



HiFIT

High Frequency Impact Treatment

**THE REVOLUTION FOR WELDED CONSTRUCTIONS:
POST-WELD TREATMENT WITH HiFIT**



**DURABILITY FOR
WELDED CONSTRUCTIONS**



THE HIFIT POST WELD TREATMENT

THE HIFIT PROCESS

High Frequency Impact Treatment is a high-frequency hammering process that considerably increases the operational strength and service life of dynamically loaded, welded steel structures by means of targeted post-treatment of the weld seam transitions.

The HiFIT process can be used universally and requires only a small amount of equipment. Nevertheless, HiFIT provides highly reproducible results and offers the possibility of quality monitoring. The HiFIT method has been scientifically investigated in extensive fatigue tests under numerous boundary conditions. HiFIT has proven to be particularly efficient and effective. In 2016, an independent IIW guideline and in 2019 the DAST guideline 026 emerged, in which HiFIT is counted among the qualified procedures. The HiFIT device was developed by DYNATEC Gesellschaft für CAE und Dynamik mbH.

HiFIT is a High Frequency Hammering process. It is also referred to in German as "HFH" and in English as HFMI, for "High Frequency Mechanical Impact".



Before / after: Thanks to the HiFIT method, the weld fatigue limit is improved by 80% to 100%!



APPLICATIONS

WELD SEAM POST-TREATMENT BY HIGH-FREQUENCY HAMMERING

Welding is the most widely-used process for joining steel. In order to produce a suitable weld seam, many parameters must be taken into account. Loads that occur consistently are tolerated up to a certain level. However, the component fails under the same load if it is applied repeatedly. With so-called cyclic loads, local cracks form that grow over time and lead to failure.

The fatigue of dynamically stressed components and structures causes costs in the billions every year. Often the cause is the notch effect at the weld seam transitions in conjunction with the residual stress caused by welding. The formation of cracks then leads to the failure of the joint. In many cases, they limit the service life of the components and the structures. In addition, there are changes in the conditions of use that could not be taken into account in the design, such as longer operating times, higher loads, and the desire for longer use. In newly-welded constructions, higher-strength steels cannot be used efficiently because the welded joint is often leads to a shorter service life.

Other post weld processes such as grinding, shot peening, or remelting improve fatigue resistance but are more difficult to apply and thus often inefficient.

THE HIFIT PROCESS IS

- efficient
- reproducible
- process reliable

AREAS OF APPLICATION

Steel bridges
 Construction machinery
 Cranes
 Load handling devices
 Wind turbines
 Roller coasters
 and much more.

ADVANTAGES

The advantages of HiFIT weld post-treatment are impressive and lead to an enormous increase in the profitability of the welded constructions. Here is the summary from the REFRESH project:

80 – 100% INCREASE IN WELD SEAM FATIGUE STRENGTH

- The weld seam transition is geometrically rounded out
- The weld transition is plastically deformed and strengthened by local deformations.
- Residual compressive stresses prevent crack formation and crack propagation on the surface.

INCREASING THE WELD SEAM LIFE

Over 1000 tests have proven that the service life is increased several times over (5 to 15 times).

APPLICATION ALSO FOR EXISTING CONSTRUCTIONS

- If existing constructions are renovated in time, there is almost no difference to the service life of newly-treated weld seams. This results in potentially using existing constructions far beyond their previous service life.
- Provided there are no macroscopically visible cracks, HiFIT is a very suitable renovation tool. The increase in weld service life is almost equal to that of new (HiFIT-treated) constructions. If cracks are present, the welded joint must be repaired professionally. Afterwards HiFIT can be applied with high efficiency.

USE OF HIGHER-GRADE STEELS BECOMES ECONOMICALLY VIABLE WITH HIFIT.

The higher the yield strength of the chosen material, the more effective the HiFIT treatment. The FAT class can be increased by up to 8 classes. This enables weight-optimized constructions.

SIMPLEST HANDLING

- Mobile air compressors can also be used outside of production facilities. No additional power source is required.
- The compact design and low weight allow access to hard-to-reach places. The space requirement is only slightly larger than that of a welding torch.
- Robust LED lights in the tip of the unit provide optimal light even under difficult working conditions.

PROCESS RELIABILITY

- The treated area can be checked by visual inspection.
- The treatment mark is measured with a special template.

-  Increase in fatigue strength
-  Increase in weld seam life
-  Increase in service life for new and old constructions
-  Use of higher quality steels
-  Simplest handling
-  Process reliability





Picture left side: Test setup for fatigue tests as part of the REFRESH project at TU Braunschweig (Germany).

EFFECTIVENESS OF THE METHOD

Hammering is so effective because it combines geometrical (rounding), material (strengthening), and stress-related (residual compressive stresses) aspects. The spherical tip of the HiFIT pin creates a deformation and filleting of the weld transition with the defined impulse. The plastic deformation of the surface causes a compressive residual stress of the edge layer, which can be detected up to a depth of 2 mm. The superposition of the introduced residual compressive stresses with the acting loads stops micro-cracks or even prevents them from occurring in the first place. As a result, a uniform continuous hammer trace is visible at the weld seam transition.

DETECTION METHODS

There are several verification methods:

- Nominal stress concept
- Structural stress concept
- Notch stress concept
- 4R method

IIW GUIDELINE FOR HFH TREATMENTS

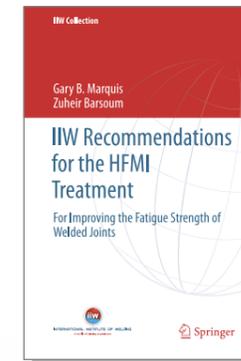
Prof. Gary Marquis, Prof. Zuheir Barsoum and colleagues have carried out numerous studies and publications in this context, which have consistently demonstrated the reliability, effectiveness, and user-friendly aspects of post-weld treatment with HFMI.

During this period, Commission XIII of the International Institute of Welding presented 46 documents demonstrating the improvement of welded constructions.

The IIW Guideline HFH describes the process, its application, and its quality control. This makes it possible to use all the advantages of HiFIT. The guideline shows that the HFMI treatment increases the FAT classes of the weld detail, depending on the yield strength of the material used. In the applicable rules, the slope of the S/N curve for untreated welded joints is specified as $m = 3$. After HFMI treatment, the slope is adjusted to $m = 5$. Flatter S/N curves lead to enormous improvements for the design in terms of weld fatigue strength and weld service life. The guideline also gives informative design examples. Two are shown here.

DAST GUIDELINE 026

Published in 2019, this guideline describes the fatigue design for the application of high-frequency hammering processes. With the help of this guideline, fatigue-stressed components can be designed together with DIN EN 1090-2. HiFIT is one of the three recommended methods.



IIW Guideline and DAST 026

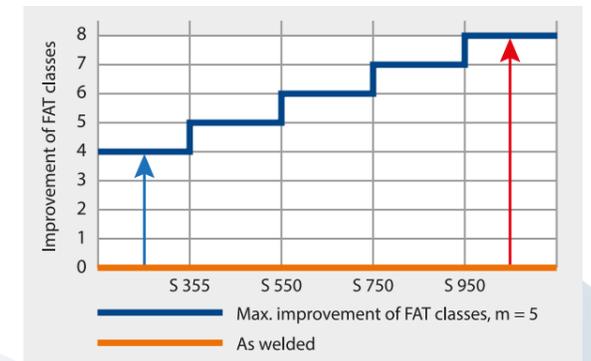


Fig. 1: Max. improvement of FAT classes by HiFIT method (according IIW Guideline for HFMI)

DESIGN EXAMPLES

EXAMPLE 1

A welded joint made of a material $f_y < 355$ MPa is classified in FAT class 63. The maximum load range is 63 MPa at 2×10^6 load cycles (see fig. 2). HiFIT hammering increases the FAT class by 4 steps (see fig. 1, blue arrow) to FAT 100, the permissible load range is now 100 MPa. The increase is approx. 60%! With the same load range (63 MPa), the service life increases from 2 million to 40 million load cycles! That is a factor of 20! (see fig. 2)

EXAMPLE 2

The same welded joint is now made in a material $f_y \geq 950$ MPa. If the construction is not hammered, nothing changes in the load range and the number of maximum load cycles (load range 63 MPa at 2×10^6 load cycles) (see fig. 3). The use of a high-strength steel grade alone does not result in any improvement. The HiFIT treatment now increases the FAT class by 8 steps (see fig. 1, red arrow) from 63 to 160 MPa. The load range is now 160 MPa @ 2 million load cycles. This means an improvement of approx. 150%! With the same load range (63 MPa) the lifetime increases from 2 million to over 100 million load cycles! The component will probably never fail! (see fig. 3).

(For the sake of simplicity, no effects were taken into account in the examples that require possible reductions in the notch case class, such as higher R-values, thickness effects, etc.).

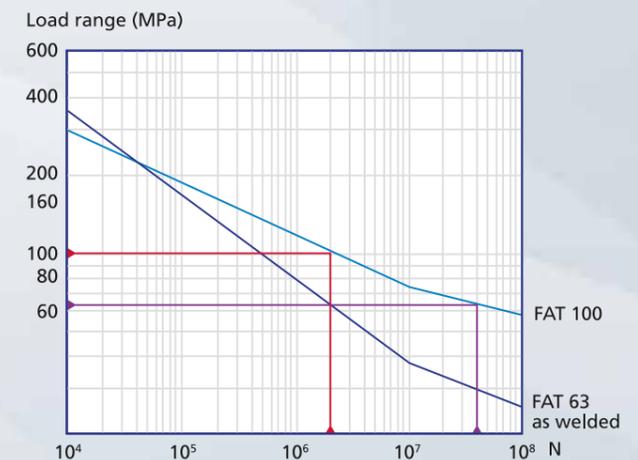


Fig. 2: S-N diagram for $f_y < 355$ MPa; $R \leq 0.15$ (according IIW Guideline for HFMI)

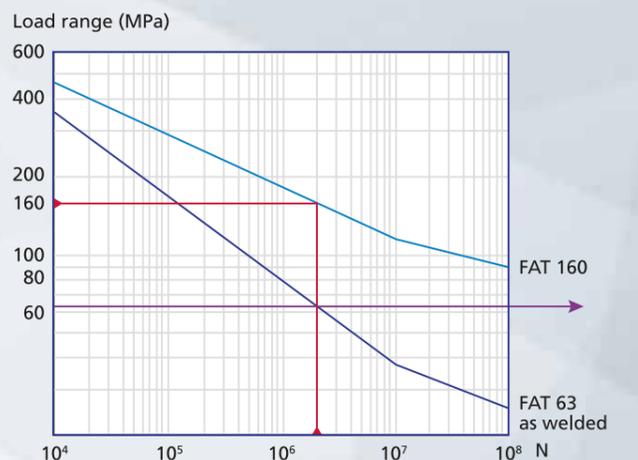


Fig. 3: S-N diagram for $f_y \geq 950$ MPa; $R \leq 0.15$



PREMIUM
improved HiFIT-Unit HFM 21R1



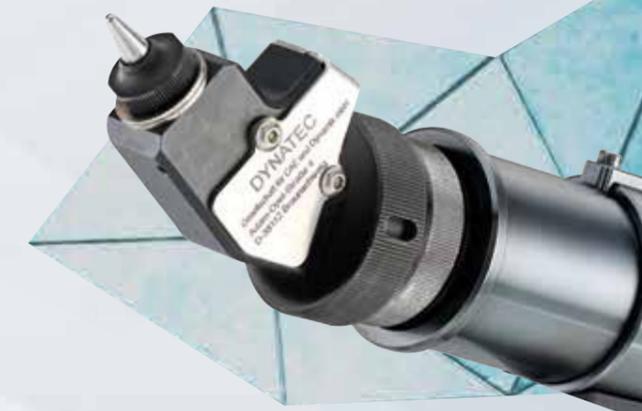
STANDARD
The proven HiFIT unit HFM 12P1 with and without angle head

BASIC
HiFIT type as standard but without electrical components

New accessories:

HiFIT ANGLE HEAD 08-30

Ultimate addition when it comes to treatment under difficult access.



THE HiFIT UNIT

TECHNICAL DATA

	PREMIUM	STANDARD	BASIC
Compressed-air supply:	6 to 8 bar	6 to 8 bar	6 to 8 bar
Power supply (battery):	3,7 V	3,7 V	-
Dimensions (L x W x H):	225 x 60 x 205 mm	288 x 46 x 170 mm	288 x 46 x 170 mm
Weight:	2,3 kg	1,8 kg	1,8 kg
Required airflow rate:	min. 250 l/min	min. 250 l/min	min. 250 l/min
Impact frequency:	180 – 300 Hz	180 – 300 Hz	180 – 300 Hz

(Subject to technical changes)

GENERAL / BASIC INFORMATION

The HiFIT unit is a pneumatically-operated, hand-held unit and only requires a compressed air supply of 6 – 8 bar at the unit and an air flow of at least 250 l/min. No additional electrical power supply or control unit is required. The impact frequency is between 180 Hz and 300 Hz, depending on the intensity setting. The intensity is set with a special adjustment mechanism and not via the supply pressure and is thus adjusted to the material of the parts to be treated. Due to the high impact frequency of up to 300 Hz, components can be finished in the shortest possible processing time. In robot-guided applications, feed rates of over 20 mm/s (120 cm/min) have already been achieved without any problems. The compact HiFIT unit is ideally suited for cramped situations in which a post-weld treatment is to be carried out.

FEATURES

- Robust and compact design for difficult to reach places
- low weight
- powerful
- long service life
- easy to guide
- integrated illumination with excellent luminosity
- easy to replace wear parts
- weld spatter is effortlessly removed at the same time removed
- the working result is highly reproducible



Automated, sensor-guided HiFIT application on a robot

HANDLING

The HiFIT process is controlled by the result achieved. The position of the forming and the achieved penetration depth facilitate the documentation of the measure. The device setting is not determined by abstract presetting but by the result on the workpiece.

EXECUTION

The higher-frequency hammering process, like welding, belongs to the "special processes". Therefore, the requirements for the

- manufacturer
- the company applying the process
- qualification of the personnel

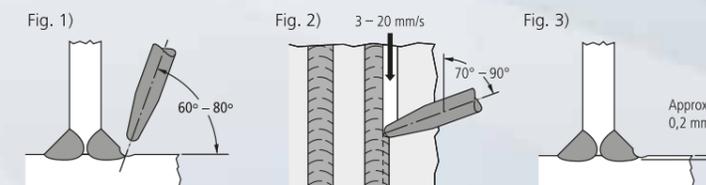
must be fulfilled. The following description cannot replace the training measure of the executing staff.

PROCEDURE:

- The impact intensity of the HiFIT device must be set before the application depending on the material and the air pressure.
- The setting should be checked on a sample and corrected if necessary.

For optimum effectiveness, the unit must be

- between 60° – 80° to the base material (see fig. 1) and 70° – 90° in the feed direction (see fig. 2).



HANDLING

- with a feed speed of 3 – 20 mm/s along the weld seam exactly along the fusion line. Higher speeds are possible. Usually only one pass is necessary.

INSPECTION

Visual inspection:

- The treatment mark must be clearly visible at the defined weld seam.
- The weld transition that can be identified as a line must not be visible.

Measurement test:

- The indentation depth of the treatment trace must be approx. 0.2 mm (see Fig. 3).
- This is checked by means of a template provided (see picture below).





SCOPE OF SERVICES

HiFIT is a holistic solution concept for extending the service life of welded constructions.

SALE

The HiFIT unit and the associated spare parts and accessories are sold worldwide exclusively by HiFIT Vertriebs GmbH.

SPARE PARTS SERVICE

Quick availability of wear and spare parts is a matter of course for us. If a HiFIT unit needs to be repaired or serviced, we will provide you with a replacement unit for this time.

SERVICE

We are also happy to take on projects where the purchase of equipment is not economically viable. Our competent and experienced employees process your welded construction quickly and reliably with our equipment. You have the welding construction, we do the rest.

CONSULTING SERVICE

In cooperation with our colleagues from DYNATEC Gesellschaft für CAE und Dynamik mbH, we offer you the possibility of improving your design with you as well as evaluating various approaches to a solution. Special analysis procedures are available for this purpose.

TRAINING

HiFIT equipment belongs in the hands of experts. In order to work safely, efficiently, and effectively, user training is highly recommended. Although the handling is simple, all users should be informed about the higher frequency hammering process in order to achieve the best possible effect for the welded construction. We also train the quality assurance staff who will eventually have to assess the component for proper handling. Our training covers the following areas:

THEORY

- The residual stress of welded components
- Theory of higher-frequency hammering, mode of action and effectiveness
- Safety instruction
- Prerequisites for a successful HiFIT treatment
- Preparation and execution of the HiFIT treatment
- Quality assurance

PRACTICE

- Handling of the HiFIT device
- Application of the HiFIT device with intensive practice sessions
- Tool maintenance and cleaning of the HiFIT device

APPLICATION EXAMPLES

Visit our homepage www.hifit.de and see the HiFIT hammer in action under the heading "Examples of use". Here you will get a suitable impression of the fast and amazingly easy handling of the HiFIT hammer. HiFIT is suitable for robot-guided applications. System-optimized solutions are available for this. Please also visit our homepage at www.hifit.de. There you can watch explanatory videos on automated machining and other topics.

Since the development and introduction of the HiFIT machine in 2007, the HiFIT machines have been continuously improved. Benefit from our valuable experience and professional staff. This is proven by our impressive references in the fields:

FIELDS OF APPLICATION

- mechanical engineering
- vehicle construction
- construction machinery
- bridge construction
- crane construction
- special applications



THE HIFIT ANGLE ATTACHMENT



THE ALL-ROUND SOLUTION FOR EVERY APPLICATION



The HiFIT angle attachment is used in combination with a HiFIT unit for post-weld treatment in hard-to-reach areas. All HiFIT models are suitable.

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