Research on Damage Assessment Method Based on Practical Training

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Abstract. In recent years, more and more attention has been paid to practical training. Damage assessment in practical training is an important research content, which is different from ordinary damage assessment. In the process of practical training, time is tight and data acquisition is limited, so damage assessment is more difficult. In this paper, a damage assessment method based on practical training is proposed, which includes standards and specifications establishment, system software development, practical training data measurement, ammunition manual development. The standards and specifications include target vulnerability evaluation criteria, ammunition warhead power and damage effect evaluation criteria, and weapons and ammunition damage effectiveness evaluation criteria. The system software includes weapon and ammunition damage effectiveness test system, weapon and ammunition test data information management system and weapon and ammunition damage effectiveness evaluation system. Practical training data measurement involves establishing and improving the damage effect test mechanism of actual combat training, carefully planning the damage effect test activities of actual combat training, and scientifically carrying out the damage effect test of actual combat training. The ammunition manual development requires comprehensive analysis of research results at home and abroad, full use of actual training data, close to the combat and training needs of the army, and ensure the innovation, credibility and practicability of the manual.

Keywords: Practical, training, damage assessment, standards and specifications, data measurement

1 INTRODUCTION

Damage assessment is the evaluation and estimation of the damage ability of weapons and ammunition and the damage effect of targets. It is widely used in weapon and ammunition index demonstration, performance test, state identification, train and equipment finalization, combat test and in-service assessment, as well as the determination of ammunition production and mobilization capacity scale, ammunition procurement, reserve base formulation, battlefield construction and target protection, combat use and other links in the whole life cycle of weapons and equipment. It is to realize the innovative development of weapons and ammunition Reasonable procurement and storage, accurate allocation and accurate use are the basis and key. In recent years, the whole army has made great efforts to strengthen combat

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training, and the combat drills of real ammunition against various typical targets are increasing day by day. At the same time, military enterprises, relevant institutes and other units have cooperated with combat training activities, carried out the test and evaluation of real ammunition damage effect data, and obtained a large number of ammunition damage effect test data, it has laid a solid foundation for the scientific evaluation of the damage effectiveness of weapons and ammunition. Therefore, it is of great practical significance to carry out real-time acquisition, effective management, in-depth mining and accurate evaluation of real ammunition damage effect data under the guidance of practical training, scientifically use advanced technical means, make full use of practical training damage effect data, verify the numerical calculation model and simulation technology method of damage evaluation, and carry out weapon and ammunition damage evaluation. [1-4]

2 THE PREPARATION OF STANDARDS AND SPECIFICATIONS IS THE BASIC BASIS FOR DAMAGE ASSESSMENT

Damage assessment includes target vulnerability assessment, ammunition warhead power and damage effect assessment, weapon and ammunition damage effectiveness assessment, etc. The connotation and requirements of each type of assessment are different. Therefore, it is necessary to establish unified standards by categories to standardize damage assessment. [5]

2.1 Target vulnerability assessment criteria

Target vulnerability assessment is to evaluate and estimate the degree of difficulty of target being damaged by attack. Generally, the target is divided into several components or subsystems according to its structural characteristics or functional units, and the target damage tree is established according to the importance of each component or subsystem to the function of the target system; According to the damage degree of each component or subsystem, resulting in the loss of the function of the target system, and the evaluation and estimation of the recovery time of the function of the target system due to the repair of the component or subsystem structure, the target vulnerability evaluation model is constructed; According to the vulnerability model of the target system, the damage standard of the target system is obtained through theoretical calculation, analysis and experimental verification. [6]

Target vulnerability assessment standards mainly include: target vulnerability assessment method, test and measurement specification, target damage standard and target equivalence criterion, etc. Among them, the target damage standard consists of damage task (destroy, suppress, damage), damage level (severe, moderate, mild), damage index (probability or expected value), criterion (function loss and repair time), damage criterion (damage threshold), etc.

2.2 Evaluation criteria for power and damage effect of ammunition warhead

The power and damage effect evaluation of ammunition warhead is the evaluation and estimation of the inherent ability of warhead to damage or produce other effects on typical targets. The purpose is to construct the power field of ammunition warhead through the numerical calculation method formed by the structure, material and damage mechanism of

ammunition warhead, or the power calculation method formed by the fitting of test data; Based on this, the evaluation method of target / equivalent target damage law (damage level and corresponding damage range) and relevant test specifications of ammunition warhead under typical missile target intersection conditions are established.

The evaluation criteria of ammunition warhead power and damage effect mainly include: power field evaluation / construction method, target / equivalent target damage standard (damage level and corresponding damage range) evaluation and determination method, power field static and dynamic explosion test method and test specification, etc.

2.3 Evaluation criteria for damage effectiveness of weapons and ammunition

The damage effectiveness evaluation of weapons and ammunition is the evaluation and estimation of the ability of weapons to damage targets by comprehensively considering the performance of weapons system, the power of ammunition warhead, target vulnerability, missile target intersection conditions, damage indicators, fire use mode and use environment. The purpose is to build a method (model) for evaluating the target damage effect of weapons and ammunition under various combat conditions through theoretical analysis, and build a simulation system for the damage effectiveness of weapons and ammunition through experimental verification. On this basis, compile the ammunition damage effectiveness manual, or provide technical and data support for the combat command information system (fire planning system). [7]

The evaluation criteria of weapon and ammunition damage effectiveness mainly include: damage effectiveness evaluation method, damage effectiveness test specification, etc.

3 SYSTEM SOFTWARE DEVELOPMENT IS AN EFFECTIVE MEANS OF DAMAGE ASSESSMENT

Damage assessment is a complex system engineering. Only with the help of advanced technical means can damage assessment be carried out efficiently in practical training. Focusing on the damage evaluation of practical training, the focus is to do a good job in the development of "test, analysis and evaluation" and other systems.

3.1 Weapon and ammunition damage effect test system

According to the actual combat training damage effect test task requirements, carry out system design and Optimization in the aspects of test accuracy, automation and rapidity of data processing, simplicity, reliability and complex environment adaptability of test process operation, develop weapon and ammunition damage effect test system, strengthen system integration and intelligent function expansion, and meet the needs of diversified multi missile support, Quickly obtain the live ammunition training process and strike effect data, meet the requirements of typical target damage effect test in different regions and different ammunition types under various weather conditions, and provide an effective means for actual training damage effect test.

The weapon and ammunition damage effect test system is usually composed of subsystems such as situation awareness, trajectory tracking calculation, ammunition power and damage

effect image test, target damage effect rapid evaluation, data fusion and comprehensive demonstration, integration and support. The situation awareness subsystem mainly includes meteorological environment information acquisition, target data and image acquisition in the shooting range, real scene three-dimensional rapid reconstruction and battlefield situation information management; The trajectory tracking and calculation subsystem mainly includes two-dimensional active tracking multifunctional radar, infrared TV tracking and high-speed photography of trajectory end point; The image test subsystem of ammunition power and damage effect mainly includes modules such as ammunition power field test, target damage effect image test, analysis and calculation, etc; The rapid evaluation subsystem of target damage effect mainly includes power field reconstruction, target action calculation, comprehensive evaluation of target damage effect and so on; The data fusion and comprehensive demonstration subsystem is mainly based on the three-dimensional digital map of the shooting range, which fuses and displays the ammunition trajectory image, the comparison image before and after target strike, and the calculation results of ammunition end parameters respectively. The images can be played slowly, compared and played, and transmitted to relevant terminals according to the demand; The integration and support subsystem mainly integrates the above subsystem displays and relevant control equipment, data fusion equipment, large screen displays and relevant personnel consoles into 3 ~ 5 retractable deformable shelter vehicles, and is equipped with power supply, air conditioning, maintenance tools and materials required for life. [8]

3.2 Weapon and ammunition test data information management system

With the in-depth promotion of practical training, the damage effect test data of real ammunition are accumulating. In order to realize the scientific management of all elements, whole process and whole life of data information, it is necessary to develop a weapon and ammunition test data information management system to support the collection, warehousing, integration, analysis, processing, mining and utilization of damage effect test data of practical training, It provides a basis for evaluating the quality and level of military training and creates conditions for damage assessment.

Weapon and ammunition test data information management system is usually composed of basic data, test data, damage effect evaluation data, document data, statistical analysis and system management. Basic data mainly include general overview, participating troops, training courses, basic situation of shooting range, targets and damage standards, test equipment and evaluation experts; The test data mainly include terminal trajectory test, power field test, damage effect test and other data; The damage effect evaluation data mainly includes expert target scoring evaluation, end parameter calculation evaluation, power test result evaluation, image analysis evaluation and other data; Documents and data mainly include task documents, notices, meeting minutes, work summary, technical summary, evaluation report, analysis report and other data; Statistical analysis provides the function of statistical analysis on the key data of drill activities, which can carry out statistical analysis according to the damage effect, impact point dispersion, etc. according to the activity code, force number, aircraft model, ammunition model, target name, etc., and draw relevant pie charts and histograms to visually display the statistical results; System management mainly includes system user management, data management and operation management. [9]

3.3 Weapon and ammunition damage effectiveness evaluation system

Based on the statistical analysis of the test and evaluation data of actual combat training damage effect, master the laws of ammunition drop point dispersion, drop angle and drop speed under different combat environment conditions, analyze the damage effect of weapons and ammunition on targets, verify the damage effectiveness evaluation model, and develop the damage effectiveness evaluation system of weapons and ammunition by using military operation research theory and computer simulation technology, Carry out the damage effectiveness evaluation of weapons and ammunition against typical targets, lay the foundation for the research and compilation of the damage effectiveness Manual of weapons and ammunition, and provide effective means for the troops to use military weapons scientifically.

Weapon and ammunition damage effectiveness evaluation system is usually composed of basic data management, typical target construction, damage effectiveness evaluation and system management. Basic data management mainly includes weapon platform database, ammunition database, target database, damage effect database, etc; The typical target construction module mainly includes two-dimensional (three-dimensional) graphics construction of point (single) target, area (Group) target, line (airport runway) target and so on; The damage effectiveness evaluation module is divided into two methods: analysis and simulation. It mainly uses the change law of various factors affecting the assault effect to predict the assault effect under a certain force or calculate the number of forces required to achieve a certain expected assault effect according to the target type, shooter's technical level, weapons and other assault conditions; The system management function module includes three parts: system user management, data management and operation management.

4 LIVE AMMUNITION DATA MEASUREMENT IS AN IMPORTANT BASIS FOR DAMAGE ASSESSMENT

Damage evaluation needs a large number of actual training and damage effect test data. Therefore, combined with the annual actual combat training task, it is necessary to regularly carry out the damage effect test of live ammunition, and collect the damage effect data of different types of ammunition and types on typical targets, so as to provide quantitative basis for damage evaluation.

4.1 Establish and improve the damage effect test mechanism of practical training

Damage assessment is not only a research activity involving a wide range of disciplines, a wide range of applications and close relationship, but also an experimental and highly consumptive practical activity. Since the 13th five year plan, combined with the air force's "red sword", "golden dart", "precision", "aviation dart" and other practical training activities, we have carried out the damage effect test and evaluation of live ammunition, which has laid a foundation for damage evaluation. However, the damage effect test mechanism of practical training has not been formed, which restricts the effective promotion of damage evaluation. Therefore, in order to make full use of limited resources, we should establish a working mechanism that can effectively coordinate military organs, combat forces and military enterprises, make full use of the annual actual combat training activities of the army, obtain the damage effect test data of live ammunition as much as possible, provide quantitative basis

for damage assessment, and ensure that the damage assessment work is close to the actual combat training of the army.

4.2 Carefully plan the damage effect test activities of practical training

Guided by the preparation for military struggle, according to the operational tasks in the main direction and damage assessment requirements, combined with the experience of damage effect test and damage assessment of practical training, actively participate in the organization and planning of troops' practical training activities, realize the in-depth integration of military and civilian, and improve the effectiveness of troops' practical training and the level of deep training and intensive training ability. First, participate in the formulation of target system construction scheme. According to the actual training requirements, ground target design specifications, combined with the geographical location and conditions of the specific shooting range, put forward the design scheme of the target system required for the actual training, which can not only reflect the basic characteristics of the target system, but also be convenient, feasible and economical, and give the damage effect evaluation method and standard of the target system, Improve the pertinence of practical training and the effectiveness of damage assessment. Second, participate in the formulation of Firepower Strike plans. According to the target system construction scheme formulated, combined with the target system and the basic characteristics of the target, according to the damage performance of the ammunition to be used, through analysis and calculation, the fire attack scheme and damage effect evaluation method are given, which lays a foundation for the damage effect evaluation of practical training. [10]

4.3 Scientifically carry out actual training damage effect test

According to the annual actual combat training plan of the army, technical methods such as photoelectric tracking, information perception, artificial intelligence, data mining and damage evaluation are adopted to scientifically carry out the damage effect test and evaluation of actual combat training. Collect, process, analyze and store the damage effect test data, and evaluate the damage effect of weapons and ammunition by combining the damage effect calculation and evaluation based on end parameters, image analysis and evaluation based on image comparative analysis and expert target detection scoring evaluation, so as to provide a basis for objectively evaluating the quality and level of actual combat training of the army, It lays a foundation for damage assessment and provides support for the development of weapon and ammunition damage effectiveness manual.

5 THE COMPILATION OF AMMUNITION MANUAL IS THE FUNDAMENTAL PURPOSE OF DAMAGE ASSESSMENT

The ultimate purpose of damage assessment is to develop a weapon and ammunition damage effectiveness manual that can be used flexibly and conveniently by command organs and troops, provide effective means for command organs to formulate fire attack plans, calculate assault forces and predict assault effects, and play a direct normative and guiding role in determining assault methods, selecting and using ammunition and improving assault effects.

Therefore, the research and compilation of weapons and ammunition damage effectiveness manual must pay attention to innovation, credibility and practicability.

5.1 Comprehensively analyze the research results at home and abroad and strive for innovation in content

Deeply analyze and study foreign military materials such as the joint ammunition effectiveness manual of the US Army and the operational use guide of aviation damage weapons of the Russian army, and absorb their useful experience and methods. Summarize China's research achievements in this field, learn from each other's strong points and complement each other's weaknesses, carry out research on weapon and ammunition damage evaluation by using actual combat training damage effect test and evaluation data, focus on making breakthroughs in missile signal coordination, missile target matching, parameter acquisition and effectiveness evaluation, and develop weapon and ammunition damage effectiveness manual and supporting software, Innovate the contents and methods of weapon and ammunition damage effectiveness manual.

5.2 Make full use of actual training data to improve the credibility of the manual

According to the test data of actual combat training damage effect, the damage effect of ammunition on typical targets and the damage efficiency evaluation of weapons and ammunition are carried out. Ensure that the basic data, theoretical methods and empirical formulas are obtained on the basis of a large number of research and demonstration and statistical analysis of practical training data, so as to improve the confidence of weapons and ammunition damage effectiveness manual.

5.3 Stick to the combat and training needs of the force and highlight the practicability of the manual

The core of weapon and ammunition damage effectiveness manual is to solve the problem of how to make rational use of troops and weapons in operation and training. Therefore, it is necessary to analyze and study the active main war ammunition and its supporting fuzes according to the requirements of military struggle preparation and combined with the army's mission and tasks, so as to give full play to the operational efficiency of weapons and ammunition; Analyze and study the basic characteristics of typical targets, such as composition, function, structure and vulnerability, and make rational use of weapons and ammunition; Based on the statistical analysis and theoretical calculation of the damage effect data of practical training, combined with the use experience of the same type of ammunition abroad, and according to the requirements of different damage degrees, calculate the tactical damage area, damage radius and average necessary hit bullets of the active main war ammunition against typical targets, and compile the damage effect parameter table of the main war ammunition against typical targets; Calculate the damage effect or required force of weapons and ammunition against typical targets according to weapon launch conditions, ammunition hit accuracy and typical target characteristics, and draw curves or lists; According to the combat and training needs of the army, summarize the actual combat training experience and damage evaluation research results, and develop a weapon and ammunition damage effectiveness manual and its supporting software that can be used flexibly and

conveniently for the army, so as to improve the combat capability and planning level of the army.

6 SUMMARY

This paper proposes a damage assessment method based on practical training, including standard specification preparation, system software development, live ammunition data measurement, ammunition manual development and so on. Doing a good job in these aspects will effectively improve China's damage assessment capability and better support the development of relevant equipment.

REFERENCES

[1] Li Lei, Shi Quan, Li Bing, Ji Lijuan, Zhang Wei. An Evaluation Method for Functional Damage of Complex Equipment. Journal of Sichuan Ordnance, 42(5):123-128,179 (2021).

[2] Qiu Congli, Zhang Taohong, Liu Lin, Liu Jianguo. Research on Evaluation Method of Damaging Effectiveness of Suppressed Artillery Against Exposed Effectives. Fire Control & Command Control, 45(8):181-185 (2020).

[3] Zhang Qingjie, Zhao Jin, Zheng Bin. An Evaluation Method of Fire Damage Effectiveness. Fire Control & Command Control, 42(2): 114-118 (2017).

[4] Wang Xiaoqiang, Wang Lin, Yan Zhengang, Han Zhenfei. Evaluation Method of Damage Helicopter Field Missile Against Typical Armored Target. Journal of Projectiles, Rockets, Missiles and Guidance, 40(5):134-137 (2020).

[5] Feng Xiaowei, Lu Yonggang, Li Yongze. Damage Assessment Method of Aircraft Targets under Blast Wave. Chinese Journal of High Pressure Physics, 33(4):122-126 (2019).

[6] Gao Ruiyuan, Fan Hanyang, Fan Hongming. Research on Damage Effect Assessment Method of Aircraft Targets. Fire Control & Command Control, 44(8):136-140 (2019).

[7] Wang Hua, Xin Tengda, Cui Cunyan, Wang Yan, Zhao Beilei, Zhao Jiguang. Summary of Weapon Damage Assessment Research Methods. Journal of Equipment Academy, 28(1):105-110 (2017).

[8] Hou Qihao, Yao Yiping, Cao Xiang. Battle Damage Assessment of Air-to-ground Attack in Theater-Level Warfare Simulation. Command Control & Simulation, 41(1):54-59 (2019).

[9] Xu Yuxin, Cai Zilei, Wu Wei, Zhao Pengduo, Qiao Zhijun. Current Research and Development of Ammunition Damage Effect Assessment Technology. Transactions of Beijing Institute of Technology, 41(6):569-578 (2021).

[10] Li Feng, Shi Quan, Sun Zheng. Summary of Technical Research on the Evaluation of Target Mutilation. Journal of Sichuan Ordnance, 39(9):69-72 (2018).