EFFECTS OF ROOFING MATERIALS ON NAVAIDS SIGNAL STRENGTH

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5Th Annual International Research Conference

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Introduction

1. Radio navigation aids (navaids) environment includes buildings whose roofing materials interfere with air navigation signal propagation.

2. Loss of intelligence in communication between Navaids and Flying aircrafts

3. Threat to flight navigation

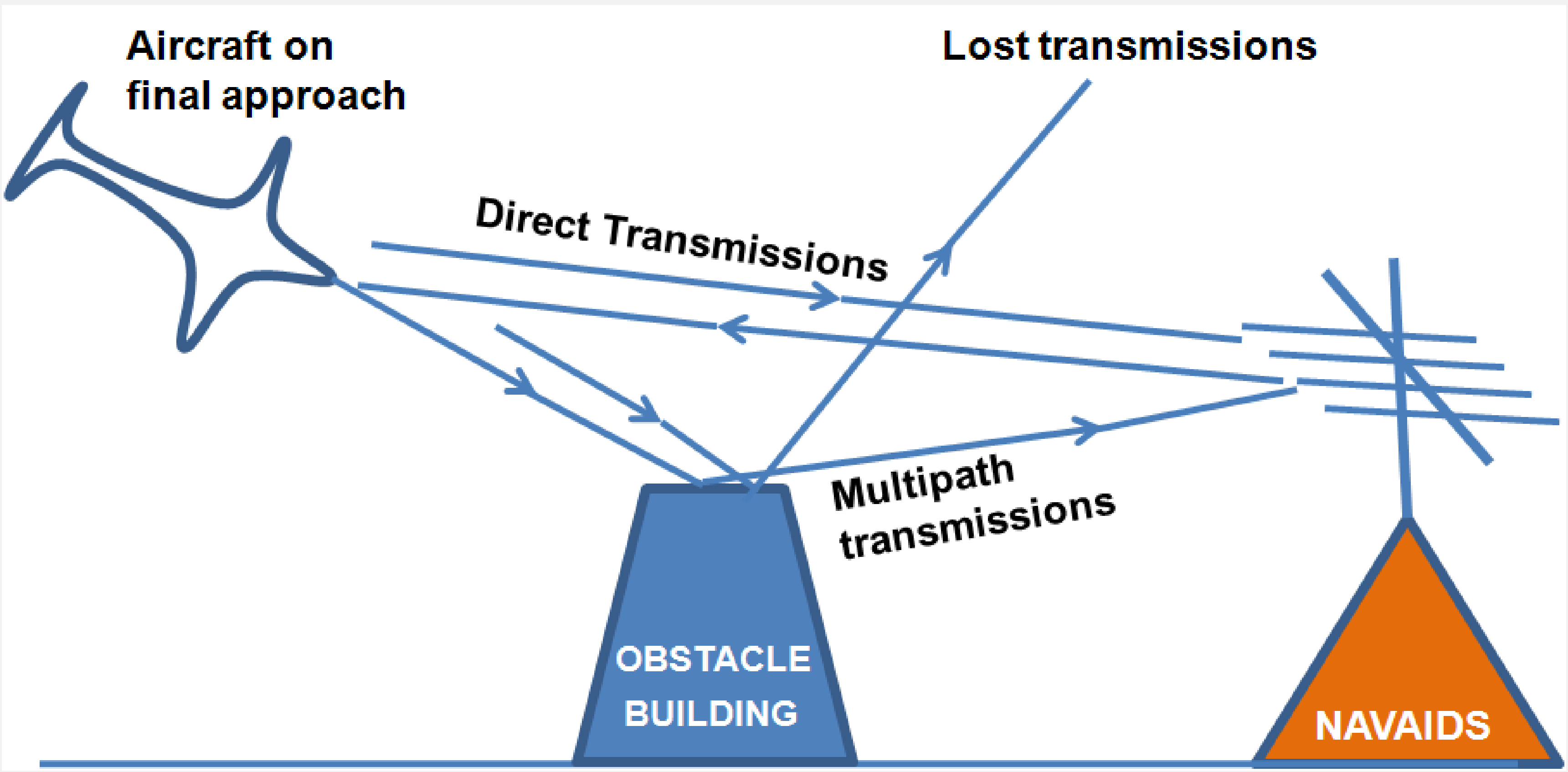
4. Restriction not supported by sufficient data

5. Half of accidents occur during landing

6. No data to link navaids/roofing materials to accidents

Objective

To determine effects of roofing materials on navaids signal strength



Scope and Limitations

1. Fraunhofer equation based on 9.4GHz and 16mm dipole antenna enabled a distance of 100cm to fulfill far-field conditions that are equivalent to open field environment.

2. Laboratory Conditions are assumed constant

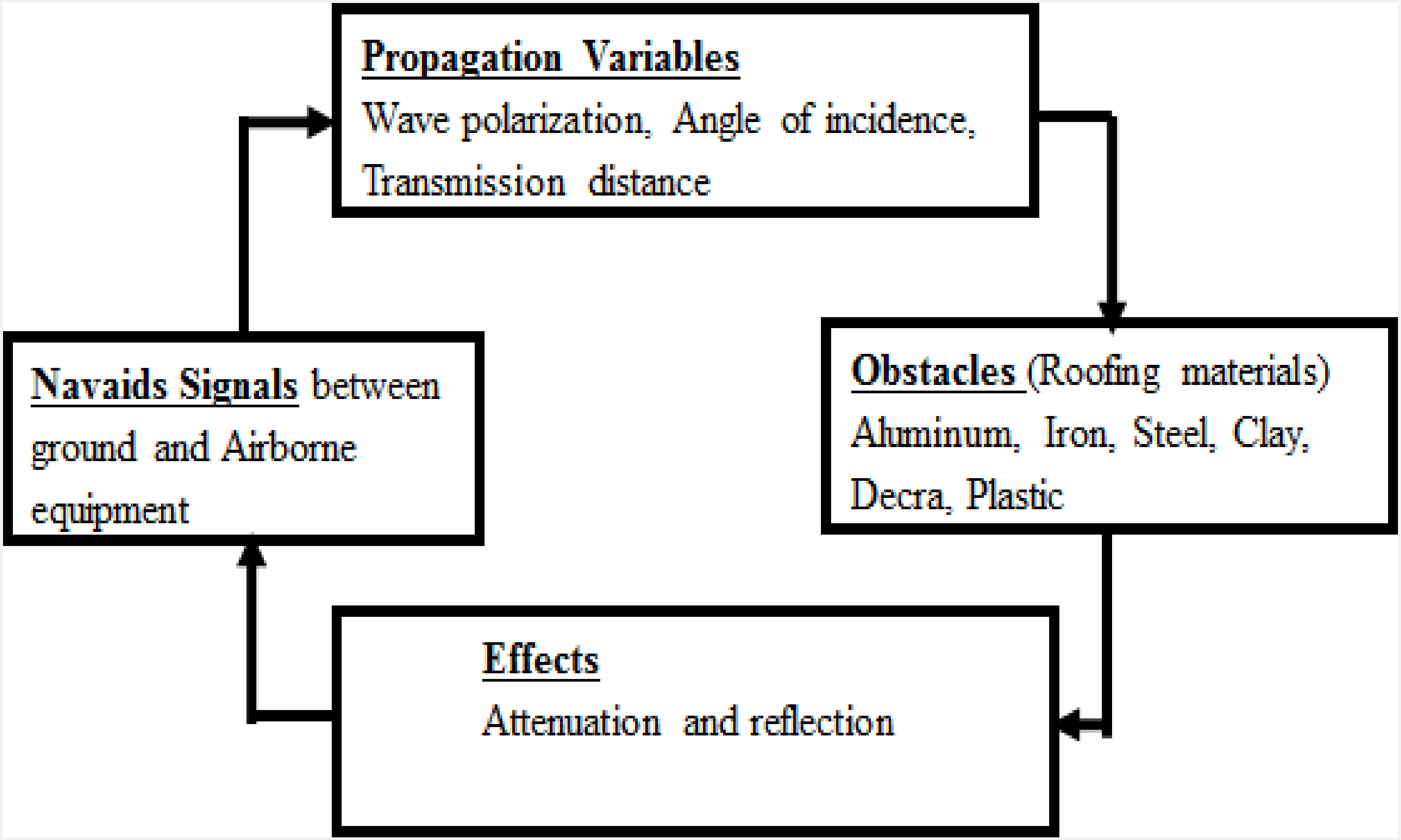
3. Roofing material effects; Attenuation and Reflection

4. The materials considered were Decra, Steel, Aluminum, Plastic, Clay and Iron.

Previous Studies

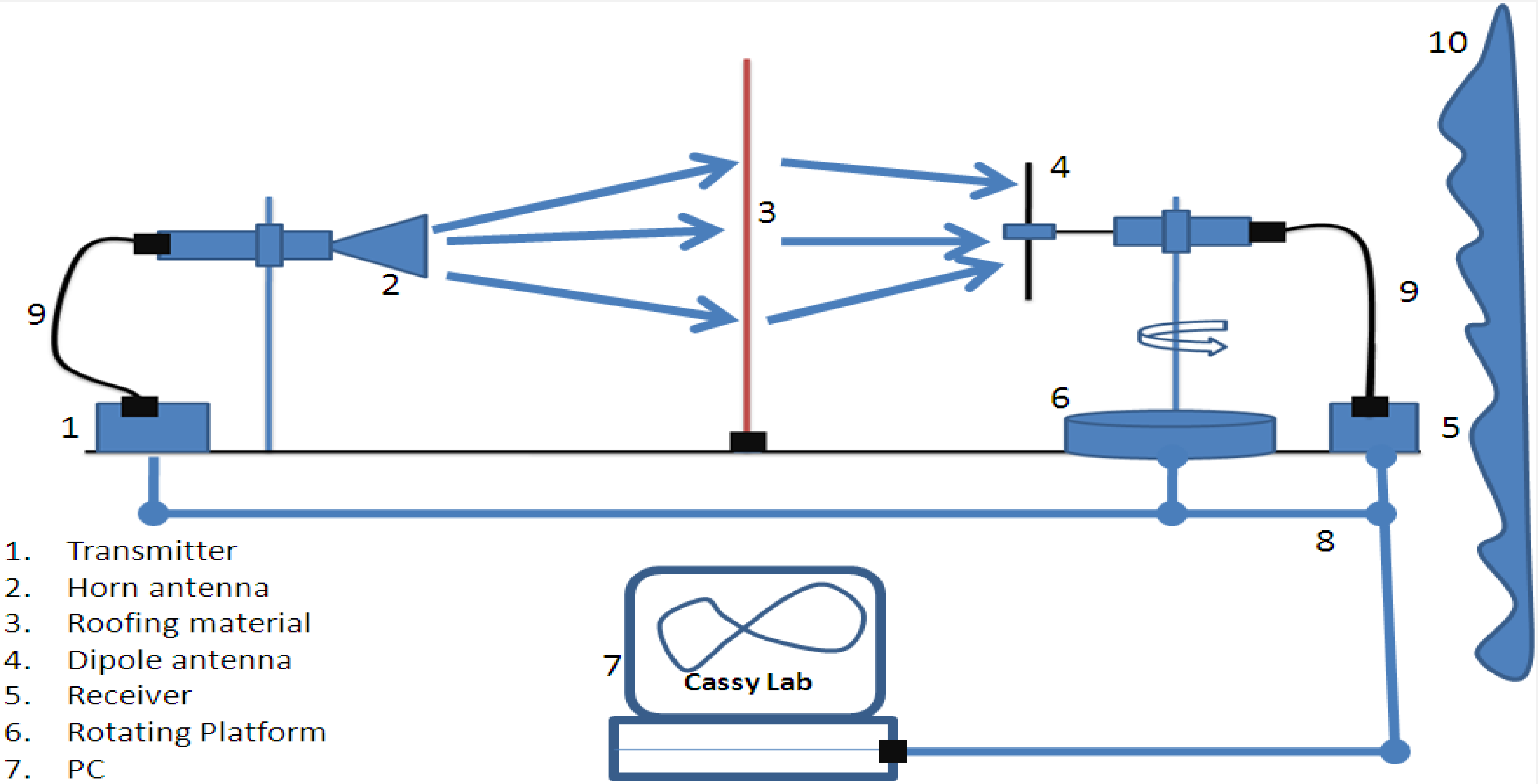
1. US NIST (1997), Pauli and Moldan (2008)
2. Marcum (2002)
3. Cortesi et al (2002)
4. Briginton (2010)
5. Chomba et al (2011a & b)

CONCEPTUAL FRAMEWORK



MATERIALS AND METHODS

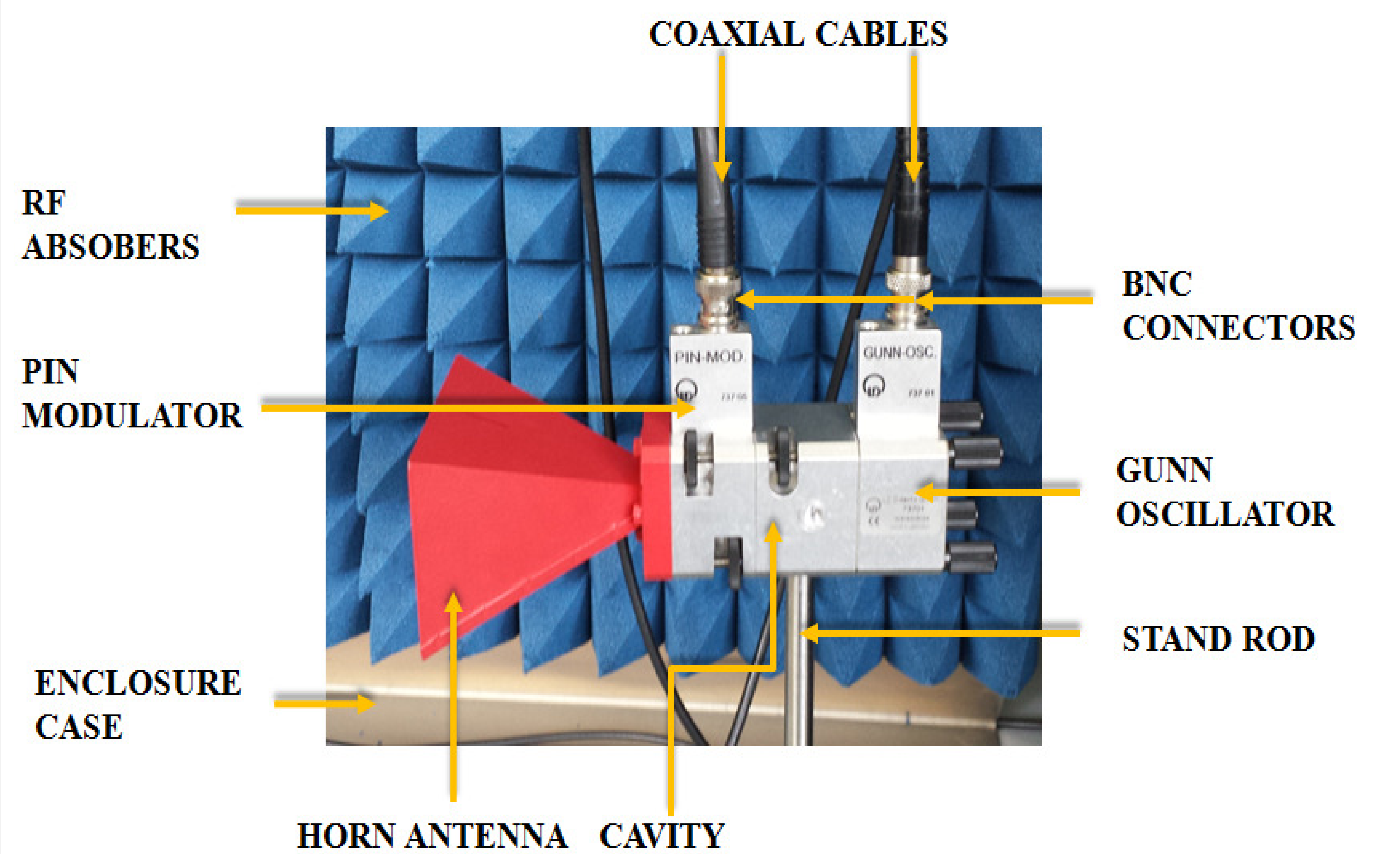
1. DESIGN (Transmission Path)



1. Transmitter
2. Horn antenna
3. Roofing material
4. Dipole antenna
5. Receiver
6. Rotating Platform
7. PC
8. Signal Cable
9. Coaxial cable
10. Microwave absorbers

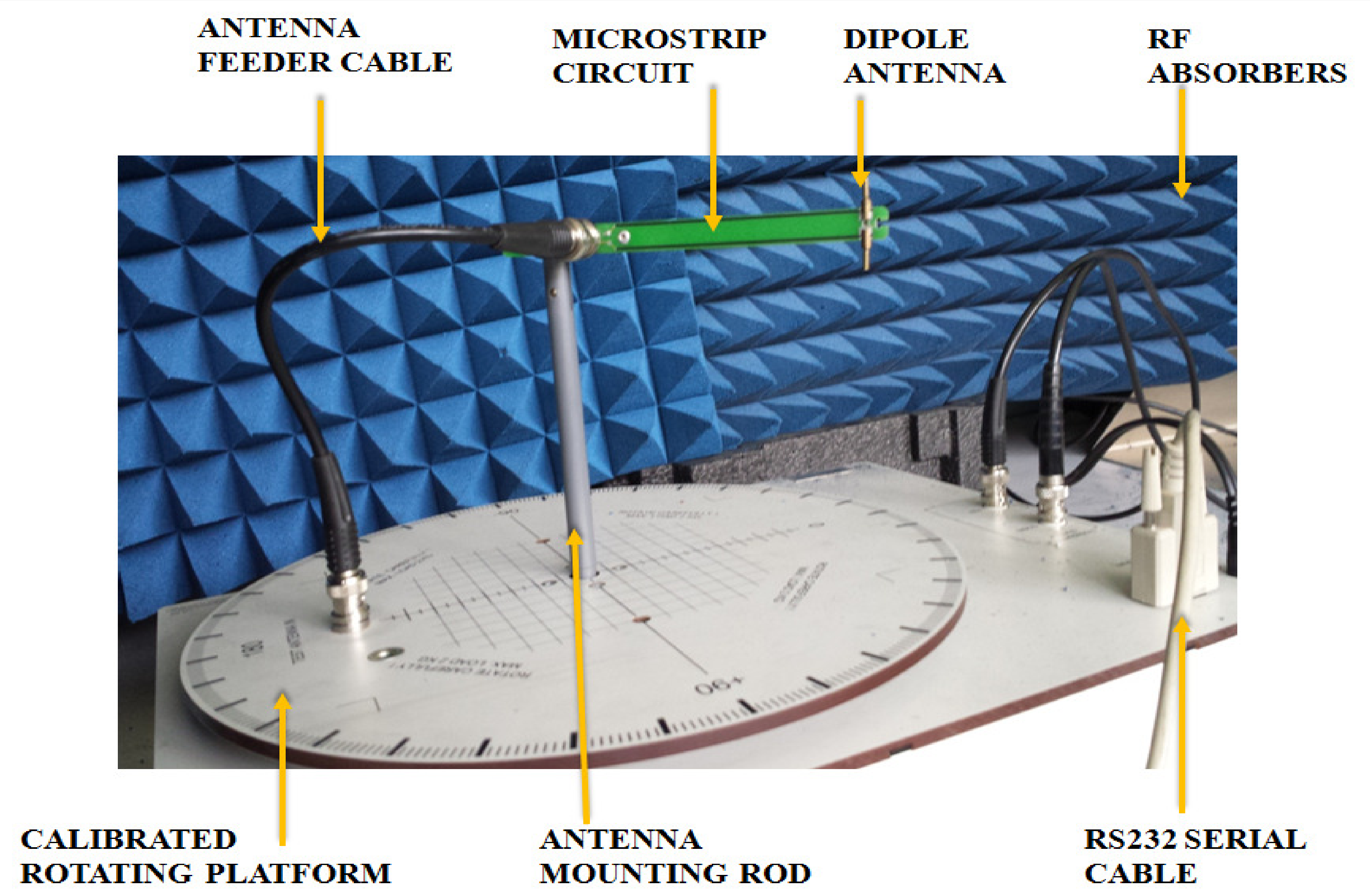
MATERIALS AND METHODS

2. RADIO TRANSMITTER ASSEMBLY



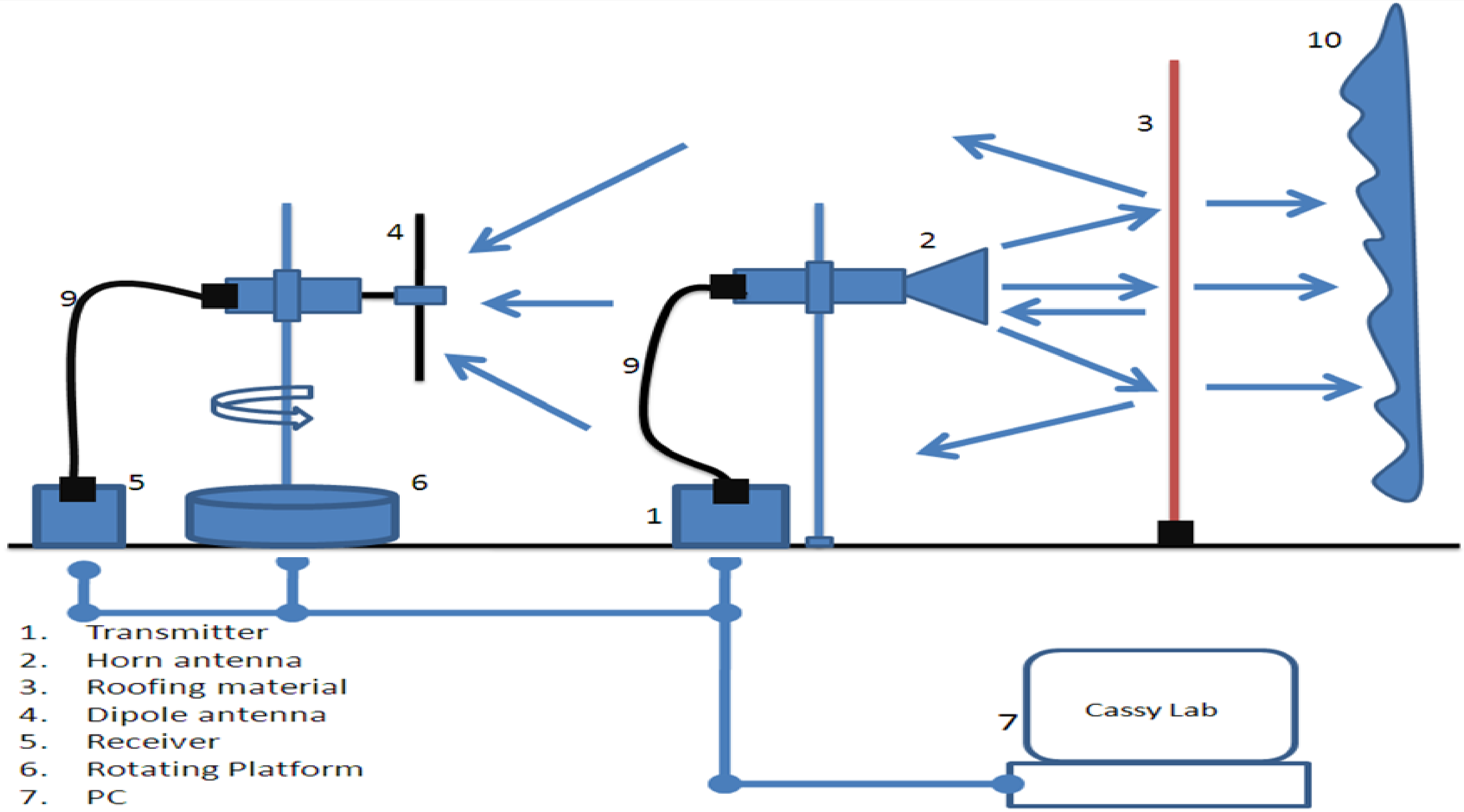
MATERIALS AND METHODS

3. RADIO RECEIVER ASSEMBLY



MATERIALS AND METHODS

5. DESIGN (Reflection Path)



1. Transmitter
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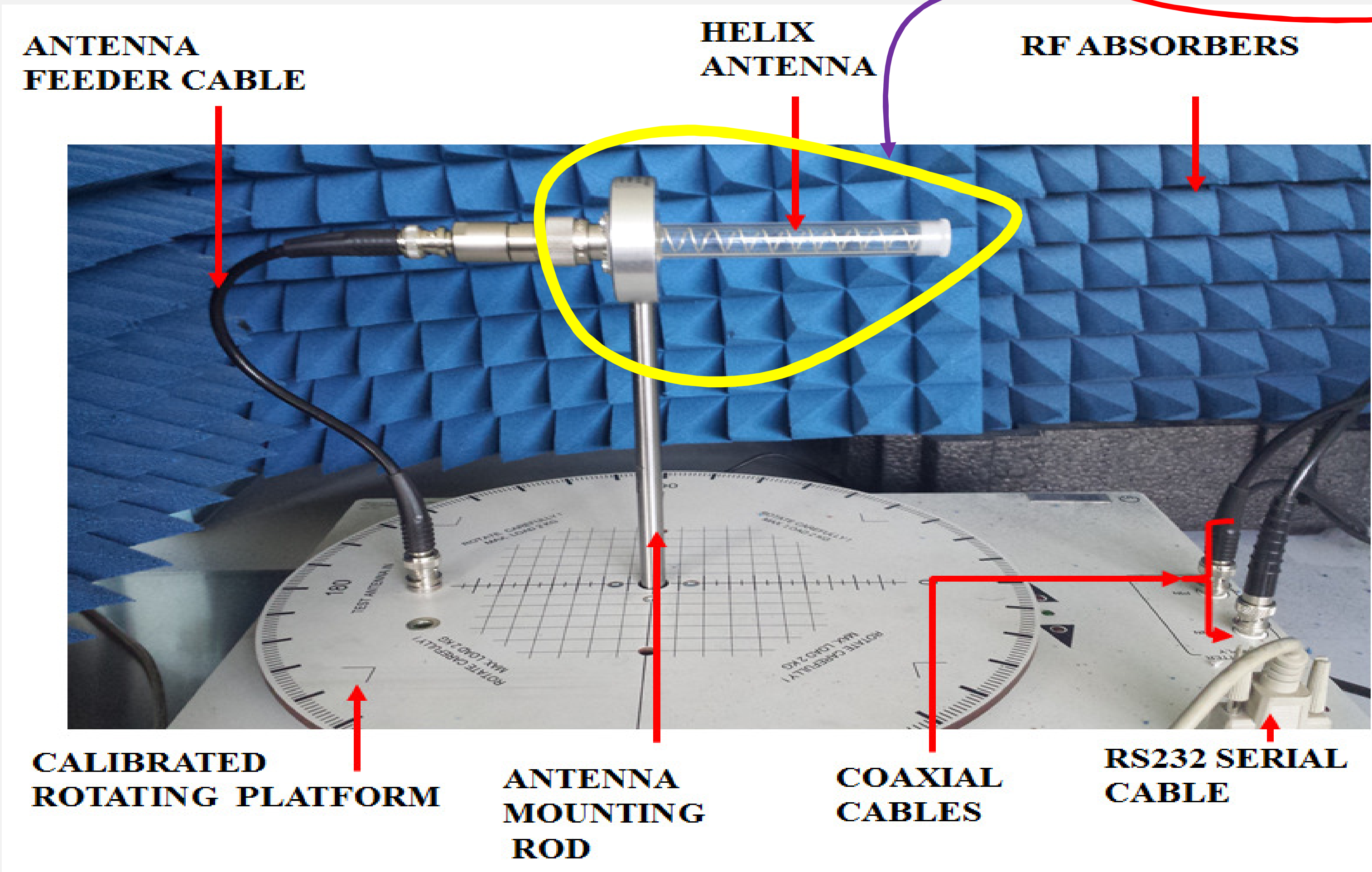
MATERIALS AND METHODS

7. MEASUREMENT OF TRANSMISSION DISTANCE

MATERIALS AND METHODS

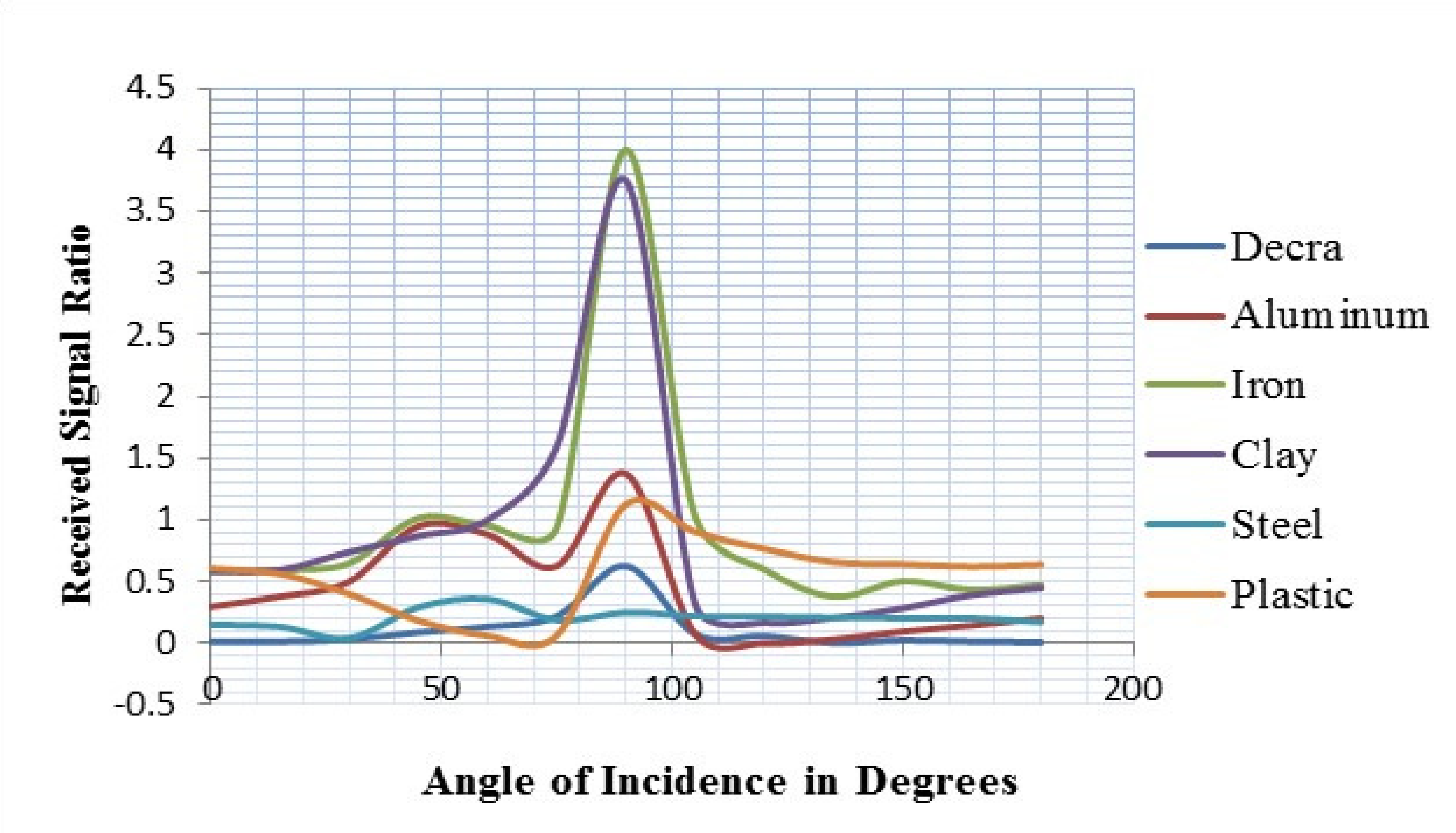
8. EFFECT ON WAVE POLARIZATION

Vertical, Horizontal or Circular orientation

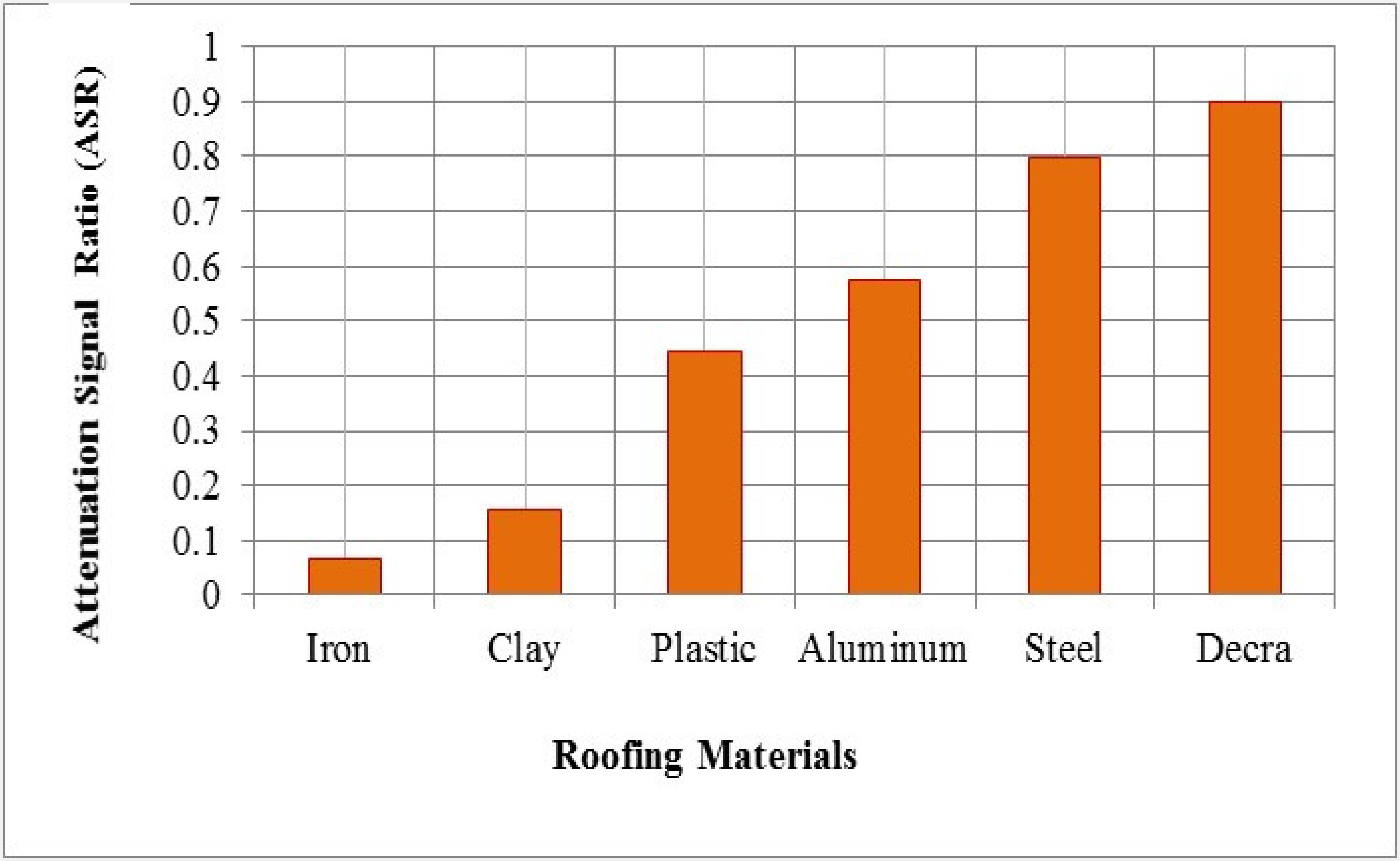


RESULTS AND DISCUSSIONS

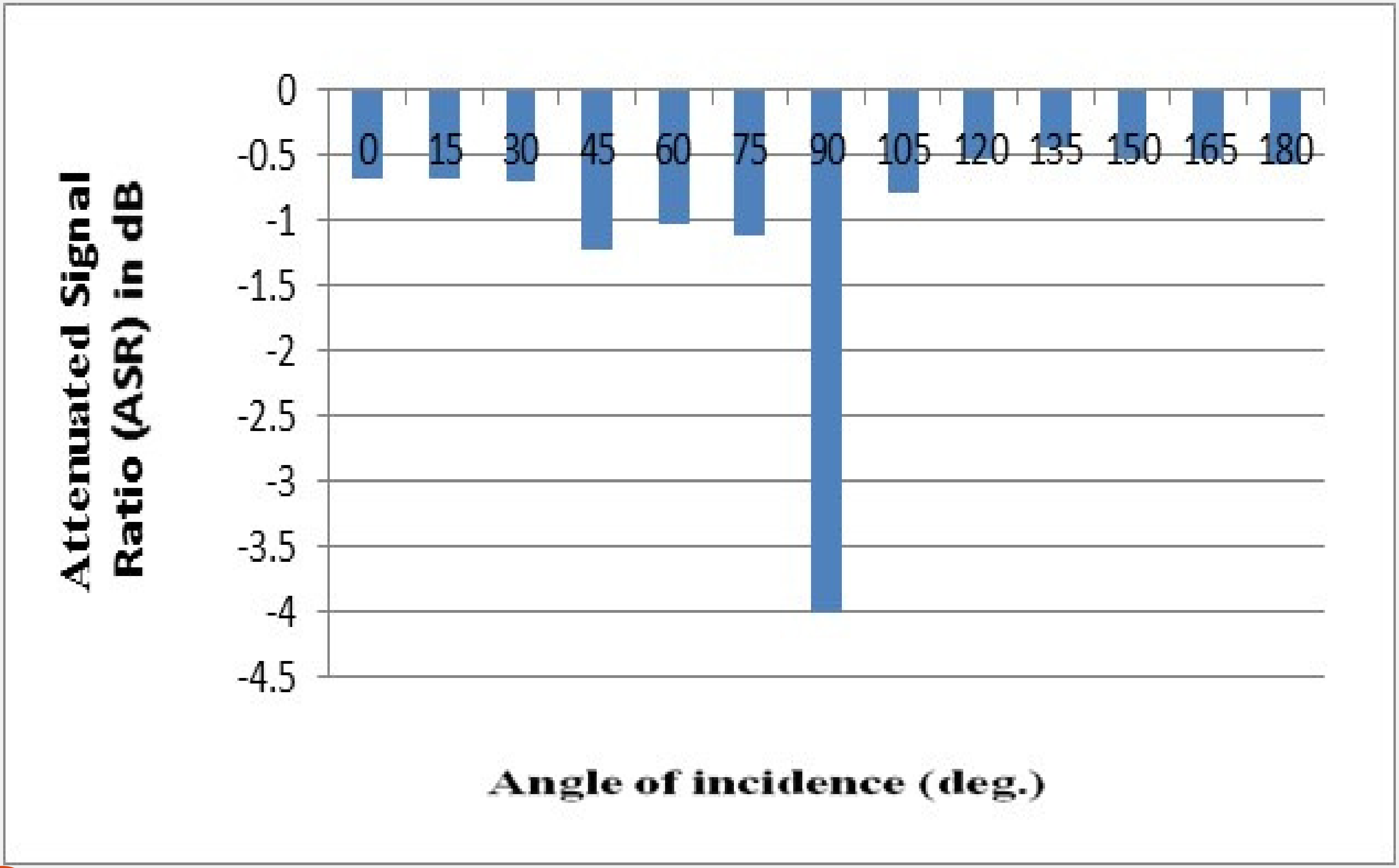
1. INTERACTION OF ROOFING MATERIALS AND ANGLE OF INCIDENCE IN TRANSMISSION PATH -RSR



4. EFFECTS OF ROOFING MATERIALS ON ATTENUATION (ASR) IN TRANSMISSION PATH



6. EFFECTS OF ANGLE OF INCIDENCE ON ATTENUATION (ASR) IN TRANSMISSION PATH



9. RSS IN THE TRANSMISSION PATH

Propagated Received Signal Strength RSS (dBmV/M)			
Materials	Mean	Max (90)	Min (135)
Decra	57.0	72.92	29.04
Steel	63.0	64.96	63.40
Aluminum	69.7	79.77	46.83
Plastic	72.0	78.02	73.35
Clay	75.5	88.48	63.24
Iron	76.4	89.04	68.48

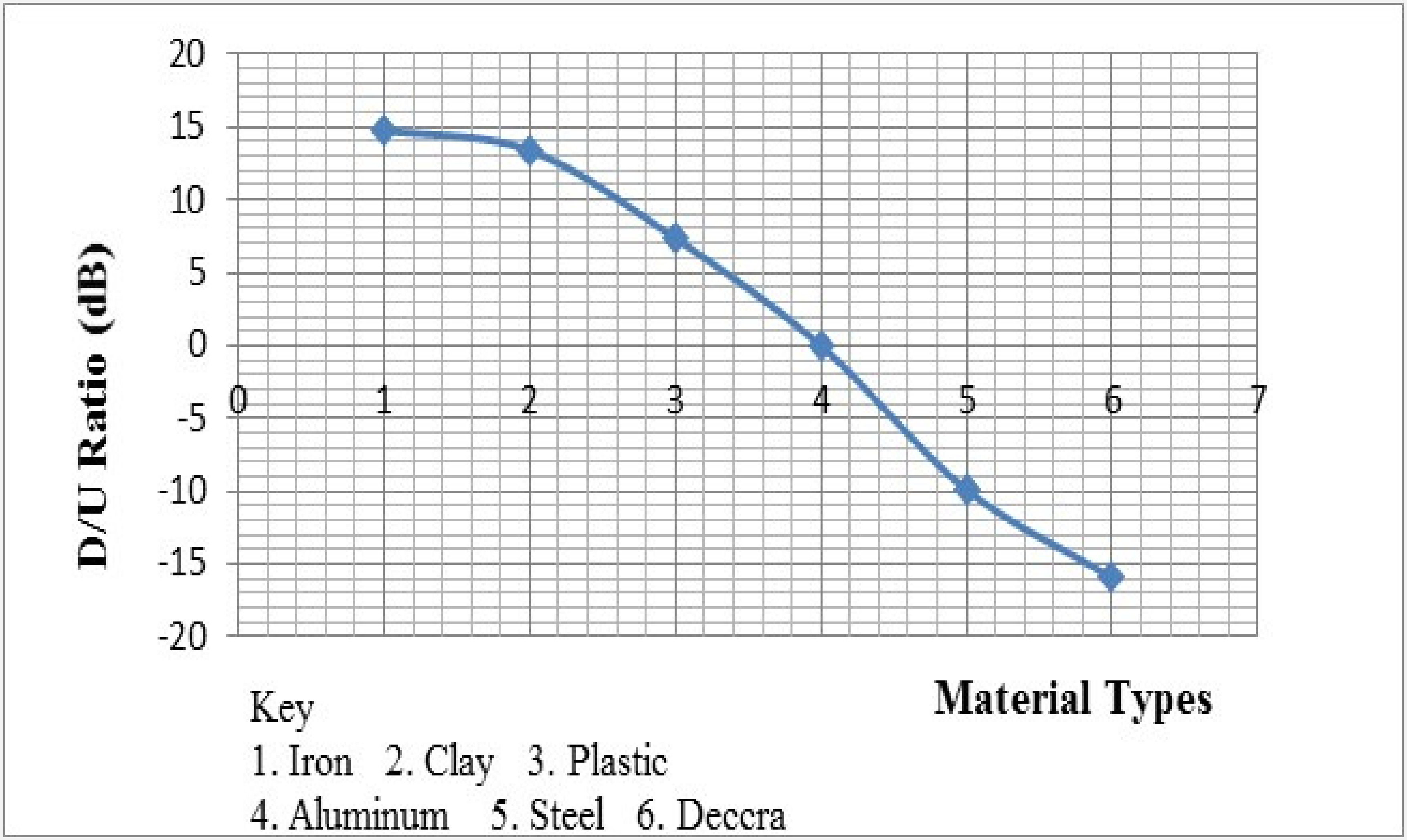
10. RSS IN THE REFLECTION PATH

	Reflected Received Signal Strength RSS (dBmV/M)		
Materials	Mean	Max (90)	Min (135)
Decra	73.01	80.52	69.32
Steel	73.03	86.54	65.82
Aluminum	69.65	83.02	52.42
Plastic	64.75	68.48	60.52
Clay	62.01	77.00	29.04
Iron	61.35	75.84	41.08

11. DESIRED TO UNDESIRED (D/U) RATIO

Materials	Iron	Clay	Plastic	Aluminum	Steel	Decra
PRSR	0.93	0.84	0.56	0.43	0.20	0.10
RRSR	0.17	0.18	0.24	0.43	0.63	0.63
D/U ratio	5.47	4.67	2.33	1.00	0.32	0.16
D/U (dB)	14.8	13.4	7.35	0.00	-9.90	-15.9

12. DESIRED TO UNDESIRED (D/U) RATIO



CONCLUSIONS

- **Decra roofing material offered highest attenuation but its mean received strength was 57dBmV/M which is well above ICAO recommended minimum of minus 28dBmV/M.**

- **Therefore roofing materials had no significant effect on navaids signal strength in the transmission path.**

CONCLUSIONS

- However decra and steel provided the highest reflected mean signal strength at 73dBm/V which translated to the lowest desired-to-undesired (D/U) signal ratio of minus 16dB which is far below the recommended value of 20dB.

- Therefore roofing materials have significant effect on navaids signal strength in the reflective path

Recommendations

1. Further studies should be directed in conducting experiments in open fields to actualize the scenario of flight navigation.

2. Studies to develop a compromise roofing material that has little effect on flight navigation should be undertaken

3. Similar studies should be conducted on roofing materials other than those considered in this research.

ACKNOWLEDGEMENTS

Thank You