
# Runway End Safety Area Construction
# A Case Study

## Airfield Pavement Evaluation
## SWIFT 2022

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# RESA Construction – A Case Study

Introduction to the Project

RESA Considerations During Design and Tendering

RESA Evaluation During Construction



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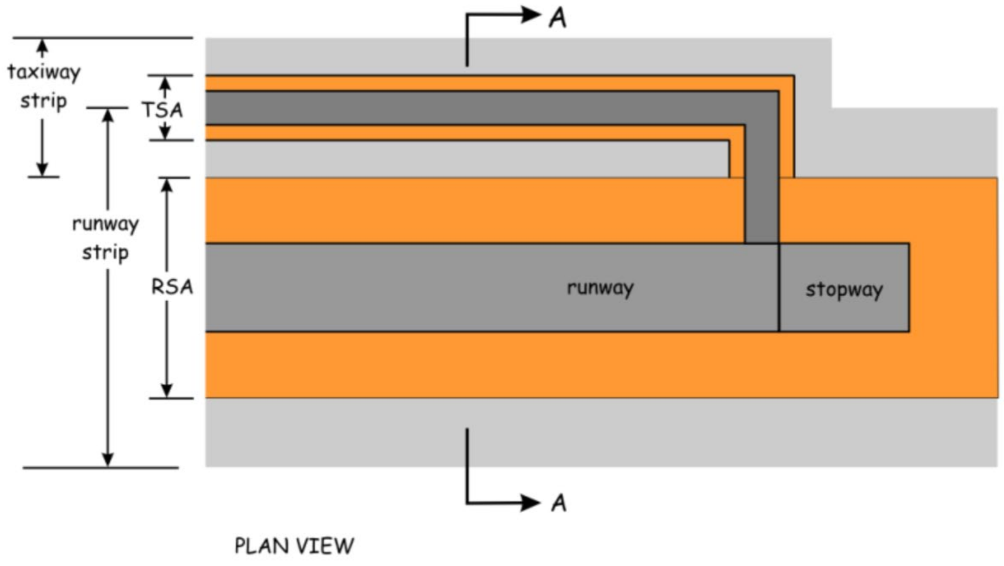
# RESA in Canada

TP312 5th edition




- Transport Canada defines a Runway End Safety Area (RESA) as an area symmetrical to the extended runway centreline, intended to reduce the severity of damage to an aeroplane undershooting or overrunning the runway
- The purpose of a RESA is to mitigate damage to an aircraft during an excursion and support the movement of emergency vehicles
- TP312 had a major overhaul in 2015 which introduced the requirement for RESA at the end of a runway strip
- Adoption is phased for existing runways but mandatory when a new runway is constructed

# Overview of GMIAA Project


- Construction of RESA's for three runway ends at the 11, 24 and 29 thresholds
- RESA at 06 threshold constructed as part of a different work program
- RESA 24 large 3 – 5 m fill area includes relocation of the airside service road
- RESA 29 maintains the existing grades and includes widening and relocation of the airside service road
- RESA 11 cut/fill balance and partial relocation of airside service road

# Considerations During Design

| TP312 Table 1-1 Column 2 (Wingspan) | Tire Pressure in psi (MPa) | RESA Minimum Bearing Strength (CBR) [Tire pressure / 10] |
|---|---|---|
| Code A and B (Small) | 60 - 145 (0.4 – 1.0) | 6 -14 |
| Code C, D, E and F (Medium) | 145 – 200 (1.0 – 1.4) | 14 - 20 |
| Code E and F (Large) | 200 – 254 (1.4 - 1.75) | 20 - 24 |

- Can be a natural compacted or engineered open area satisfying the requirements for sloping and strength under dry conditions
- Aircraft manufacturers consider that a depth of 15 cm is the maximum depth to which the nose gear may sink without collapsing
- No method specified in design or construction standards to evaluate the required CBR in the field

# Evaluation of CBR in the Lab


ASTM D1883

- TP312 specifies the CBR in the dry condition
- How will CBR be controlled in the field?
- Compaction is an important determinant of material performance – including CBR. Would like to understand how it may vary in the field.
- Borrow material quality can be quite variable as it is not an engineered product.  Care must be take to obtain representative samples
- CBR testing completed in the dry condition at different compaction levels



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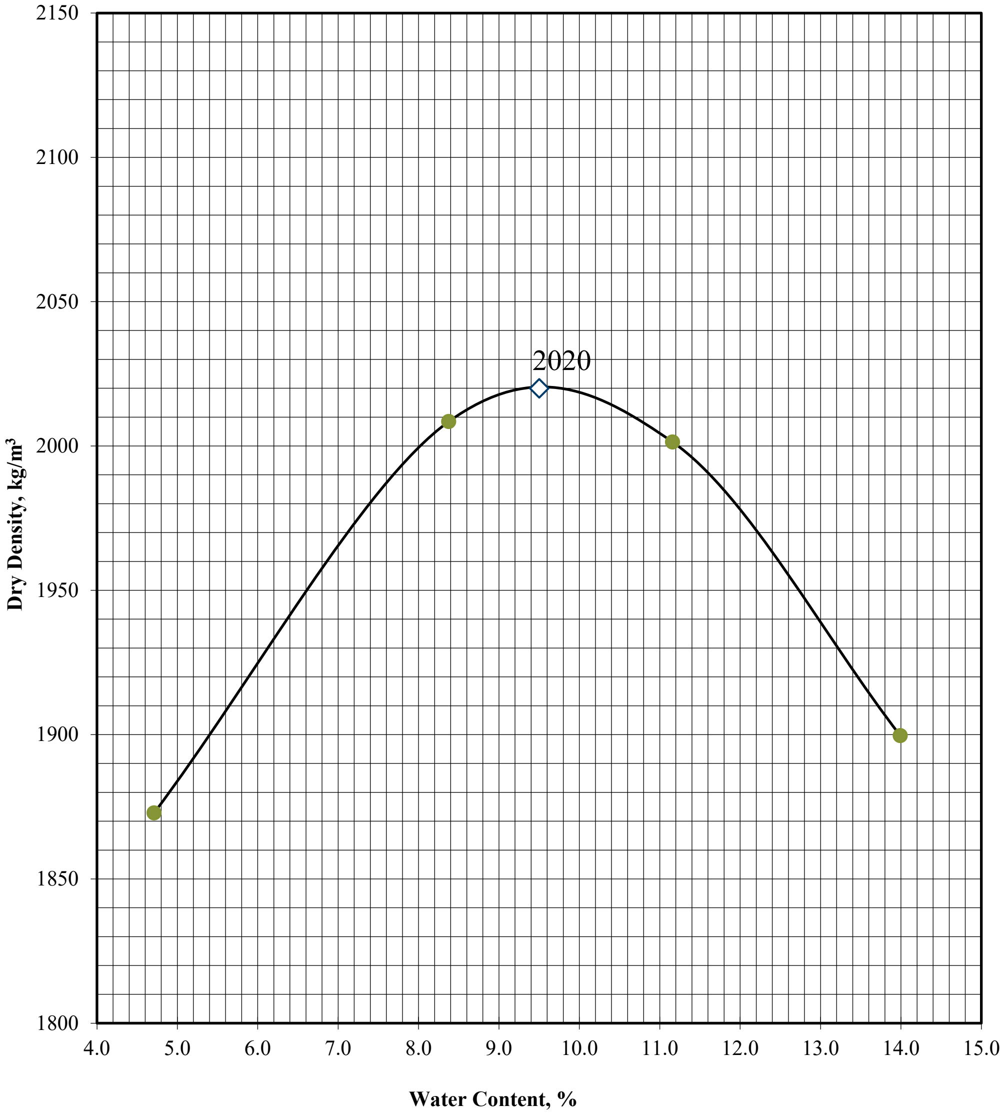
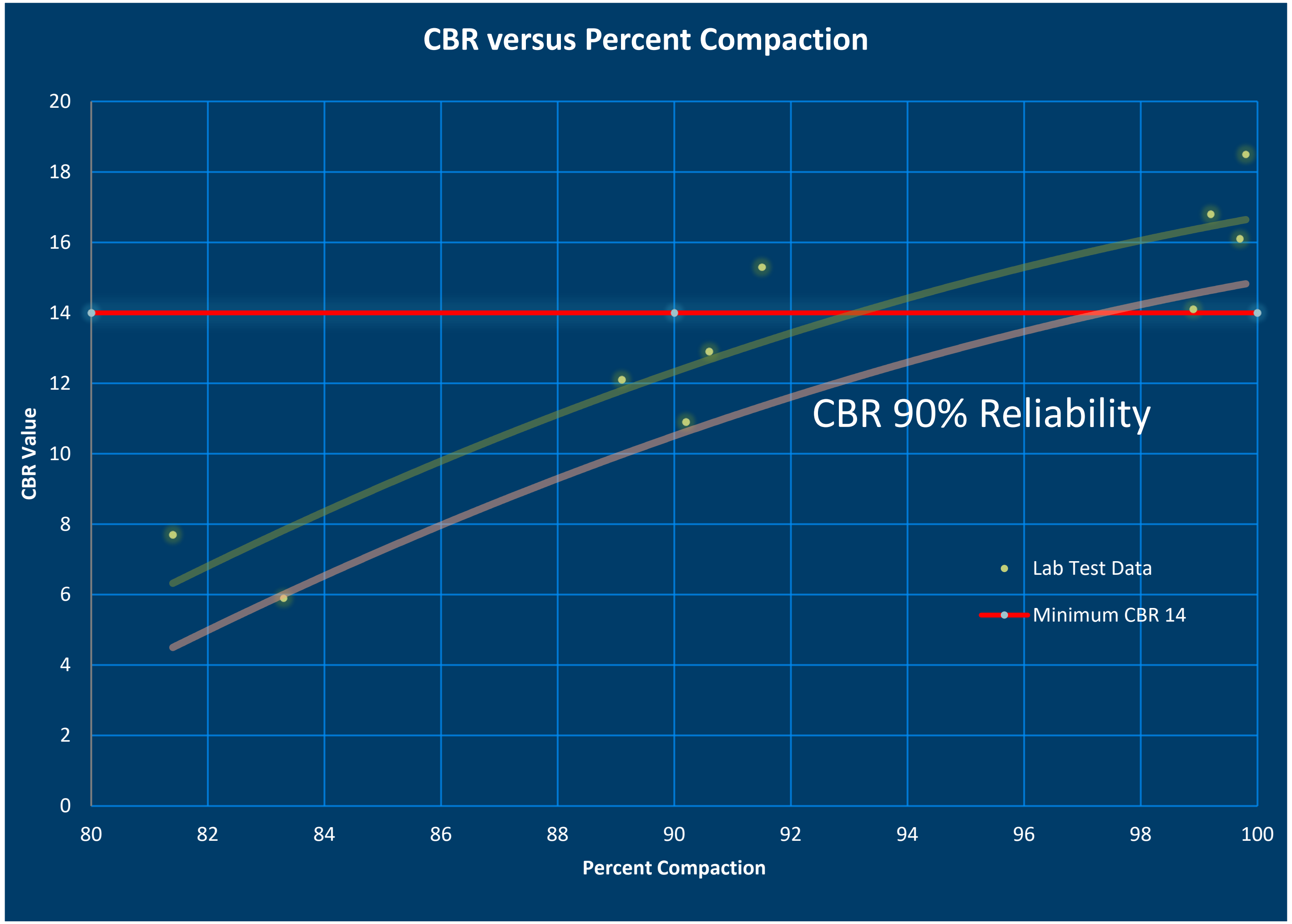
# CBR vs compaction



# Field Evaluation of RESA Material CBR

TP 312 nor the related specifications indicate how CBR should be controlled in the field

**1. Lightweight Deflectometer (LWD)**
Completed in accordance with ASTM E2583-07

**2. Dynamic Cone Penetrometer (DCP)**
Completed in accordance with ASTM D6951/D6951M-18

**3. In-Situ CBR**
Completed in accordance with ASTM D4429-09a

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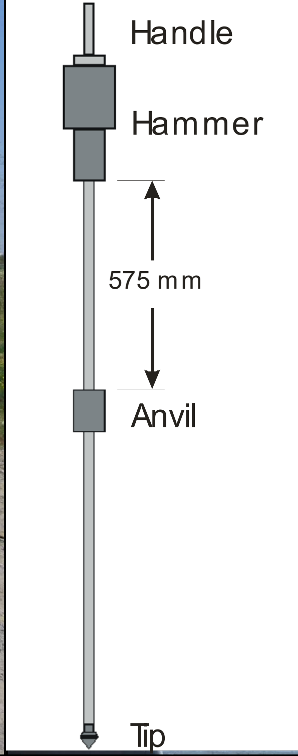


# ① LWD

Strengths

- Lightweight and mobile
- Can complete multiple tests at one location, confirming repeatability and reducing test bias
- Very quick (30+ tests per hour) allowing for the best coverage of the test area
- Results can be viewed in real time on site
- 15 to 30 cm diameter load plate allowing for a distribution of the load over a larger area reducing test bias
- Represents the average response of a column of material below the load plate

Weaknesses

- Equipment is less common and may be difficult to source from consultants with less competition
- May need more senior personnel to review and interpret the results
- Does not provide a direct measure of CBR; i.e. requires a correlation to be used to obtain CBR

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# ② DCP

Strengths

- Lightweight and mobile
- Shows the variability of performance with depth and not just the average surface performance
- Quick (10+ tests per hour) allowing for a good coverage of the test area
- Results can be viewed in real time on site if input into a PC
- Common among consultants and inexpensive so easy to source regionally

Weaknesses

- Labour intensive and tiring depending on the strength of the material (truck mounted devices also available)
- Potential for injury (repetitive motion, fatigue, pinching)
- Does not provide a direct measure of CBR; i.e. requires a correlation to be used to obtain CBR
- Three correlations are provided and the appropriate one needs to be used for the appropriate material to obtain accurate results
- Uses a small (60 $cm^2$) size tip that can be prone to test bias when encountering stones and cobbles within the test depth
- Cannot be used in material with lots of coarse aggregate.

# ③ In-Situ CBR


Strengths

- Direct representation of laboratory CBR – no correlation required
- Can apply a surcharge to simulate overlying material
- Mounted on a pickup truck and can be used wherever the pickup truck can access

Weaknesses

- Slow (1 to 2 tests per hour)
- Relatively few consultants have this equipment so may be difficult to source
- Uses a small (~5 cm) plunger that can be prone to test bias when encountering stones and cobbles within the test depth
- May need senior personnel to interpret the results



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# Lessons Learned

- For borrow materials, compaction cannot be relied upon alone to confirm material compliance
- Compaction passed for all RESA
- DCP and LWD showed low CBR results for one RESA
- Samples gathered for laboratory CBR testing confirmed low results
- Further laboratory testing showed material change
- Material removed and replaced with compliant material



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# Lessons Learned

- DCP did not always correlate to laboratory CBR
- When material properties change, the appropriate correlation must be changed
- Not always obvious in the field when a change to the correlation is required
- LWD and In-situ CBR did not have this issue
- In-situ CBR was slow and did not cover the RESA area very well but is excellent in troubleshooting concerns with DCP/LWD on site when encountered

# Conclusions

- LWD provides excellent balance between RESA test coverage and comparison to laboratory CBR if this tool is locally available
- In-situ CBR may be considered overkill for the level of accuracy required for a standard RESA. Valuable tool to troubleshoot site issues and reduce delay/impact to schedule when needed
- The supplemental pre-engineering work that was completed helped to reduce the delay on site when low CBR was identified, which mitigated the impact to schedule which might have otherwise reduced runway availability if the project was delayed.



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# Questions?


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