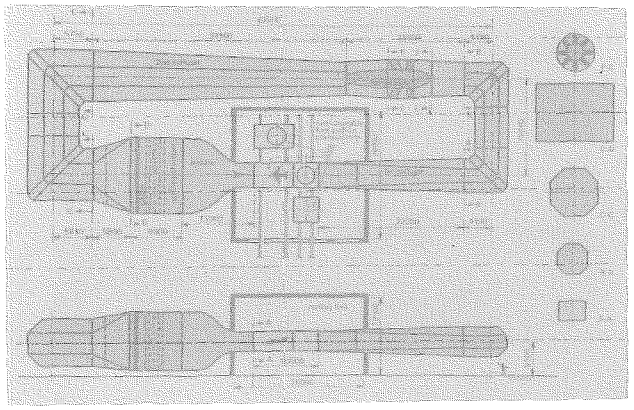

Fig. 2.1
Tunnel Layout

Combinations of the two difference test sections allow test to be carried out with either overhead External Balance or Internal Balance.

The flow in the tunnel is maintained at constant temperature by means of a Heat Exchanger in the Settling Chamber, where four anti turbulence screens are also located. A sketch of the tunnel circuit is shown in Figure 2.1 and Figure 2.2.

The presentation of results are supported by a sophisticated Data Acquisition and Reduction Systems (DARS). It is able to run on-line with real time monitoring or off-line processing either step-by-step or continuous measurements. The on-line processing gives intermediate results, which is the most useful processing. By this means, if there are some faults or misreadings, the test operation can immediately be controlled. The final presentation of off-line processing results are fully corrected of walls and supports interference, instrumentations offset and other necessary corrections.

## 3. FULL MODEL TEST

As shown in Figure 2.1 and 2.2, ILST has two options of balance, namely overhead External Balance and Internal Balance which the later is mounted at Sting Support system.

Based on those balance systems, the tunnel offer more flexible choice to carry out Full Model test, pertinens to their advantages and disadvantages.

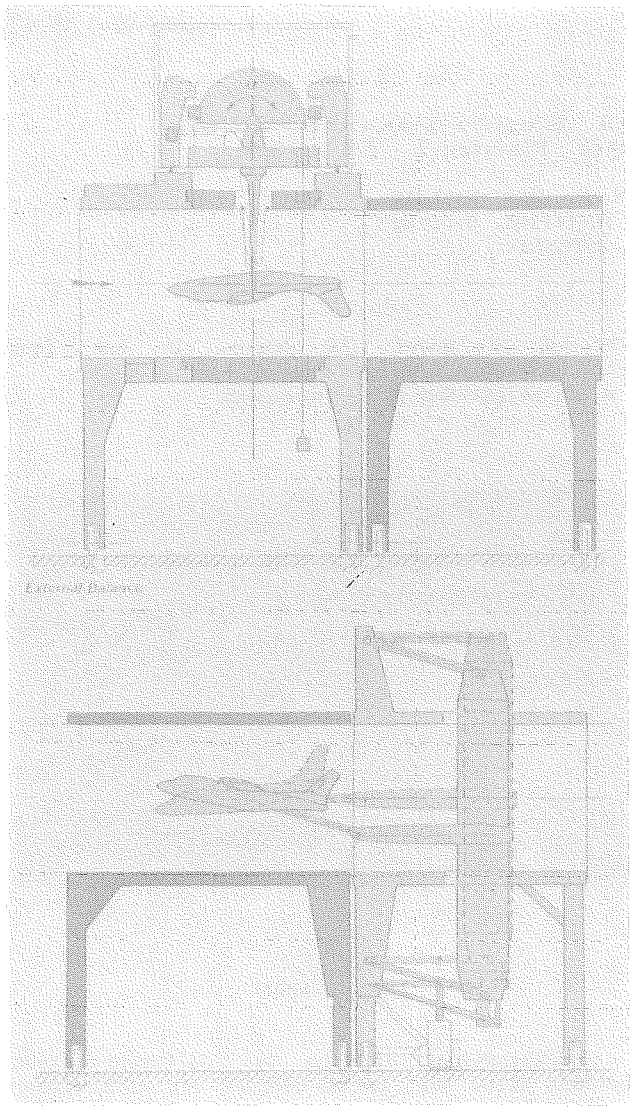

Fig. 2.2
External Balance and Sting Support (Internal Balance)

The following Full Model tests are already run in ILST :

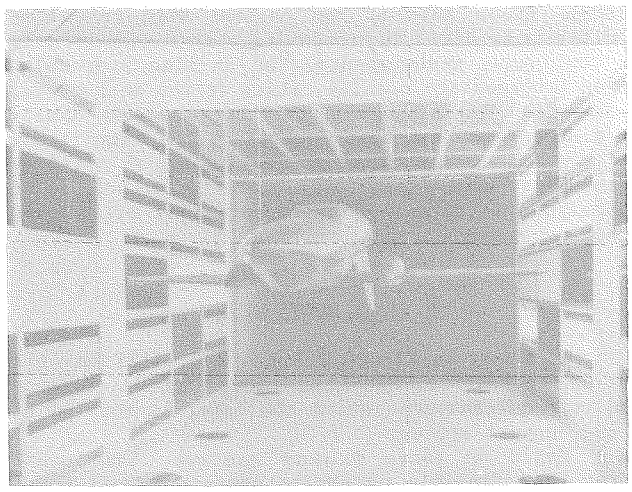

Fig. 3.1.1
Full Model Test Supported by Wire

3.1 FULL MODEL TEST SUPPORTED BY WIRES

The model test configuration is shown in Fig. 3.1.1. It gave a good results for analyzing the flow around tail.

Though the configuration has been set up with on-line corrections, the data, with respect to wire forces and moments, have to be carefully checked. There could be some inaccuracies in the determination of the drag of wire.

Two models have been tested by means of wire support namely the CN235 and the basic version of a new commuter aircraft.

3.2 FULL MODEL TEST SUPPORTED BY STRUTS

The test used the same balance as wire support test, however it can be configured as wing or central struts. The wing struts configuration is shown in Fig. 3.2.1. The presence of the struts and its wind fairings primarily introduced changes in flow field.

Experiences gave that the influence of struts, to the pressure at wing was of about 0.8 % .

This method has been intensively used to measured the basic and development model of a new commuter aircraft.

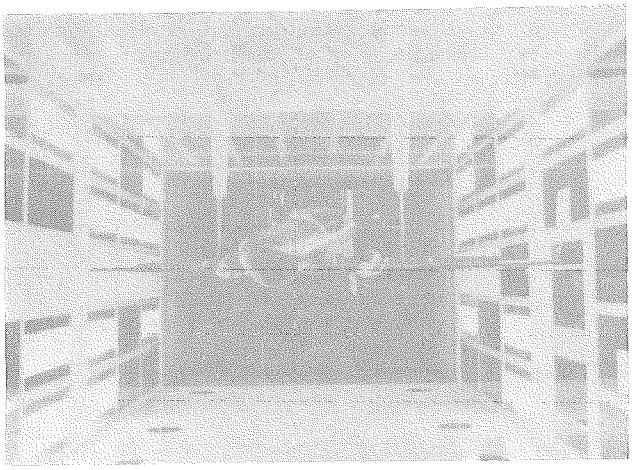

Fig. 3.2.1
Full Model Test Supported by Struts

3.3 FULL MODEL TEST SUPPORTED BY STING

The test series were run using the basic model of new commuter aircraft through an internal six

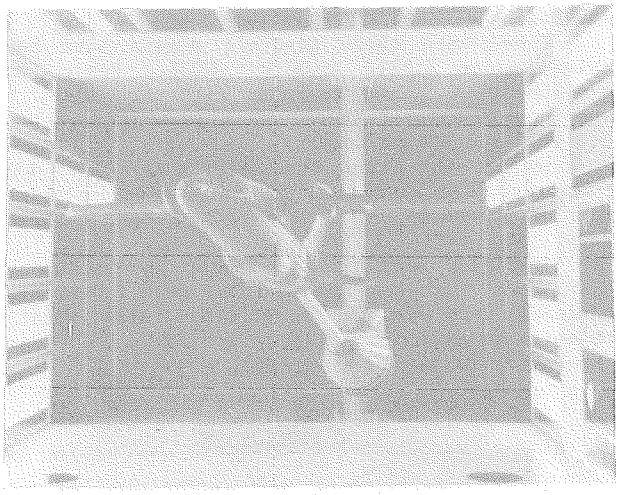

Fig. 3.3.1
Full Model Test Supported by Sting

components straingage balance. The model was mounted to a rear-mounted sting. The sting protruded from the model at the lower side of the aft fuselage under an angle of five degrees.

The test results gave a good match to the test of other supports method which used the same model. In addition, the test gave some impressions of sting interference. It seems that the local effect was very small compared to far-field effect.

Figure 3.3.1 shows the test set up of a basic model of new aircraft mounted on ILST sting support.

## 4. HALF MODEL TEST

The test was performed as a cooperative research program between IPTN/LAGG and Boeing Company. The objective was to study a high-lift model of swept (25 deg.) and unswept wing (0 deg.). This program as a whole has already been highly beneficial to both participants.

The results showed that the effect of increasing the sweep angle to the lift curve slope was found to be as good as expected by theoretical prediction. Also, the experimentally determined ratio of swept and unswept wing of CL was very close to the expected value.

The use of a slat and flap increased the maximum lift of the cruise wing 121%, the stall angle was also increased from 15 deg. to 25 deg.

Figure 4.1 shows the half model test which was carried out in ILST.

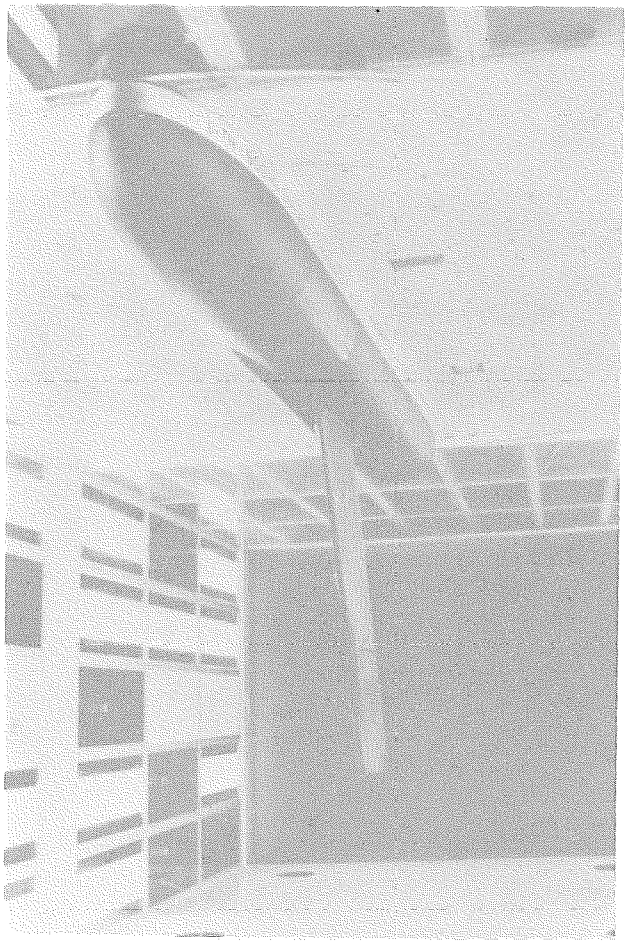

Fig. 4.1
Half Model Test

## 5. ENGINE SIMULATIONS

The engine simulation was successfully simulated for a new commuter aircraft, it is carried out by using six carbon fiber blades on TDI engine which was driven by a compressed air system. Therefore the simulation was free from interferences, and be able to achieve real flight speed to be simulated.

## 6. NON AERONAUTICS

In 1989, a non aeronautics test was set up in ILST. The test was aimed to measure turbulence characteristics around helideck and windflow sensors of a ship model. The turbulence flows are primarily generated due to the structure of the ship and the wind direction.

The windtunnel test indicated that some installed sensors must be relocated to give an accurate read out. The test also produced informations of turbulence intensity at the landing spot.

## 7. RESEARCH and DEVELOPMENT

Currently, there are two main categories of research in ILST :

- Research of Wall Interferences and Corrections.
- Research of Support Interferences and Corrections.

In addition, testing methods are also developed to increase the operational efficiency as well as to adopt some progress of modern equipments.

The assessment of wire support indicated that drag force of wire support is considerably high, Figure 7.1 shows a typical result.

An experimental test has been carried out to assess the influence of Sting Support, it used struts support instead of wire support test results as a reference. Figure 7.2 shows one aspect of the analysis.

Recently, we are developing a two dimensional test method by means of measuring boundary conditions and wake rakes. It is expected that by this method, the tunnel and its instruments can be configured as

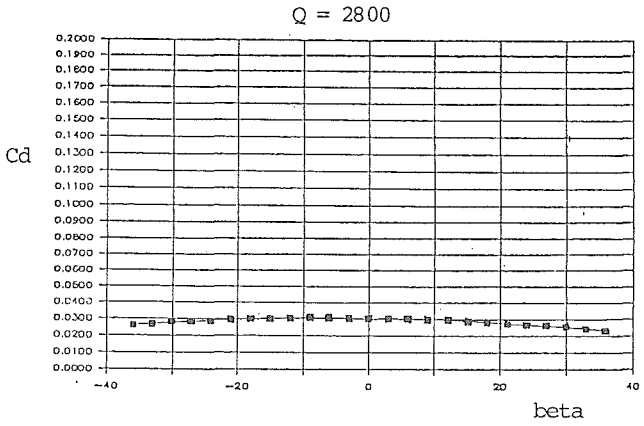


Fig. 7.1
Aerodynamic Characteristics of A Wire Suspension Support

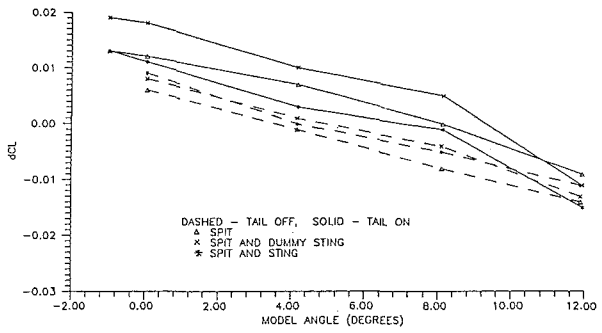


Fig. 7.2
Sting Effects on Model of Cruise

a fixed measuring device. The model is an object which can easily be changed, because there is no pressure holes at the model.

## 8. CONCLUDING REMARKS

During five years of operations, ILST has been able to provide a support facilities and services for carried out aerodynamics tests in Indonesia.

The structure of tunnel's test section gave more flexible choices to obtain a complete assessment of a model. For instance, data results of external balance test can be compared to the results of internal balance test of the same model.

Research activities are still in progress to improve testing procedures and methods by means of computerized measurement system. Currently, some work are running to prepare a research program for flutter and aeroacoustics tests in the near future.

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