Engineering Materials Arresting System (EMAS)

Contents

- Background
- What's EMAS
- R&D of EMAS
- Prospect of EMAS
- Conclusions

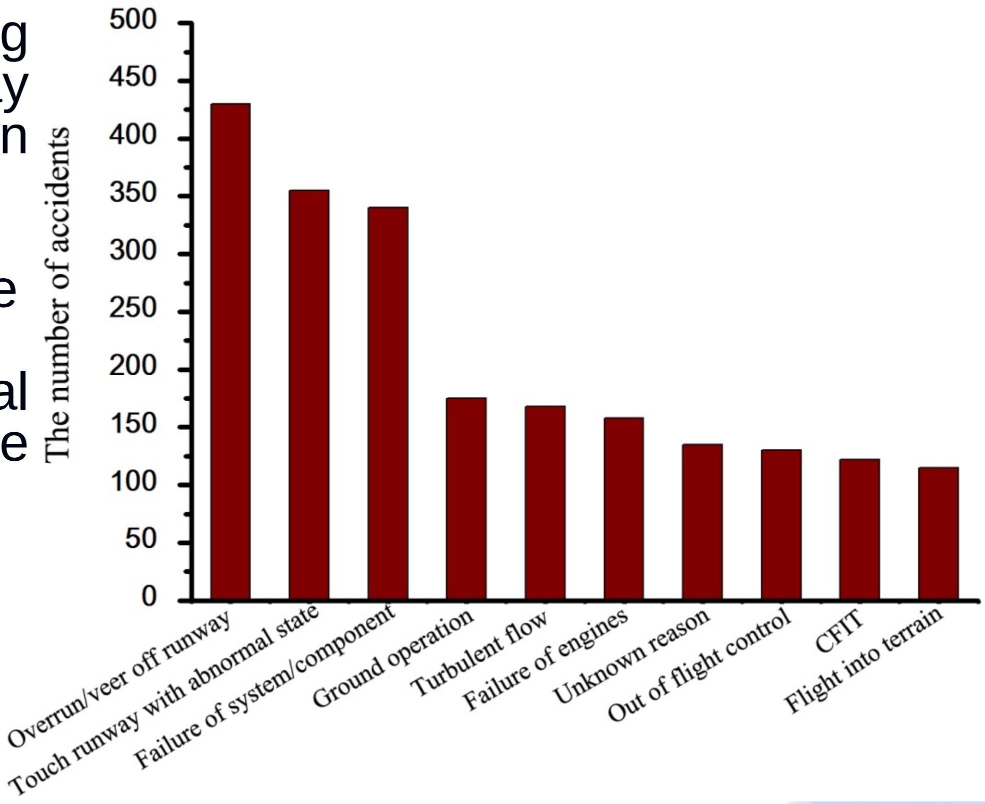
Background

Overrun/veer-off runway

◆ The number of accidents resulting from overrun/veer-off runway accounts for ca. 25% of all aviation transportation accident

◆ Occurring once a week on average

◆ Ranks at the top of severe potential accident statistic, both around the globe (1998-2007).



To be the Major Threat to Aviation Safety

Background

Disastrous consequence of Overrunning aircrafts

April 2013, in Phuket airport, an overrunning aircraft (B737) run into the sea, and its structure was severely damaged.

Dec 2009, 40 passengers were injured in an overrun runway incident of a B737 aircraft in Jamaica, and its fuselage structure was severely damaged.

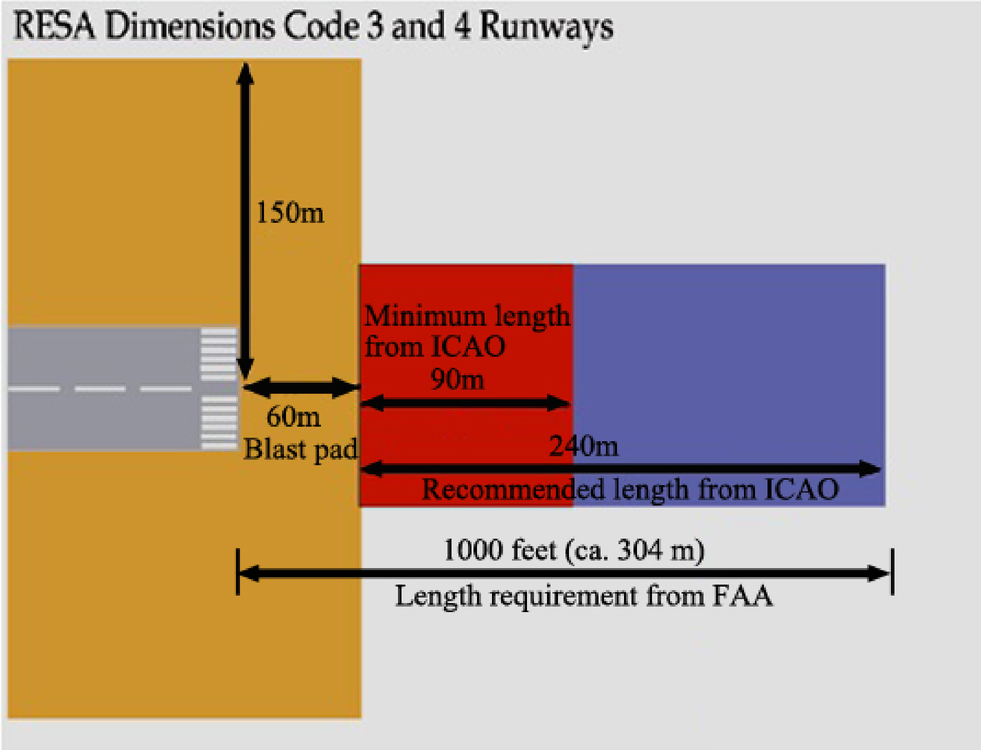
How to reduce the risks?

Background

General Solution:
To set up RESA with appropriate length

For code 3 and code 4 runways:

- ICAO: minimum length of RESA is 90 m;
- ICAO: recommend minimum length of RESA is 240 m.
- FAA: length requirement is 1000 feet (ca. 304m).



Background

Special Situations:

◆ RESA with sub-standard length, due to existing construction and natural obstacles (rivers, lakes or highway, etc)

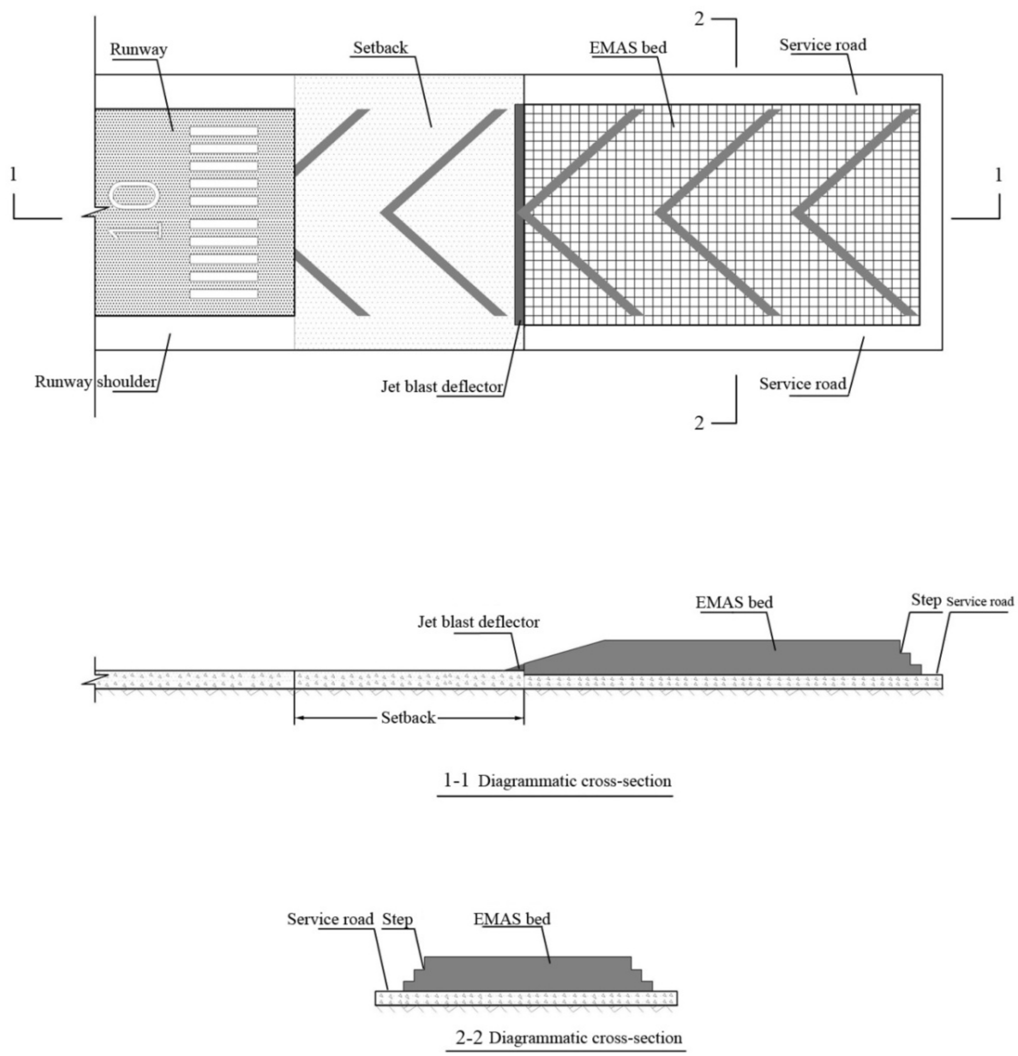
◆ RESA with minimum length, however, there are dangerous geography conditions beyond RESA (sea, cliff, residential area, etc.)

Devastating disasters of overrunning aircrafts

What to Do? Arresting Them!

What is EMAS?

◆**Purpose**: To obtain equivalent safety margin with 240m RESA.
◆**Role**: To decelerate aircrafts overrunning the runway.
◆**Location**: Laid at end of runway;
◆**Structure**: Consisting of setback, EMAS bed and service roads;



What is EMAS?

Arresting principle of EMAS

Overrunning aircrafts

Run into EMAS bed

Pressure from landing gears to EMAS materials

EMAS materials are crushed to absorb kinetic energy of the aircrafts

Aircrafts are gradually slowed down and arrested within EMAS bed

The safety of the passengers aboard and the structural integrity of the aircraft.

Video

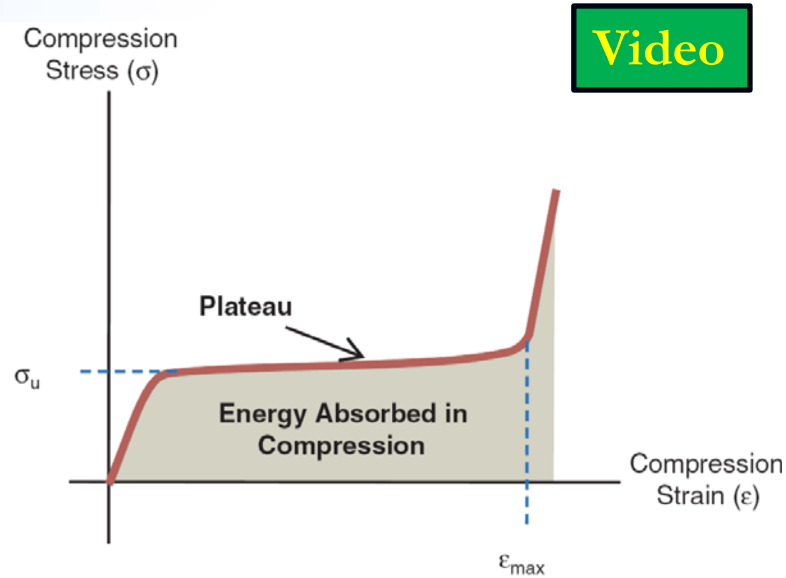


Fig. The stress - crushing curve of EMAS materi

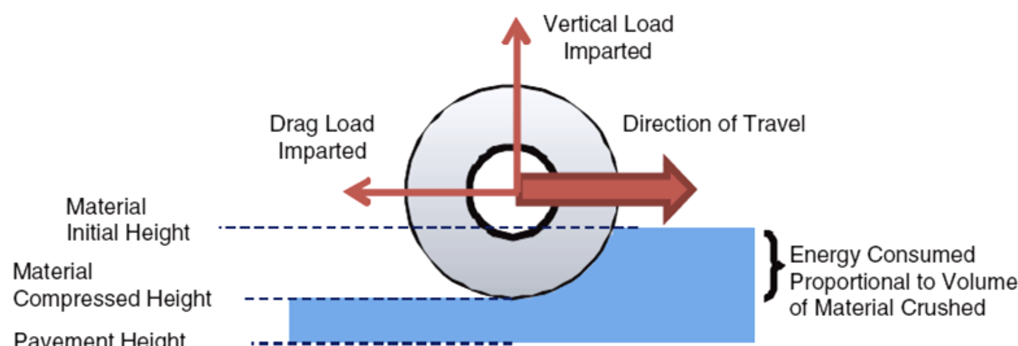
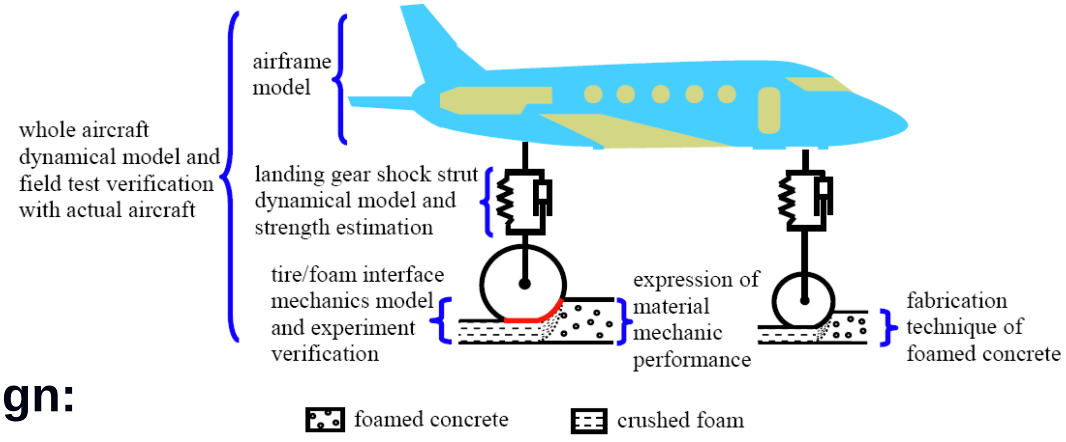


Fig. The crushing-energy absorption of EMAS materi

What is EMAS?

Key technologies of EMAS

- **EMAS materials technology:**
  - Mechanical property: Fitness, homogeneity, stability, etc.
  - Weatherability: UV, water, High and low temperature, salt fog, etc.
  - Service safety: Flame retarding, smoke density, toxicity, etc.



- **Simulation model for EMAS design:**
  - Input parameters: properties of EMAS materials, aircraft types, exit speed, etc;
  - Output parameters: Aircrafts’ speed decay curve, deceleration curve, stopping distance, loads imposed on landing gears, etc.

R&D of EMAS

Major EMAS Products: ESCO's EMAS and Hangke's EMAS

Items	ESCO' EMAS	Hangke's EMAS
Beginning of EMAS research	Ca.1990s	2010
EMAS standard	FAA AC 150/5220-22	FAA AC 150/5220-22 and Chinese EMAS industry standard (under review)
Approved by	FAA	CAAC
EMAS materials	Foam materials	Foam materials
The first application	JFK airport (1996)	Tengchong airport (2013)

Data obtained from open data from ESCO and Hangke company.

R&D of EMAS

FAA AC 150/5220-22 and Chinese EMAS industry standard

◆ Chinese EMAS industry standard is based on FAA AC 150/5220-22, and it covers all requirements items in the FAA AC.

Table. Brief introduction of main differences between two standards

Item	FAA AC 150/5220-22	Chinese EMAS standard
EMAS design	1.No specific design conditions; 2.No design margin; 3.No specific design consideration of set back;	1.Specific design conditions for standard/non-standard design; 2.Design margin of 10%; 3.To design setback on basis of jet blast resistance of EMAS;
Characteristics of EMAS materials	1.Qualitative requirements on EMAS; 2.No specific detection method; 3.No environmental protection requirements	1.Qualitative and quantitative requirements on various EMAS materials; 2. Specific detection method of various EMAS materials; 3.Adding environmental requirements

R&D of EMAS

FAA AC 150/5220-22 and Chinese EMAS industry standard

Table. Brief introduction of main differences between two standards

Item	FAA AC 150/5220-22	Chinese EMAS industry standard
Arresting performance verification	1.Either an actual aircraft or an equivalent single wheel verification test; 2.No specific test parameters and quantitative requirements; 3.No requirements on accuracy of simulation model;	1.Both of actual aircraft verification tests and equivalent single wheel verification tests; 2.Specific test parameters (test times, aircraft type, exit speed, etc.) 3.Relative error of below 10% between calculated and measured values of stopping distance.
Installation and maintenance	No specific installation /acceptance / maintenance requirements.	Specific installation /acceptance / maintenance requirements during overall EMAS project

Chinese standard presents stricter, specific and quantitative requirements during overall EMAS project.

R&D of EMAS

Arresting performance of ESCO's EMAS and Hangke's EMAS

	Item	ESCO' EMAS	Hangke's EMAS
Actual aircraft verification test	Aircraft type	B727	B737
	Speed running into EMAS bed	55 kn	Three ranges of 20 kn~30 kn, 40 kn~50 kn, and above 60 kn
	Times	1	6
	Damage of landing gears	Collapsed	Safe
	Errors of simulation model	6.3%	Between 0.4% - 6.7%, average 3.6%
	Jet blast resistance	No verification	Undergo the maximum jet blast speed of 332 MPH for 60 s
	Safety of passengers	Safe	Safe. No excessive loads imposed on manikins.
Arresting case	Times	8	0
	Specific parameters	No	-----

Detail test data chain will ensure service safety of EMAS.

Data obtained from open data from ESCO and Hangke company.

R&D of EMAS

Arresting performance of ESCO’s EMAS and Hangke’s EMAS

Fig. Equivalent single wheel load verification tests

Fig. Actual aircraft verification tests

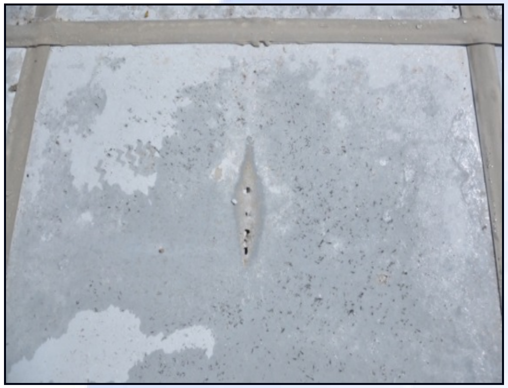
Fig. Assessment of passenger safety during arresting

Data obtained from test reports of Hangke company.

R&D of EMAS

Problems of installed EMAS

Aging of covers



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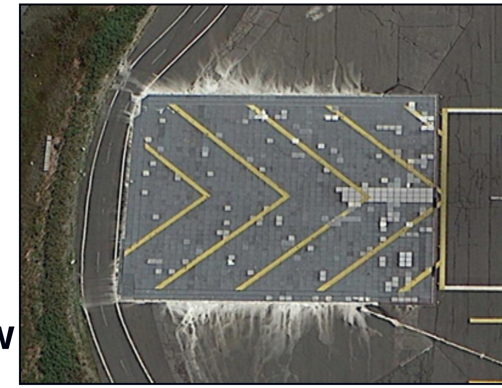
Sealing failure

- **Water**
- **Frozen-thaw**
- **Etc.**

Pulverization of EMAS materials



- Unreliable arresting performance;
- Life reduction of EMAS;
- Frequent maintenance needs;

- High cost;
- Influence on airports operation

Data obtained from Jiuzhaihuanglong airport and ACRP report 29.

R&D of EMAS

Technology innovations of Hangke's EMAS

Covers coating

◆ Great resistance property against UV radiation;
◆ Maintained easily through a non-disassembly and non-replacement way.

Sealant materials

◆ Great resistance properties against UV radiation;
◆ No ponding on the EMAS bed;
◆ Great sealing property.

Waterproofness of entire EMAS materials

◆ Great hydrophobic;
◆ Poor water absorption;
◆ Great Freeze-thaw resistance.

- ☐ **Upgrade the weatherability and service life of EMAS;**
- ☐ **Reduce the service cost of EMAS.**

Data obtained from on-site survey in Hangke company.

Prospect of EMAS

- **USA:** 14 CFR Part 139 (Airport Certification) indicates that if economic feasibility and be failed to prolong RESA length to 1000 feet, it is necessary for the airports to install EMAS.
- **ICAO:** Annex 14 (Volume Ⅰ, 2013) presents that if an arresting system is installed, the length of RESA may be reduced, based on the design specification of the system, subject to acceptance by the State.
- **China:** CAAC has been pushing the development of EMAS in china. In May 2013, the management document (No. CA-2013-53) indicated that six airports should finish EMAS projects in the "12th 5 year plan", and then EMAS will also be set up in other 14 airports.

Conclusions

◆EMAS with reasonable cost could enhance airport safety margin, especially for the airports with sub-standard RESA or dangerous geography conditions.

◆Based on great performance of EMAS and policy support, EMAS has very good application prospect.